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The Capco Institute Journal of Financial Transformation

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Financial Technology

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Dear Reader,

Welcome to issue 44 of the Capco Institute Journal of Financial Transformation.

As we near the end of 2016, the political climate continues to present significant challenges for the financial industry. Across Europe, Brexit rumblings continue with implications for the future location and growth of key European financial services hubs. In the United States, the aftermath of the Presidential election promises impacts that could be significant.

More than ever, our industry needs clear understanding of how it can prevail and profit in the face of change. Increasingly, it is clear that technology will offer the key to withstanding change and to driving it. At the intersection of finance and technology is a phenomenon that is reshaping the industry status quo – FinTech – the theme for this edition.

FinTech, Financial Technology, is driving disruption of the traditional value chain, actively shaping financial services and the next generation of digital service offerings. It is reducing process cost and timescales and transforming the customer experience, through ever increasing personalization. In short, FinTech is no longer theory, but is now at the epicenter of disruption.

Our Journal offers analysis of two key areas of FinTech impact: T+2 and blockchain. Technology will play a central part in preparing for shortened settlement cycles beyond T+2 and blockchain is rapidly achieving escape velocity through hard evidence of its applicability to capital markets infrastructure.

As we enter 2017, a radically changing finance industry ecosystem is enabling technology start-ups and long established global players to team and cross-pollinate ideas. As a consequence, they can deliver transformational technologies and customer experiences, in shorter time scales. It is credible to believe that FinTech will assume an even greater role in the year ahead – the more we understand, challenge, leverage, and integrate financial technologies, the more we can achieve, at greater pace. That's why the theme of this Journal is so timely and important.

As ever, we hope you enjoy the quality of the expertise and opinion on offer and that you will want to continue the debate with us.

With best wishes for the year ahead.

Lance Levy
CEO, Capco

Financial Technology: From Enabler to Greatest Challenge

The relationship between the financial services industry and technology has never been as straightforward as many seem to think. It is true that advances in technology have enabled financial institutions to improve on many of the services they provide to clients. This includes online banking or even simple ATMs, as well as process management: from instituting risk management models to streamlining trade execution, settlement, and clearance.

However, while a large number of benefits come with each new generation of technology, at every cross-section the threat of new entrants has increased. These threats initially peaked during the Internet boom of the late 1990s, when Internet companies were expected to disintermediate the established players and provide the kinds of services, and pricing, that customers really wanted. The crash of the Internet stocks brought about an end to this threat, and in fact increased the value of advice.

The threat posed by newcomers didn't completely disappear, and many of their protagonists were just waiting for the next opportunity to enter the market. It was a long time coming, but it finally arrived a couple of years ago with the advent of FinTech, the all-encompassing term that means different things to different people. FinTech is expected to revolutionize the world of banking and finance. Insofar as possible, it will extract businesses that should no longer be undertaken by established financial institutions to improve the efficiency of processes and the service provided to end-users.

No doubt many are concerned about the advent of FinTec, especially since a large number of the firms in this field have already had over a decade to learn from the likes of PayPal and other online payment and peer-to-peer systems. Even worse, many are founded by experienced bankers, not ambitious young technologists. However, as bankers started taking a deeper look at the environment they realized that many of the technologies developed by the newcomers, such as blockchain, could be very beneficial to their own institutions. Many are experimenting with these new technologies and even collaborating with the newcomers to improve their own operations and services.

Because of the level of attention on FinTech and its application by established players to transform our industry, this edition of the Journal is dedicated to financial technology. The articles look at how new technologies are helping improve the way trades are undertaken and settled. They also examine how these developments might result in transformational change across a number of areas within financial services, such as personal and corporate lending. However, unlike other publications covering this topic, our focus is not on the dreams of the FinTech newcomers, but on what is genuinely taking place.

We hope that you enjoy reading this edition of the Journal and that you continue to support us by submitting your best ideas to this publication.

On behalf of the Board of Editors,

Shahin Shojai

Operational

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Time is Risk: Shortening the U.S. Trade Settlement Cycle

John Abel – Executive Director, Settlement and Asset Servicing Strategy, Product Management Group, DTCC

If all goes according to plan, on September 5, 2017, the U.S. financial services industry will achieve "T+2" – that is, reduce the securities settlement cycle from the current "trade date plus three days" to "trade date plus two days" – a huge accomplishment expected to yield important benefits almost immediately after implementation.

Not only will the move to T+2 reduce operational, systemic, and counterparty risk, limit the pro-cyclicality that can happen during times of volatility, lower liquidity needs, and enable capital to be freed up faster for reinvestment, it will also align the U.S. with other T+2 settlement markets across the globe.

The enormous, multi-year undertaking to shorten the U.S. settlement cycle was not driven by regulatory mandate but rather was led and coordinated by market participants. This initiative demonstrates the industry's ongoing commitment to continual improvements in the operation of our capital markets.

SETTLEMENT CYCLE RISK

Investors often cite the axiom "time is money" to convey the concept of opportunity cost. For those in the business of post-trade processing – especially those of us at The Depository Trust & Clearing Corporation (DTCC), which processes trillions of dollars of securities transactions for the U.S. financial industry each trading day – time is risk.

In other words, the longer it takes after a trade is executed to exchange funds for securities – that is, to settle a trade between counterparties – the greater the risk that securities firms and investors can be hit by losses in the intervening period and become unable to finalize and pay for their transactions.

To manage the risks related to unsettled trades, DTCC imposes a number of risk mitigants, not the least of which is the collection of margin or clearing fund. The amount of margin or clearing fund required from each clearing member of DTCC is, in part, a measure of that member's portfolio of unsettled trades. The greater the settlement cycle of those unsettled trades, the more trades are contained in the portfolio, which in turn results in a higher amount of margin required from that member.

Therefore, in the realm of post-trade settlement, not only can we say, "time is risk" but also "risk is money."

MITIGATING RISK

Over the decades, markets have experienced numerous periods of stress and volatility, and market turmoil will inevitably occur in the future. In some cases, share prices can plummet in a matter of seconds and trading volumes can soar.

It is this history, and inevitability, of market turbulence that spurred market participants in the U.S. several years ago to begin exploring ways to mitigate counterparty risk. The logical solution, market participants agreed, was to shorten the current T+3 settlement cycle, and thus narrow the window for post-trade processing.

However, turning this seemingly simple proposal into operational reality has demanded several years of deliberate and synchronized effort by thousands of parties – broker-dealers, banks, financial services firms, service providers, industry associations, exchanges, DTCC, and regulators.

The march toward T+2 began in earnest two years ago, and during that time the industry has made steady progress. DTCC, in close collaboration with industry organizations and trade associations such as the Securities Industry and Financial Markets Association (SIFMA), representing the sell-side, and the Investment Company Institute (ICI), for the buy-side, has assembled a number of industry working groups to drive the project forward.

Along the way these groups have kept regulators well informed. Because a shorter settlement cycle will improve market efficiency and safety and enhance protection for investors, a number of regulators, including the U.S Securities and Exchange Commission (SEC), have endorsed the change.

STARTING AT T+1

Many people are surprised to learn that in the 1920s, financial transactions in the U.S. were cleared and settled in just one day, even though the processes were completely manual. But trades back then were relatively simple, and volume was comparatively low.

Fast-forward to the early 1960s, when trading volumes and the complexity of the instruments grew exponentially: so much physical paper was exchanging hands that the SEC was forced to close the exchanges every Wednesday and increase the time permitted between trade execution and settlement date. Eventually the markets moved to a T+5 cycle.

T+5, or "trade date plus five days," meant a trade executed on Monday (trade date) would not be finalized until the following Monday. On that date, payment would be exchanged and ownership of the asset transferred. For the buyer of a security, payment would be received by the investor's brokerage firm no later than five business days after the trade was executed; for the seller, the securities certificate would be delivered to the brokerage firm no later than five business days after the transaction.

This extended settlement cycle was needed because transactions processing hadn't changed much since the 1920s: investors would not pay until they had received physical delivery of their certificates. In fact, before electronic record-keeping, virtually all securities transactions were conducted on paper and Wall Street employed hundreds of messengers who raced through the streets every afternoon after market closing, delivering certificates to brokers who bought stocks and bonds and returning with checks to pay for them.

This paperwork crunch spurred the industry to begin dematerializing securities – that is, replacing physical certificates with book-entry securities. Dematerialization relieved pressure on the post-trade system but did not erase the risks inherent in the multi-day settlement cycle.

PROGRESS: FROM T+5 TO T+3

On Monday, October 19, 1987 – known now as "Black Monday" – stock markets around the world crashed. In a cascading domino effect, global markets lost an unprecedented amount of value in a very short time. In the U.S., this volatility resulted in the largest one-day percentage decline in the Dow Jones Industrial Average (DJIA).

In the months following the crash, regulators in the U.S. researched possible root causes and worked to overhaul trade-clearing protocols, establish new rules, and reduce credit, market, and liquidity risk. Their consensus solution: to shorten the trade lifecycle and lower the window of time for settlement.

In 1995, the SEC adopted Rule 15c6-1 under the Securities Exchange Act of 1934, which resulted in moving from T+5 to T+3 settlement for a number of asset classes, lessening the inventory of unsettled trades at any one time and strengthening the U.S. financial markets to better withstand unpredictable times of stress.

Today, securities in the U.S. clear and settle over different periods of time through different clearinghouses and depositories that are determined by the category of security, but the majority of U.S. exchange-listed securities are cleared and settled in three business days. This customary three-day settlement date applies to most security transactions, including stocks and corporate and municipal bonds. Government securities and stock options settle on the next business day following the trade, and trades in some asset classes, like commercial paper (CP), settle on the same day.

THE T+2 PROPOSAL

After the unprecedented market events of the 2007-2008 global financial crisis, many new regulations were enacted with the intent of restoring stability and confidence and mitigating systemic risk. During this time, Europe, as part of Target2 for Securities, proposed harmonizing the European settlement cycles at T+2.

While the new regulations did a lot to reduce risk across the financial services industry, none of them addressed shortening the settlement cycle. As a result, the industry launched its own effort to explore the feasibility of such a change. In 2012, DTCC commissioned the Boston Consulting Group (BCG) to conduct an independent study to analyze the costs, benefits, opportunities, and challenges of moving to T+1 or T+2 by streamlining processes in the U.S. market.

BCG presented the following cost-benefit analysis and conclusions in October 2012:

- The initial cost of moving from T+3 to a T+2 settlement cycle in the U.S. would be an estimated U.S.$550 mln.
- Shortening the cycle to T+2 would yield recurrent annual savings of approximately U.S.$195 mln, including a reduction in the clearing fund requirements of National Securities Clearing Corporation (NSCC) and participant capital funding costs by an estimated U.S.$25 mln – meaning the initial investment would be recovered in only 2 ½ to 3 ½ years.
- The industry cost of getting to T+1 would be approximately U.S.$1.8 bln.
- Annual industry operational cost savings for T+1 would be between U.S.$175 mln and U.S.$370 mln, depending on the adoption of defined enhancements, and T+1 would reduce the clearing fund requirements of NSCC and participant capital funding costs by an estimated U.S.$35 mln.

THREE OPTIONS

Once BCG's cost-benefit analysis was complete, the industry began the task of deciding whether to move to T+1 or T+2 or remain at T+3. Many industry participants had strong opinions on each of the three options, but consensus was essential for a decision that would have such wide-ranging impacts on the financial system.

After much debate, the industry agreed that a move to T+2 was feasible in a reasonable amount of time and would produce significant benefits. But the hardest work lay ahead: designing and carrying out an implementation plan.

In collaboration with market participants, DTCC in late 2014 formed an Industry Steering Committee to provide overall direction and guidance to the T+2 project. The committee comprises representatives from many of the major trade associations and each of the impacted market segments and is co-chaired by representatives from SIFMA and ICI. The Steering Committee in turn created a T+2 Industry Working Group responsible for evaluating the changes that needed to occur to support the move to T+2.

DEFINING THE REQUIREMENTS

The Steering Committee quickly moved into action, publishing in early 2015 a requirements document that outlined the industry-level changes required to support the move to T+2. The committee also identified the rules that would need to be modified.

In a letter to SEC Chair Mary Jo White, the Steering Committee delineated these changes and formally requested SEC support for the T+2 project. Chair White responded in the fall of 2015, indicating her support for T+2, asking other impacted regulators and self-regulated organizations (SROs) to develop plans to update their own rule sets, and calling on the committee to develop a detailed implementation plan.

The Steering Committee released its plan in December. Committee members have used the document, "T+2 Industry Implementation Playbook," to help guide them through their development process.

PLANNING FOR TESTING AND IMPLEMENTATION

With the roadmap in place, the industry turned its attention to testing and implementation. The project's implementation timeline includes a robust and rigorous industry-wide testing plan in 2017 to ensure firms have the adequate resources in place to mitigate operational and implementation risk.

An industry group was convened to architect how testing would be conducted and to start developing detailed test plans. The testing group focused its attention on industry infrastructures: the test design involves the Bats and NASDAQ equity exchanges, the Options Clearing Corporation (OCC) and DTCC's Omgeo, NSCC, and Depository Trust Company (DTC) subsidiaries.

To support the testing effort, DTCC will establish a new test environment designed to allow members to test T+2 and T+3 functionality at the same time. Testing via both DTCC environments is scheduled to begin in early 2017.

DTCC, with the help of the Industry T+2 Testing Group, also published two documents to help members prepare for testing. The first, issued in March 2016, gives a high-level overview of how testing will be conducted while the second document, released in July, provides more detail on the testing facilities, including instructions for accessing the testing systems and suggested testing scenarios.

As testing proceeds and the target go-live date approaches, Steering Committee members will take on the added role of industry "Command Center," monitoring Industry readiness and coordinating implementation tasks. Ultimately, the Steering Committee will be instrumental in helping decide if the industry is ready to move to T+2 in September 2017.

CRITICAL REGULATORY CHANGES

In 1995, firms succeeded in moving from T+5 to T+3 by compressing the post-trade processing timeframe; this achievement required modest improvements in automation and technology. To get to T+2, however, will impact the entire trade processing workflow, and require changes to dependent processes and regulations.

Both buy-side and sell-side firms will have to adapt to make T+2 work. Some firms have proven to be ready and flexible, with a business model that can adjust well to an accelerated transaction processing timetable; others, especially those that still rely on manual processes, have been challenged to accommodate this shorter settlement cycle. And while some technology challenges remain to be addressed, the next wave of changes required to migrate to T+2 involve processes, behavior (business and client), and especially regulations.

The Municipal Securities Rulemaking Board (MSRB), an industry SRO overseeing broker-dealers that buy, sell, and underwrite municipal securities, was the first regulatory body to publish – in December 2015 – updated rule changes to facilitate shortening the U.S. settlement cycle to two days. The Financial Industry Regulatory Authority (FINRA) was the second, releasing its T+2 rule changes in March 2016. FINRA is an independent, not-for-profit organization authorized by the U.S. Congress to protect U.S. investors.

NASDAQ has also issued T+2 rule changes for its members, and just recently, in late September 2016, the SEC also took action to propose a rule change to facilitate the move to a two-date settlement cycle. For those who were still "waiting to see" what would happen next, the proposed rule change from the SEC provides the regulatory certainty necessary to help the financial services industry achieve its goal of moving to a two-day settlement cycle by September 2017.

HARMONIZING GLOBAL CYCLES

In our increasingly borderless and integrated global markets, systems need to be constructed with the flexibility to accommodate trade settlement cycles in other markets and time zones. Many European Union (E.U.) member states moved to T+2 on October 6, 2014.

Several markets in the Asia/Pacific region are already settling in T+2 or T+1; other major markets – including Canada, Singapore, Japan and Australia – still settle on the T+3 cycle, but are looking to reduce it. In fact, the Canadian market has announced its plans to move to T+2 on September 5, 2017, coinciding with the U.S market's move.

Harmonization decreases complexity and costs for firms with significant cross-border activity. Currently, 65% of the world's 10 largest exchanges based on market capitalization settle on a T+3 cycle; when the U.S. moves to T+2, only 13% of those exchanges will remain at T+3. The change to T+2 will align the U.S. markets with this global trend, and will bolster certainty, safety, and soundness in capital markets around the world.

STILL ON THE TO-DO LIST

Although the industry has made tremendous progress in its move to T+2, some work remains ahead of implementation.

- **Rule changes:** the Industry Steering Committee continues to meet regularly with all the impacted regulators and SROs. Some have not yet published their rule changes for the new settlement cycle, but all are committed to making their required changes well in advance of September 2017.
- **Development:** with testing set to begin in early 2017, internal development work should be complete and internally tested by the end of 2016. Most firms are on target to participate in testing, having identified their required changes early this year. For industry participants that are farther behind in their preparations, Industry Steering Committee members are conducting robust outreach to ensure everyone is aware of T+2 and its implementation schedule and to address any issues industry members may be encountering.
- **Testing:** a substantial amount of industry testing material has been produced. Now industry participants must devote resources to understanding the suggested test scenarios and putting in place all the connections required to support industry testing.

WHAT TO EXPECT AT IMPLEMENTATION

A lot of thought went into the selection of the implementation date, September 5, 2017. The fifth of September is not typically a high-volume day (no option expirations or index rebalancing) nor a standard corporate action date (the 1st or 15th of a month), and in 2017, it falls conveniently after the long Labor Day weekend, giving participants an extra day to migrate and test code changes.

The move to T+2 will start to impact certain corporate action processing long before the T+2 go-live. Dividend ex-dates are generally announced well in advance of payment dates and payment dates that happen after the T+2 implementation date will have shorter ex-date windows.

The move to T+2 will also require a "double settlement day" (trades on the last day of T+3 and the first day of T+2 will settle on the same day), a situation that is not uncommon in the U.S. but still something participants need to plan for.

NO SIMPLE SOLUTION

The costs and benefits of further shortening the settlement cycle have been a subject of discussion among regulators and industry participants since the implementation of T+3. At the height of the dot-com boom in the late 1990s, when technology firms explored the potential for almost-instantaneous transactions, the financial industry considered T+1 and even T+0.

Recently the industry has even been exploring the use of distributed ledger or blockchain technologies as a tool to facilitate further shortening of the U.S trade settlement cycle.

While DTCC is currently focused on helping move the U.S. financial industry from the T+3 settlement cycle to T+2, we are already two steps beyond that. DTCC's trade-capture and downstream systems have been for many years aligned to support expedited settlement, which occurs on a daily basis for parties that request it. DTCC's Universal Trade Capture (UTC) service, for example, gives clients the flexibility to submit exchange trades for clearance and settlement on either a regular (T+3), shortened (T+0, T+1, T+2), or extended settlement basis across all U.S. markets.

What is the feasibility of moving the U.S. to T+1 or even T+0? Many in the industry cite Blockchain and other new technologies as the solution to the complexities that have, until now, impeded a shift to T+1 or T+0. However, an important reality is not widely recognized: current technology may not be the barrier to a shorter settlement cycle. Much of the core trading, clearing, and settlement processes already support T+1 and T+0. Rather, it is many of the business practices in place across the financial services industry that makes a move so difficult.

While the newest technologies will undoubtedly have a future role in post trade processing, it is unlikely they will be a "silver bullet" for a further shortening of the settlement cycle in an industry like financial services, where the diversity of players, proprietary systems, and cultures is so wide. Making a future transition to a T+1 or T+0 standard settlement cycle would be challenging and require extensive work by the industry – regardless of the technology used. In the meantime, the change to T+2 will mitigate risk significantly for U.S. investors and is an achievement the industry should be proud of.

Where Do We Go From Here? Preparing for Shortened Settlement Cycles Beyond T+2

Steven Halliwell – Partner, Capco
Michael Martinen – Managing Principal, Capco
Julia Simmons – Senior Consultant, Capco

In 2017, the U.S. and Canada will be breaking their 20-year T+3 settlement cycle in what will be the greatest reform since 1995's migration from T+5 to T+3. The move to T+2 settlement is intended to harmonize with global markets already on a T+2 settlement cycle, reduce risk and exposure, enhance market liquidity, and increase efficiencies. Both countries will be moving approximately 100 products in scope across equities, corporate and municipal bonds, and unit investment trusts (UIT) to a T+2 settlement in the third quarter of 2017. These products combined account for approximately U.S.$950 billion in daily clearing.[1] To prepare for T+2, the Depository Trust & Clearing Corporation (DTCC) is planning to conduct industry testing in Q1-2017 ahead of the proposed go-live date of September 5, 2017.

BACKGROUND ON T+2

In response to the trending global migration to T+2, DTCC commissioned a study in 2012 to investigate the cost, benefits, and challenges of the U.S. and Canada migrating from a T+3 settlement cycle to T+2. Their findings confirmed the benefits of increased operational efficiencies and reduced risk (see Table 1).

Following these findings, an Industry Steering Committee (ISC) and Industry Working Group (IWG), along with Sub-Working Groups (SWGs), were set up to determine the feasibility, impacts, and benefits of shortening the settlement cycle to T+2. SWGs consisted of over 400 industry experts from U.S. financial service organizations, and were tasked with providing guidance and oversight in the migration by determining the required changes to various business processes. A subsequent whitepaper published by the ISC in June 2015 provided a timeline leading up to Q3-2017 go-live, complete with milestones and high level requirements for trade processing, asset servicing, documentation, and regulatory guidance for the industry players on target for migration.

With a reduced settlement window comes a number of material changes to the settlement process that may pose technological and operational challenges. Firms will need to accelerate a number of activities, such as liquidity management, FX processing, and margin call calculations while also reducing the time allowed to settle transactions. This will ultimately impact buy-side

1 Average daily volumes taken from DTCC's 2014 annual report

Increased efficiencies	Enhanced liquidity	Reduced risk and exposure	Global harmonization
Cost savings related to reduced funding requirements and more efficient capital utilization	**Reduced liquidity needs for NSCC and Lower CCP margin requirement, reduced procyclicality, and CCP liquidity need**	**Reduction in operational risk and operational incidents, and improvement in operational controls. Decline in counterparty risk and exposure**	**Alignment of settlement cycles across geographies**
• Improvements to STP via new investments in technology • Transition to institutional same day trade matching • Cost savings related to reduced funding requirements and more efficient capital utilization	• Satisfying client demand for shortened settlement cycles (i.e., large purchases, tax implications for retail clients) • Decrease in pro-cyclicality during periods of high market stress and volatility • Reduction in liquidity needs for NSCC and increase in capital availability for member firms • Decline in potential systemic impact of stressed market events due to lower CCP margin requirement and liquidity, and reduced pro-cyclicality	• Reduction in operational risk and operational incidents, and improvement in operational controls • Decline in buy-side counterparty exposure • Reduction in broker-to-broker counterparty risk • Reduced retail investor risk for a potential broker-dealer failure (pre-settlement of trade)	• Settlement cycle consistency across geographies

Table 1 – Benefits of T+2 Migration

and sell-side firms, custodians, utilities, and vendor providers. Additionally, the required technology changes and their operational impact may be underestimated by firms, while legacy infrastructure may struggle to meet the revised needs and timeframes. Firms' bandwidth for financial and operational resources may become strained in the face of ongoing parallel initiatives related to capital planning and stress testing enhancements, data quality, data lineage, and associated analytics and reporting, as well as new mandates or emphasis related to consumer protection and cyber security.

In order to be successful in the T+2 migration and its planned milestones by Q3-2017, all impacted firms will ideally have performed an impact assessment of their current processes vis-à-vis the proposed processes in order to identify the areas that will require investments, and will have developed size and scope estimates for the effort required to support T+2. In parallel, firms should be building out an appropriate change management and communication program to initiate and implement successful change both internally and with trading counterparties to ultimately ensure readiness. A key part of this program is a detailed testing strategy to coordinate and execute testing with internal systems, customers, and industry infrastructures and utilities.

Significant effort and investment will be required from the various member firms to comply with the Q3-2017 implementation deadline, and maintaining a forward-looking perspective on shortened settlement cycles will expedite a firm's competitiveness in the race toward straight-through-processing (STP) and market efficiency.

STEPS TO IMPLEMENTATION DATE – Q3-2017

The transformation to a shortened settlement cycle will have a significant impact on firms across all stages of the trade lifecycle. Prepared firms will have already assessed the level of impact and developed a testing strategy to reduce operational risk, as well as committed to the suggested timeline to decrease the likelihood of falling behind the scheduled milestones ahead of the implementation date.

Market participants should aim to complete internal builds by Q3-2016 and internal testing by Q1-2017. Industry-wide testing with DTCC for market participants will commence in early 2017 to meet the go-live date of September 5, 2017.

With the current industry-wide uncertainty around the specific requirements for readiness, many market participants are placing added emphasis on the testing phase. To adequately prepare for this increased focus on internal and industry-facing testing, it is critical for each organization to produce a comprehensive testing strategy and determine an effective approach for testing facilitation and execution.

"WHERE DO WE GO FROM HERE? CHAOS OR COMMUNITY?" IMPLEMENTATION AND BEYOND...

Borrowing the title of the last written work penned by Nobel Peace Prize Laureate and social justice advocate Martin Luther King Jr., firms looking ahead may ask whether they should prepare for an even shorter settlement cycle as a path to a truly ideal state. The concept of STP, following the move to T+2 at the end of 2017, is a realistic possibility.

In 2013, DTCC commissioned an analysis on the potential for shortening the settlement cycle. As part of this analysis, they partnered with SIFMA (Securities Industry & Financial Markets Association) to determine the feasibility of both T+2 and T+1. Based on the cost/benefit analysis, T+1 was deemed impractical. At U.S.$550 mln, the investment necessary for T+2 was estimated to be a third of the cost of implementing changes to accommodate a shorter settlement of T+1 (U.S.$1.8 bln).[2]

T+1 is dependent on robust real time processing and STP to be successful, but current institutional dependencies on batch processing and legacy systems pose an obstacle. In addition, due to time zone differences, foreign investors (especially those in the Asia Pacific region) would have unreasonably limited time to remediate any issues prior to the settlement date, posing a radical disruption to the market. The burden of these obstacles cannot be underestimated in considering a firm's path to a shortened settlement cycle. However, the steps firms are taking to migrate to a T+2 settlement cycle will set them up for success towards even more efficient settlement processes. New investments in technology will help firms improve operational efficiencies toward STP. Earlier matching will provide the advantage of identifying and reconciling problem trades earlier on in the settlement process. This will ultimately result in reduced funding requirements and more efficient capital utilization.

The decision to move to a T+2 as opposed to an even shorter settlement cycle was made prior to the advent of the advanced distributed ledger insight we now have today. This is a concept now being seriously addressed in the markets. DTCC's commitment to use Repurchase Agreements as a proof of concept and the exploration of Australian and Japanese stock exchanges in developing blockchain operational architecture demonstrate how current distributed ledger concepts are being applied with the intent of improving operational efficiencies in the markets.

Much of the decision to move to a shortened settlement cycle was motivated by the intent of increasing processing speeds while reducing settlement risk, and the concept of a distributed ledger accomplishes this while freeing up even more counterparty capital that would normally be reserved for trade settlement. Providing a clear picture of counterparty assets and liabilities via a shared network free from extraneous human processes may lead the path to a safer market less dependent on centralized clearing agents burdened with risk and responsibilities that can delay the settlement process, while also leading the way to more of an agency model that the Dodd Frank regulations are promoting.

However, for the industry to convert to STP and transparent markets through a centralized distributed ledger, mass market acceptance and participation is key. Digitally transforming financial instruments into computer programs known as "smart contracts" with encrypted contract terms is a key component of automated settlement. While this would reduce costs by centralizing or even removing operational processes, it would also require industry agreement on acceptable standards and how to sync these standard contracts securely across industry infrastructure. Successful industry adoption of this technology will be challenging given the size of the trading and clearing market. From an individual perspective, the way that impacted firms establish program management to coordinate internally and with the DTCC in industry testing will establish a path to success in managing future changes to even shorter settlement cycles.

Some of the required changes needed to accommodate same-day settlement that will challenge institutions may be more achievable as part of the "intermediary" move to T+2. As a first step, firms can conduct a thorough analysis on the process behavior supporting T+1 settlement as it already exists today for certain products (such as options, a selection of mutual funds, and some fixed income products). Conversely, developing shortened settlement cycle procedures using a prototype of asset classes that have low cleared volume may be a good starting point as there is little cleared infrastructure in place and, therefore, more opportunities to create a foundation from scratch. For these product types (or any products) to move closer to T+0, effort must be especially focused around the FX market and stock loan (to facilitate automation in securities recall and processing of corporate actions), real time netting of positions, and faster guarantees from clearing houses.

Once T+2 is implemented, these changes will be considered small milestones that set the stage for an additional shortening of the settlement cycle in sync with the advances towards STP. This will also align with the generational shift in management, where the millennial generation, accustomed to fast technology advances, will have more influence on decisions and controls.

2 http://www.dtcc.com/~/media/Files/Downloads/WhitePapers/CBA_BCG_Shortening_the_Settlement_Cycle_October2012.pdf

CONCLUSION

As industry participants strive towards the requirements for T+2 readiness and beyond, the need to strategically assess current and future plans for settlement efficiently is paramount. Increased pressure on operating costs and the recent commoditization of core functions within banking operations has only accelerated the discussion topic "Where do we go from here?" Mindful preparation for shortened settlement that aligns with the industry inclination toward STP can distinguish an impacted institution from competitors, and set it up for success beyond the T+2 implementation timeline.

Seeing the Forest for the Trees – The Taming of Big Data

Sanjay Sidhwani – SVP - Data Analytics, Synchrony Financial

The quandary of big data in recent years is similar to looking at a rainforest. There is so much of it, it is not an issue of seeing where and what it is, it is the fear of not seeing the forest for the trees. A rainforest has so many important ecosystems and tiny elements that may be hugely important, similar to big data. Many businesses have the challenge of seeing the thousands of types of data and identifying which elements of the data are important, and what to do about those elements.

At Synchrony Financial, we are a consumer finance company with a deep heritage in the retail sector. As such, we have a very large quantity of data, from several sources, which could include stock keeping unit (SKU) data on purchase transactions, marketing touchpoints, channel interactions, payment history, etc. Our data is not only credit card data normally gathered from an issuer perspective, it is also data we gather to provide value to a retailer. As such, our data tools must be top notch – both scalable and flexible, in order to provide greater insights. And with the accumulation of data comes the responsibility of safeguarding the storage, access, and transfer of data, and ensuring the proper usage of key data elements. The security and protection of private customer data also needs to be a top priority.

In our experience, one strategy that is very helpful in identifying the important elements of the data available is data visualization. Data visualization tools can be crucial in identifying important factors, trends, and outliers in data. After these important factors are uncovered, the question becomes how to create programs that address the important items that can positively impact a business. This can be done with agile methodology. We have found that programs that use agile methodology (created using the partnership of IT and analytics) can have a large impact on business success, as described in more detail below.

DATA VISUALIZATION – TRANSLATING DATA INTO ACTIONABLE INSIGHTS

Data visualization can be a powerful tool to quickly observe trends and take action on the data observed. These tools make it easier for leaders across all disciplines to access key data without having to dig through thousands of data points and charts. It is more helpful to let the data tell a story through visual formats. These can include heat maps, infographics, and a combination

of pictures and graphs. Four types of tools are especially helpful:

1. **Executive dashboards:** by translating data into a visual format, dashboards help users more clearly identify business insights, trends, and performance gaps, and to more easily share the results across the company. Once the dashboards are created, business leaders and analysts know what to look for and can easily interpret the data presented.
2. **Pictures and graphs:** using pictures and graphs to portray data can sometimes be the differentiating factor in observing an insight that could otherwise go unnoticed. Paying attention to outliers and unique patterns can help highlight potential opportunities and areas of improvement.
3. **Sensitivity modeling:** data visualization software can be used as an interactive tool for running sensitivity models on a particular variable. For instance, the impact of price changes on profitability, or the impact of weather changes on sales, can be assessed. Once these models are put into place, the risk of uncertainty can be reduced.
4. **Heat maps:** another example of an effective way to display data is heat mapping. Individual values are represented in a tabular or graphical format in various colors to denote a range of performance from low to high. This visual representation allows users to hone in on where performance is strong, and where opportunities exist.

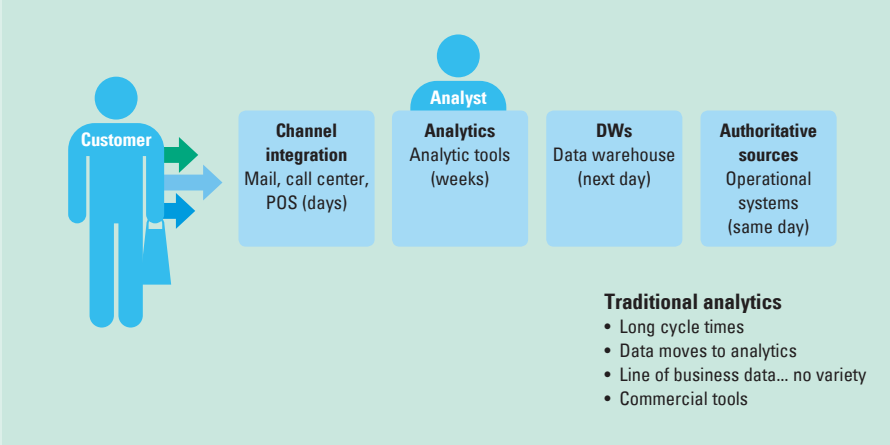
Data visualization tools are valuable to help organizations simplify large amounts of information into insights through a visual format. Letting the numbers tell the story often results in bringing insights to life and communicating them across the organization. And now that they see the data and understand its implications, the organization can impact change by using the agile process, as described below.

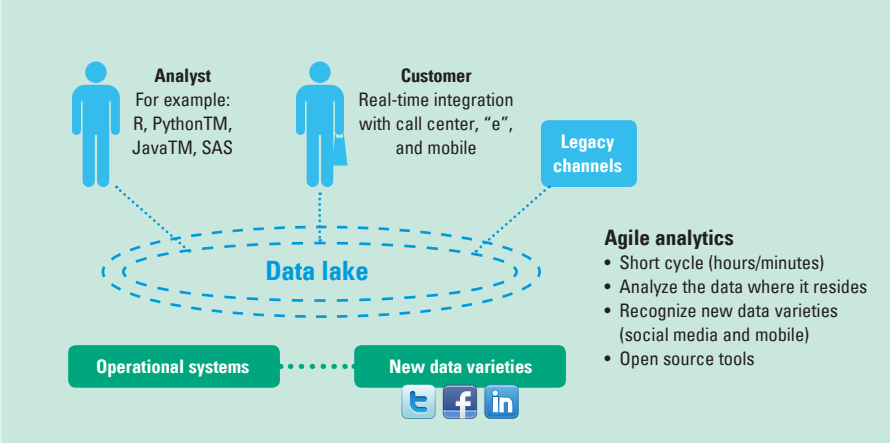
THE AGILE PROCESS – USING THE PARTNERSHIP OF IT AND ANALYTICS TO IMPACT CHANGE

Creating a partnership between the analytics and IT teams is extremely important. Working together with a common vision and goal, the two departments can use the agile process to effectively produce workable solutions quickly and efficiently. By simplifying and speeding up the process of analyzing big data, companies are able to improve their marketing efforts and build better customer relationships.

Let us take a look at the traditional data model. When a customer engages with a business, whether to make a purchase, pay a bill, or make an inquiry, the interaction and the resulting data are recorded in one of its operational systems. Traditionally, analytics processes have been separated from operational systems, because these processes demand considerable resources that can slow down the system and impact business. Consequently, businesses move data to a data warehouse platform so analysts can study the information without impacting the operational system. These commercial tools can be difficult to use and result in long cycle times.

The agile approach can solve these issues. With an agile process, the IT and analytics teams can work together toward a common business goal from the start. The analytics team works with IT to develop insights from big data and then use the data in a timely





manner – yielding improved customer personalization and more impactful marketing programs.

The agile process also allows for:

1. **Minimization of data movement:** the goal of the process is to engage the customer at the moment of decision. To react with that kind of speed, you need a platform that minimizes the number of times you move the data. A data lake provides a scalable platform where data is ingested from the operational system very quickly, without moving to the analytics environment.
2. **Availability of the tools:** open source tools are simpler and more affordable. Analysts run the data in real time and leverage tools in parallel to perform analysis.
3. **Shorter cycle times:** performing analytics at scale requires a platform that is integrated with customer channels. This moves analytics closer to the customer, resulting in shorter cycle times and greater meaningful engagement.

Once an agile infrastructure is in place, there are essential steps for helping to harness the power of that data. First, make the implication of the data clear – not just to the analysts, but also to key stakeholders. A data platform can be used for both "push" and "pull" reporting on key business metrics so performance of your business can be tracked.

Data in today's world is ubiquitous. Some is clear and definable – like a specific tree in a forest. Others are more unstructured and free flowing – the eco-system and co-relationships, for instance. In order to interpret the data and have an impact, data visualization can be used to see specific issues or trends, and the agile process can be used to provide the solutions and immediacy required to provide the solutions.

Development of Distributed Ledger Technology and a First Operational Risk Assessment[1]

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Abstract
Distributed ledger technology (DLT) is a new approach, first implemented by Bitcoin, the basic features of which are the elimination of any intermediaries in peer-to-peer (financial) transactions and the replacement of "trust" by a game theoretical approach of consensus among all participants who agree "to play a repeated game." The promises of DLT are more efficiency (by removal of redundant intermediaries), more resilience against attacks or manipulation (through multiple replicas and chaining of transactions with mutual references), and more security for asset owners (by making an original transaction technically unalterable/immutable). Nevertheless, the so-called "TheDAO hack" in June 2016 made clear that a complex DLT-based software system is vulnerable against manipulation if one has in-depth understanding of the code and its errors. In this paper, a first risk assessment of the new technology of "smart contracts" is made and the question about "code is law" is discussed. While the basic concept of Bitcoin does not raise new types of operational risk, the current technology of "smart contracts" has a fundamental flaw due to the combination of complex software (with inherent probability of errors and software aging) on one side and the static/non-changeable, approach of blockchain on the other. Static/non-changeable contracts can be used for short-term "one-time" interactions, but any long-term relationship has to be governed by common standards, legislative frameworks, and operational risk management – together providing the possibility for adoption to real world changes. These findings are in line with the recent development of DLT to distributed "private" ledgers and to central share services utilities for, for example, post-trading processing for a closed group of participants with pre-identified roles and responsibilities.

1 We would like to thank the following for their comments on the previous drafts of this article: Helmut Siekmann (Goethe University Frankfurt, IMFS), Christian Janze (Goethe University Frankfurt, E-FinanceLab), Ritva Tikkanen (Justus Liebig University Gießen), Roman Beck (IT University of Copenhagen), Thomas Schönfeld (PwC, Frankfurt), and especially thank Wolfgang König (Goethe University Frankfurt, Managing Director House of Finance) for the organization of the E-FinanceLab Fall Conference 2016 on "Blockchain: technology, legal and regulation, and application in the finance realm." The views expressed in this article are those of the authors and are in no way representative of the views of their employers.

INTRODUCTION: FROM VULNERABILITIES OF THE BITCOIN ECOSYSTEM TO THE "THEDAO HACK"

DLT, also known as "blockchain," has been capturing interest since the publication of Ali et al.'s (2014) article in the Bank of England Quarterly Bulletin. Even though we are still coming to grips with this new technology, reading through the many analyses of DLT it is not clear whether it is a solution looking for a problem or whether many genuinely believe that it will solve all problems of the previous decades. In reality, while DLT is an innovative jigsaw puzzle of existing pieces and can be a catalyst for new applications and solutions, as with all new technologies one has to assess its operational risk ramifications – especially if used for critical financial infrastructures.

One frequently used narrative suggests that "blockchain" provides a cryptographically secured, immutable, and resilient registry of transactions concerning rights of ownership. In other words, it would be a real "golden source" without any need of regulated and/or trusted intermediaries. However, a number of incidents with Bitcoin, such as insolvency of the Bitcoin exchange Mt. Gox, criminal Ponzi schemes such as the pyramid scheme "MMM," or the fraud after a "security breach" at the Bitcoin exchange Bitfinex [Baldwin and Poon (2016)] make one question the validity of such claims. The Bitfinex case is quite informative since it notified clients that it will "share" the losses across its entire user community irrespective of whether a client was actually affected and where and in which currency their funds were [Finextra (2016)].

Those rather well known types of risks in the context of virtual currencies have already been widely covered elsewhere [EBA (2014)] and will not be covered in this article. Our decision to exclude them was also related to the fact that (i) they all followed well-known modus operandi and (ii) they happened outside of Bitcoin blockchain and in the "real" world of fiat money. Nevertheless, it should be mentioned that the European Commission published a number of proposals for amendments to the current directive on fighting money laundering, financial crime, and terrorist financing as a result (July 5, 2016). These included proposals to bring virtual currency custodian wallet providers (CWPs) and virtual currency exchange platforms (VCEPs) within the scope of the directive as obliged entities. The European Banking Authority (EBA) commented on that proposal and according to EBA's point of view: "There is a risk that consumers and business partners of VCEPs and CWPs may not be aware that the imposition of requirements on VCEPs and CWPs for AML/CFT purposes does not include or imply consumer protection or prudential safeguards, including capital requirements, calculation of own funds, safeguarding requirements, separation of client accounts, and the extensive authorization liability" [EBA (2016)].

All the aforementioned issues concerning asset protection are aligned with the current regulatory initiatives and do not depend per se on new technologies. However, the so-called "TheDAO hack" exhibited unique characteristics, since someone was able to exploit vulnerabilities in the underlying blockchain technology and the "smart contract" extension. TheDAO is a so called "decentralized autonomous organization," which is an organization with no people and based only on codes representing contractual relationships. In June 2016, an "attacker" was able to take the equivalent of more than U.S.$40 mln from TheDAO. The fact that it happened within the rather complex technical system raises many questions, such as: was it a "software error" or a (intended, but hidden) feature of the written code? Was it a "game" in a closed environment with peculiar rules or some criminal action against applicable laws?

In this paper, the first risk assessment of DLT and "smart contracts" is presented. It is aligned with the framework of Aven (2011), with the main focus being (i) the assumptions and limitations of the technology, (ii) its usability and reliability, and (iii) our understanding and communications about it.

As DLT – and even more so smart contracts – is a rather new technology, this paper will cover it in a step-by-step format. This approach includes an analysis of the fundamental limitations of DLT and provides a risk assessment of the extension to smart contracts. It also scrutinizes the sociological aspects of new technology, where an entire community wants to believe in the benefit of a new technology without considering its theoretical limitations and without applying the common standards of operational risk management.

THE ROAD TO THE BLOCKCHAIN – POSSIBILITIES AND IMPOSSIBILITIES IN A NUTSHELL

As DLT deals, by definition, with transactions concerning rights of ownership (something "ledgers" are designed for), its foundation is a distributed network of participants that want to execute transactions, i.e., transfer of rights of ownership in a network of linked computer systems ("nodes"). Of course, the classic example is the Internet, in which the end-users never know which other nodes forward their messages, which routes are taken, and which nodes dynamically join or exit the network.

For more than 40 years, distributed computer systems have been studied, and the possibilities and impossibilities of the technology assessed [Attiya and Ellen (2014)]. Those fundamental impossibilities and conditional possibilities of distributed computing have to be the first step in risk assessment, as they provide the theoretical foundation and, consequently, the fundamental framework, in which the technology works.

- The "two generals problem" (or "byzantine generals problem" [Akkoyunlu et al. (1975)]): the impossibility of synchronizing two or more participants via a network of unknown (i.e., trustless) nodes in a finite time. It has to be remarked that this concerns the synchronization in general and not the exchange of secure, encrypted messages.
- "Byzantine fault tolerance" [Lamport et al. (1982)]: possibility of resilience of a network of known nodes against failure or manipulation based on a voting consensus with a pre-defined fall back option in case of timeout (typically handed over to an external third-party, such as human pilots in case the triple autopilot system cannot "agree").
- Impossibility of distributed consensus [Fischer et al. (1985)]: impossibility of a consensus in a distributed network with the conditions that (i) one process/node may fail and (ii) the consensus should be reached in finite time.
- Proof of work concept [Dwork and Naor (1992)]: basis for a probabilistic approach to select a neutral referee in a network of ex-ante trustless nodes. As with any voting in an open, anonymous, computer network for a quorum consensus can be compromised by a single faulty entity simulating multiple identities ["Sybil Attack," see Douceur (2002)]. Proof of work provides a "game theoretical" solution for consensus under some conditions.
- Introduction of the concept of "software aging" [Parnas (1994)]: understanding that software systems always have errors, which result from the interaction of the different layers, but especially that software can "get old" and will develop "unexpected" errors over time due to the complexity of the technology and the interaction of multiple layers.
- CAP-theorem [Brewer (2000 and 2012)]: impossibility in any networked shared-data system that one can achieve all three desirable properties: consistency, availability, and partition tolerance (= fault tolerance, if part of the system fails).
- Development of "secure hash algorithm 2" [SHA-2 (2001)]: SHA-2 – as an example of hash functions – is a set of injective hash "one-way" functions designed by the National Security Agency (NSA) and published by the U.S. National Institute of Standards and Technology (NIST) for the cryptographic protection of sensitive information against manipulation, especially when stored in or transmitted via open networks.
- Double spending problem [and its prevention; see Osipkov et al. (2007) and Hoepman (2008)]: possibilities to prevent so called "double spending" as a failure mode of electronic cash schemes, as any electronic message, i.e., a bit string of 0's and 1's, can be copied and sent to manifold different beneficiaries in a network.

With this set of possibilities and impossibilities in distributed computing, the scene was set at the end of the last decade for practical solutions to solve the challenge of "electronic cash" in distributed computer systems under certain limitations (see Figure 1 for illustration of an approach to distinguish DLT from general database management systems).

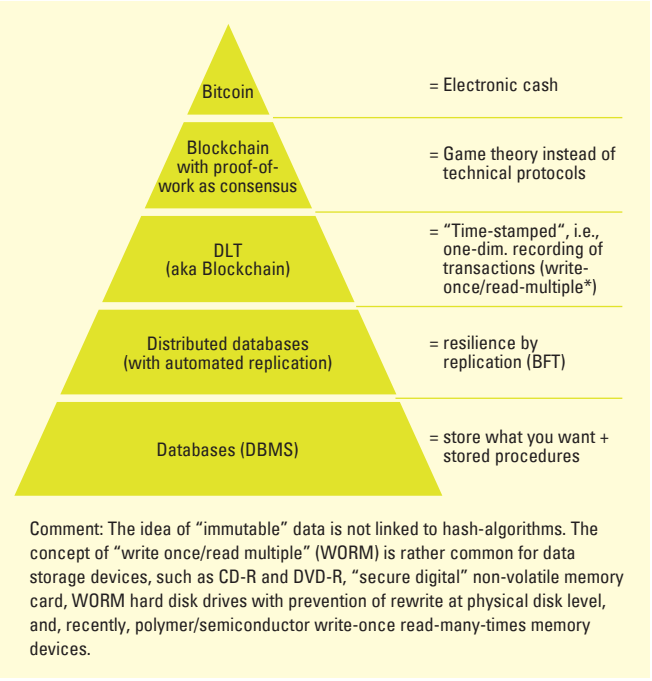


Figure 1 – A schematic approach to distinguish DLT and established database management systems

THE CONCEPT OF BITCOIN – GAME THEORY AND EVENTUAL CONSISTENCY

The quest for "electronic cash" had the goal of creating a substitute for real cash in an open distributed computer network of equal peers without any intermediaries that could provide "trust."

In 2008, Satoshi Nakamoto (2008; a pseudonym) published a paper entitled "Bitcoin: a peer-to-peer electronic cash system," [see, for example, Ali et al. (2014)]. It is well known that this first implementation of DLT is inefficient, expensive, rather slow, and without sufficient capacity as compared with established payment system networks.

Nevertheless, Bitcoin was a solution to the question above – but with clear assumptions. The innovation of Bitcoin was thinking out-of-the-box and, consequently, a game theoretical solution with a "proof-of-work" to select one neutral referee instead of "democratic" voting protocols [Decker and Wattenhofer (2013)]. The game had

a set number of parameters that had to be accepted by all. First, all "players" have to pledge their stakes (investment in computer resources = cost for hardware, energy consumption, etc.). Second, the "proof-of-work" is the virtual equivalent to tossing the dice (to decide who may start a game). Third, the winner will be the referee for the next block with a fixed sequence of new transactions and is rewarded with a combination of newly created Bitcoins (i.e., seigniorage) and transaction fees (paid by the users).

With this set of parameters, Bitcoin is a repeated game and a closed-loop system, in which (i) transactions and (ii) incentives for the winners are closely linked together by the same "electronic cash," i.e., Bitcoins. Any transfer of the concept of Bitcoin to other rights of ownership – e.g., property – raises the question of how to include an incentive in the model without the need of external intermediaries.

This game theoretical approach comes with the principle disadvantage of the probability of two referees – at different nodes in an extended network with latency – creating different new blocks with different transactions in parallel at the same time ("fork"). In the Bitcoin blockchain, such forks happen with approximately 1.7% of all new blocks [Decker and Wattenhofer (2013)]. This – temporary – inconsistency will be automatically restored later by the blockchain algorithm, but this "interregnum" can last up to one hour, as recorded in mid-2015. When a system trades "social" trust for an "algorithmic" substitution, one has to recap Niklas Luhmann's statement that "trust is a mechanism to reduce complexity" [Luhmann (1968)]. The substitution comes with a price tag (inefficiency) and downsides (limited finality).

While The Economist [2015] called the blockchain technology "The trust machine," the implementation of Bitcoin only has an "eventual consistency" [Decker and Wattenhofer (2013)]. Eventual consistency is neither new in distributed computing [Lindsay et al. (1980) and Vogels (2009)] nor unknown in banking [Wattenhofer (2016)]. Imagine an ATM in offline mode, i.e., the ATM is able to perform transactions but is temporarily not connected with the bank's host. A customer can make a withdrawal with their debit card using an offline transaction limit assigned to the card. A transaction could be completed even if there are insufficient funds on the account, as long as the offline transaction limit is sufficient for the stand-alone withdrawal. At a later point in time, when the ATM is back in the network again, a reconciliation process has to align the bank's ledger.

A second example is the SEPA Direct Debit Core Scheme (SDD), which grants payers a "no-questions-asked" refund right within eight weeks. A merchant debiting a payer's account by a SDD transaction has to wait for those eight weeks to reach finality or, respectively, has to calculate and manage the probability of a client's recall (i.e., credit risk).

Synopsis I

Independent of the inefficiency of Bitcoin, the probabilistic approach is no source of operational risk. Of course, eventual consistency implies a typical credit risk exposure for the beneficiary, which is rather common in payments. Nevertheless, insight into the game theoretical approach of the concept, the nature of a blockchain as a repeated game, and careful consideration of the assumptions (e.g., of an egalitarian – non-hierarchical – peer-to-peer network) are required.

THE REALITY OF THE BITCOIN ECOSYSTEM – TOWARDS CENTRALIZATION

The actual Bitcoin ecosystem has diverged from the original concept. Firstly, typical "users" of Bitcoin are not keen to operate a part of a payment infrastructure, but want to make Bitcoin payments in a simple and convenient way. Those customers use Bitcoin wallet providers and have to rely on them as "custodians" for their funds in the bitcoin ecosystem [Leinonen (2016)]. Secondly, the costly proof-of-work (with huge electrical power consumption and large investments in dedicated hardware) represents a negative externality with socially inefficient excess of resources.

This paves the way for a centralization of the Bitcoin ecosystems with an onion-like structure between a core of dedicated nodes (mining pools) and typical users. The current Bitcoin ecosystem is starting to resemble informal money transfer systems, typically "Hawala" systems [Passas (2006)], which work with a clearing of information messages between agents in different countries (hawaladar), typically based on some kinsmanship.

In addition, the centralization of computing resources within so-called mining pools opens the door to the possibility of a "51% attack," i.e., one attacker with more than 50% of the computational "hashing" power in the ecosystem could calculate proof-of-work solutions in sequence faster than the rest of the network and rewrite the transaction history [Decker and Wattenhoffer (2013)]. One mining pool, Ghash.io, reached 50% of the bitcoin network's hashing power in June 2014 [Cawrey (2014)]. The centralization can also be found in other blockchain systems, e.g., in Ethereum, with one mining entity ("dwarfpool") dominating the system with circa 48% of the resources in March 2016 [Dienelt (2016)]. For a deeper discussion, the reader is referred to the literature [Sirer and Eyal (2013), Eyal (2014), Hearn (2016)].

The onion-like ecosystem is antagonistic to the original egalitarian peer-to-peer concept. As Joichi "Joi" Ito wrote in a blog [Ito (2015)]: "there is currently centralization in the form of mining pools and core development, [but] the protocol is fundamentally designed to need decentralization to function at all."

It's worth noting that there is a current trend to centralized systems – especially in payments (see Figure 2). Different from the traditional model of the payments industry with interoperable banks and central banks, the initial steps were towards (i) centralized business platforms, such as PayPal, which internalize all accounts (buyers' and sellers' accounts) and (ii) the Bitcoin approach of a fully decentralized electronic cash system. But the more recent developments are even closer to the concept of central "utilities," be they provided by a central bank (central bank digital currency) [Broadbent (2016), Barrdear and Kumhof (2016) and Reuters (2016)], Bitcoin service providers, distributed "private" ledgers (see below), or even bank-owned initiatives, such as the SWIFT global payments innovation initiative [SWIFT (2016)].

Synopsis II

The derivation from the original concept and the development of an internal hierarchical structure centralization (instead of a peer-to-peer network) lead to the development of typical single points of failure. These vulnerabilities raise fundamental questions about the liabilities of such centralized structures – especially if not regulated as in the case of Bitcoin – to open issues concerning the risk of a "51% attacks." As long as these questions are unanswered, Bitcoin will be in legal limbo but, nonetheless, has its niche as the current usage shows. Nevertheless, the trend to centralization, as opposed to regulated interoperable intermediaries, makes one wonder about where the responsibility for an end-to-end operational risk management sits and who is liable in case of errors?

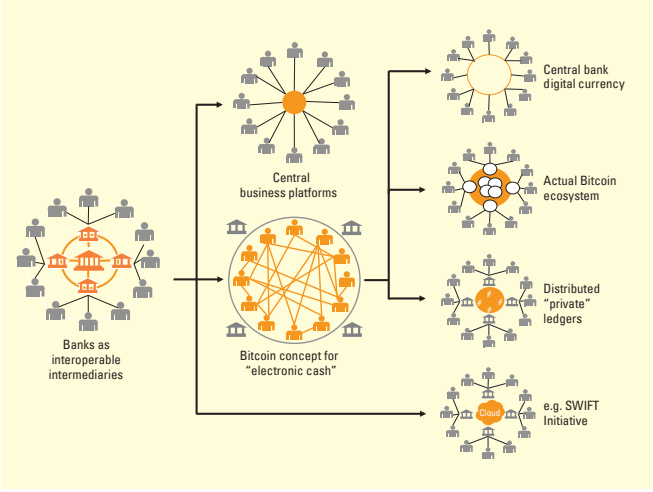


Figure 2 – A taxonomy of the current trends in banking

THE EXTENSION OF THE DLT – SMART CONTRACTS AND CODE IS LAW

The Bitcoin blockchain is a flat, sequential, one-dimensional database for the transfers of rights of ownership: Alice does not send Bitcoins to Bob's account, but broadcasts a message that a certain amount of Bitcoins can be claimed by anybody who has Bob's credentials (i.e., his cryptographic key). If someone is able to access Bob's keys, then this person has the access to Bob's assets. However, the Bitcoin blockchain has a rudimentary status concept and distinguishes "transactions" between unspent (available to be claimed) and spent (already claimed).

The so called "smart contracts" are an extension to this recordkeeping of ownership. In the current discussion, smart contracts are often described as self-executing/self-enforceable software representing contractual relations, which are stored immutably on the blockchain and, consequently, do not require any third party to create trust. In principle, a smart contract is a terminus technicus for a program code that is executed in a dedicated blockchain environment, such as Ethereum [Dienelt (2016)]. A smart contract does not do anything by itself, but has to be triggered by an external transaction and can in return create new transactions which interact with other code on the blockchain [Greenspan (2016)]. Consequently, smart contracts are similar to stored procedures in traditional database management systems. Nevertheless, every computer program is simply a sequence of zeros and ones that performs calculations and store results on a tape or "on a chain." This fundamental concept was

Code of the "smart contract"
+
Interaction with other code (i.e. other smart contracts)*
+
Compiler and virtual machine (needed to execute the code)
+
Potentially supporting services such as storage and messaging
+
Software of the blockchain itself
+
Operating systems (OS) on the distributed computers to run the local replica of the blockchain
+
Network protocol stack for the communication via the internet

* For example, in the "Ethereum" blockchain smart contract, code is written in an own programming language "Solidity," which has – per definition – the ability to provide interaction of contracts. Such intended interactions can lead to unintended reactions depending on the sequence of transactions, combination of parameters, etc.

Figure 3 – Combination of a blockchain with user provided, executable code in a complex environment of multiple layers

already described by Alan Turing as the so-called "Turing Machine" in 1937 [Turing (1936)] and has been the basis for computers since then (with the exception of parallel computing).

The crucial issue is the combination of a blockchain with user provided, executable code in a complex environment of multiple layers (Figure 3). If a blockchain contains some validated smart contracts and this code produces a result, then even 1 + 1 = 3 is "right" according to the rule of DLT. This is "code is law" according to Lessig (2000), who feared that the technical rules of cyberspace could overwrite contractual and legal norms.

Experience demonstrates that any non-trivial software has errors, and even well tested software packages typically show "low-frequency/high-severity" errors – sometimes after many years. According to Dienelt (2016), there could be approximately "100 bugs per 1,000 lines of code" in the Ethereum blockchain software. This is a new development that started 2014, and, consequently, errors are rather natural.

It would be not be fair to compare a relatively nascent technology with developments over decades, but any human-written software displays errors as inevitable companions. As a benchmark, Dienelt (2016) states that Microsoft has "one bug per 2,000 lines of code." From an operational risk perspective errors are likely to happen, hence what matters is the probability of occurrence. However, DLT will treat validated "unalterable" code as "final" and consequently excludes any probability for errors over time.

TheDAO" is the decentralized autonomous organization, an organization with the objective to implement the theoretical concept that a firm is just a set of contracts and can be set up with any people or tangible assets. It is comparable to an investor-directed venture capital fund and was crowdfunded in May 2016. The funding was stored as digital tokens in the Ethereum blockchain and the value as of 21 May 2016 was more than U.S.$150 mln provided by 11,000+ investors [Siegel (2016)]. By Saturday, 18th June, "somebody" managed to drain more than the equivalent of U.S.$50 mln into a copied "child DAO," from which they can access and forward the value after 28 days (which was the initial funding period of "TheDAO" defined in the original code). Soon after this event, there were discussions among experts about what the event actually was. Sirer (2016) stated: "I'm not even sure that this qualifies as a hack. To label something as a hack or a bug or unwanted behavior, we need to have a specification of the wanted behavior. […] The hacker read the fine print better than most, better than the developers themselves. [...] the only consistent response is to call it a job well done."

To solve this problem, Vitalik Buterin, a co-founder of the public Ethereum blockchain platform [Buterin (2016)], proposed some possible actions to "correct" the whole system according to the original "intention." But any kind of ex-post changes to the "unalterable" blockchain or any "retroactive" update to the software environment fundamentally contradicts the basic concept that blockchain is immutable and that "smart contracts" – once validated – are final and cannot be reverted or manipulated. Nevertheless, in July 2016, the Ethereum "community" – represented by the decentralized holders of the virtual currency "Ether" – voted with 97% of Ethers for a so-called hard fork solution (i.e., massive manipulation of the basic software program of the blockchain).

They supported Buterin's statement about "differences between implementation and intent." A hard fork of the Ethereum blockchain was implemented on July 20, which moved all funds of "TheDAO" to a new smart contract, returned the U.S.$40 mln and let the original owners withdraw the funds [del Castillo (2016)].

This development has two direct implications:

- The innovation of Bitcoin was the implementation of the game theoretical proof-of-work to achieve consensus and to avoid the problem that any voting in a decentralized computer network can easily be compromised with a Sybil attack. Consequently, any external "voting" – instead of the internal consensus algorithm – to solve the "TheDAO" hack is a contradictio in adiecto.
- Compared to the ex-ante rule "code is law," concepts like "original intention" open the doors for some ex-post interpretations. In the best case scenario, this leads to a teleological approach, and in the worst case, this is the road to arbitrariness.

Like any other human-made technology, smart contracts are never hundred percent secure and safe. The consequence is that (i) fault tolerance requires reliability software engineering [Lyu (1996)] and (ii) a big red "stop button" is needed in case of emergency. Thus, there has to be some intermediary outside a DLT system with a "license to kill" if some program code is going mad [Marino and Juels (2016]. Unfortunately, this is the end of immutable code in the sense of a golden record without any intermediaries.

Synopsis III

From the point of view of operational risk management, the combination of a complex software system with inevitable errors and software aging on the one side and the basic rule of "code is law" on the other has a fundamental flaw. While the concept of Bitcoin works for the right of ownership of "electronic cash" with immutable records, the extension of DLT to smart contracts depends on immutable (i.e., pre-defined and unalterable) courses of actions in a dynamic relationship between contract partners. There is an implicit assumption far from being realistic that the individual programs and the whole complex software environment are completely free of errors in the

current and any future scenario. However, "TheDAO" hack is a textbook example of a high-severity/low-frequency operational risk event, which shows up rather infrequently and is not detectable in short-term tests or in production with a limited runtime.

BOUNDED RATIONALITY AND INCOMPLETE CONTRACTS

The concept of "bounded rationality," which was developed by Simon (1957, 1991) and Gigerenzer and Selten (2002), underlines the idea that any decisions made by individuals (including decisions on how to write a software code) are made with limited rationality. In reality, not all information is available, there are cognitive limitations, or the time available to make decisions is simply not sufficient for a full calculation – whether made by people or computers. While classical economics deals with a normative concept of perfect information and pure knowledge of all possible options, "bounded rationality" is a positive approach to real situations and dynamical, path-dependent ways into the future. Consequently, any non-trivial contract cannot include ex-ante all situations to be managed later on.

The paradigm of "incomplete contracts" was further developed by Grossman and Hart (1986), Hart and Moore (1990), and Hart (1995). They argue that real-world contracts cannot specify what is to be known for every possible future contingency. In parallel to a contractual relationship, a governance model is required to solve future frictions and intermediaries can take on the role of advisors or mediators [Williamson (1979, 1985, 2002)].

As the rationality of humans – and machines – is limited, contracts will reveal incompleteness generically. The (normative) vision of a frictionless and ex-ante ultimately defined contractual relationship has to be replaced by the understanding of the actual (positive) reality of errors and inconsistencies. To remedy incompleteness, governance models are required for a balance between archaic enforcement of rules and the danger of moral hazard when freedom of contract comes without future responsibility.

It is also worth noting that – due to bounded rationality – nobody can be sure that a technical protocol like Bitcoin is free of errors and of (hidden) backdoors. No blockchain will ever be a 100% "truth machine" – and more complex protocols such as platforms for smart contracts are vulnerable to the probability of errors.

Synopsis IV
If for a split-second, one assumed that a software could be free of any errors and translate a legal contract into a code 1:1, without any problems in semantics and syntax, this code would reflect the static situation at the time of codifying. Within a closed system this may be applicable as in any game people play with fixed rules. However, dynamic contractual relationships between economic agents in reality – with contracts on paper or in the blockchain – have to take bounded rationality and incomplete contracts into account. Governance models with intermediaries and/or principle-based jurisdiction are needed to remedy those limitations, especially in the dynamic development of the real world over time. In general, human-made technology cannot overcome the limitation of bounded rationality. Mechanisms are required to solve the problem of "incompleteness" in any contractual requirement. Courts, arbitrators or, respectively, banks are essential to do this job.

DISTRIBUTED "PRIVATE" LEDGERS (DPLT)

Based on DLT in general, DPLTs were developed to facilitate decentralized recordkeeping in closed groups with ex-ante identified and registered participants, i.e., there has to be some central registry or trust center. This confronts the distributed "public" ledgers with anonymous and "trustless" peers in a distributed computer network without any intermediaries. Within such a "trusted" network, a substitute for trust between "trustless" participants is no longer required. The main remaining issue of distributed "public" ledger is byzantine fault tolerance (BFT) [Lamport et al. (1982), Castro and Liskov (1999), Castro and Liskov (2002) and Correiam et al. (2011)].

BFT ensures that a number of distributed computer systems running identical processes still achieve a consensus about the correct result in the case of one or more faulty systems. Typical examples are high-availability systems, such as autopilots in airplanes, which are working redundantly to enforce either a "majority vote" or a fallback to a predefined default case. For bookkeeping, there are no calculations to be aligned, but ledgers are to be kept synchronized. Consequently, automated reconciliation between different (internal and external) systems would be very welcome. DPLT promises to achieve this objective without the need for any manual reconciliation [Bott and Milkau (2016)]. While BFT is well established for calculation processes, the use of BFT for inter-ledger reconciliation is new and has to be compared with other technologies for the same purpose in terms of price, speed, quality, and resilience.

Synopsis V
DPLT is an option to implement byzantine fault tolerance and, consequently, enhance cyber resilience against attacks and technical outages in the financial services community as part of an active operational risk management in the first line of defense. However, it has to be clear that no technology can provide measures against financial default of counterparties or against systemic risk. To solve these issues, traditional intermediaries such as CLS for settlement

risk in FX transactions (originally Continuous Linked Settlement) or central counterparties for derivative transactions [CCPs, see, for example, Haar (2016)] are required. Those intermediaries will still play a structural role, although DLT can improve cyber resilience due to generic BFT, but with the costs of redundancy, on a technical level.

THE REDEFINITION OF SMART CONTRACTS AND SHARED SERVICE UTILITIES FOR SECURITIES

One proposed application for DPLT is securities post-trading (clearing, settlement, recordkeeping, reporting) with a redefined kind of smart contracts. As Clack et al. (2016) recently proposed: "A smart contract is an agreement whose execution is both automatable and enforceable. Automatable by computer, although some parts may require human input and control. Enforceable by either legal enforcement of rights and obligations or tamper-proof execution." The authors also proposed to implement a common language to support smart contract templates as a link between securities in the real world governed by securities legislation and smart securities on blockchain.

However, dematerialized securities, such as German "Girosammelverwahrung" [Bafin (2016)], already fulfill this definition. Any dematerialized security, which is recorded centrally at an issuer CSD, is in agreement with this definition, especially when one looks at automated dividend or interest payments, which will be initiated automatically from the issuer CSD when a data feed triggers this corporate action. Alternatively, smart contracts could automatically initiate coupon or dividend payments if triggered externally at the appropriate times with the appropriate data feed, avoiding (i) manual processes and (ii) guaranteeing that the issuer cannot default. This, however, requires that the funds are in escrow within the system (which is a strong assumption and can possibly jeopardize the business case) and that the external trigger is synchronized across the whole network.

A recent study of the Japan Exchange Group [Santo et al. (2016)] about the applicability of DLT to capital market infrastructure came to the conclusion that: "Non-deterministic factors such as time-trigger events, listening to outside data feed, or random number generation might prevent consensus because such processes are actually a challenge for smart contracts running each node to reach exactly the same result."

In addition to the technical challenge of synchronization in a decentralized network, Santo et al. pointed out the requirements for a solution to DvP (delivery versus payment) in fiat money and for payment finality with a proposed interconnection between DLT and traditional payment systems. A recent initiative by UBS [Kelly (2016)] is trying to define one possible solution with "utility settlement coin" (USC), which is described as a kind of central bank digital currency (CBDC) (see Figure 1).

However, this would be a step back when compared with TARGET2-Securities (T2S) with the integration of cash and securities settlement on one platform. DLT requires that funds for all future dividend or coupon payments and repayments are put "in escrow" in the blockchain ex-ante. Alternatively, the funds are not available on the blockchain, which brings us back to traditional reconciliation of payments along a chain of different accounting systems (i.e., the blockchain/USC/central bank money). Finally, the coding of payments from embedded options or covenants can be challenging, as a few hundred pages of contractual conditions need to be "translated" into a programming language [Sebastián (2015)].

Those fundamental problems of DLT in an extended network will help to create a centralized facility shared by a group of users, as already illustrated in Figure 1 (right side). The R3 consortium recently published a concept about a shared services utility "Concord" based on an underlying "Corda" technology for transactions in financial assets [Brown (2016)] with a "blockchain-inspired" vision about one central hub for securities transactions. This idea can be appreciated, as the (missing) standardization is an old challenge in the securities and derivatives markets. Most market participants would be keen for a more pragmatic standardisation (independently from who will set the standard), as any global standard helps to reduce costs and avoid manual corrections in back-office operations.

In addition to standardization, any long-term investment in securities requires asset protection, which has to be reflected in laws and regulation. One can discuss different options [Paech (2016a, b)], but any solution has to be in the triangle between (i) a fully decentralized system with a "tangible" corpus and coupon sheet in the hand of the investor, (ii) a central "digital" registrar with the issuer, or (iii) a system of "dematerialized" securities with bilateral contractual relationship along the whole custody chain. Nonetheless, responsibilities and obligations have to be covered by law [Sams (2015)].

Finally, even the law cannot prevent default and insolvency (but can define the framework to resolve such cases). The probability of such events requires an appropriate risk management to define risk appetite, mitigate risk exposure and manage risk events.

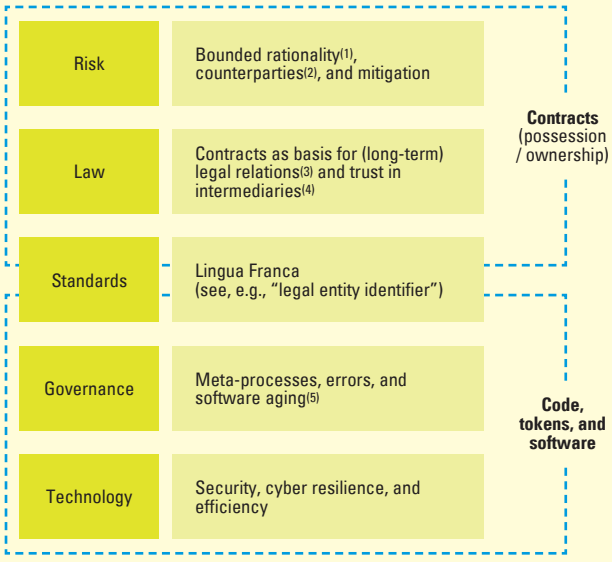
If one talks to lawyers about these questions, they will expect a precise question in legal terms. For example, in common law countries, possession is a property right in itself, while in civil law countries possession is not a right in itself but the simple fact of who has control over the asset. But control, including an entry in a database,

does not mean that there is any legal title to the object in civil law. Ask a lawyer how that relates to a data record on the blockchain in a global – cross-border/cross-jurisdiction – environment.

Short-term realistic use cases for DLT can be in those niches, in which the processing is mainly paper-based and automated reconciliation could provide an increase in efficiency and a reduction in operational risk potential (e.g., with centralized contract templates, automated checks, and instant exchange of information between the parties). Furthermore, private secondary markets for non-listed securities could be a starting point (in competition with traditional share registers) [Drummond (2016)].

Synopsis VI

Considering the current hype surrounding blockchain (for example, in terms of its potential applications in securities markets), the largest risk maybe the risk of overestimating DLT as the philosopher's stone. Especially, when used in distributed "private" ledgers (i.e., closed groups with permissioned/identified participants), the benefit of DLT comes from BFT, which provides cyber resilience plus efficiency enhancement due to automated reconciliation. However, additional layers (Figure 4) are needed to deliver a complete framework, such as for post-trade securities operations from a legal and regulatory perspective.



(1) see Grossman and Hart (1986), Hart and Moore (1990), and Hart (1995); (2) see Haar (2016); (3) see Lessig (2000); (4) see Luhmann (1968); (5) see Parnas (1994)

Figure 4 – A simplified illustration of the different layers required for a complete framework

CONCLUSION

In this paper, the current developments in DLT were reviewed from the point of view of operational risk management, and a first risk assessment was performed. The following findings were made:

- Similar to other technologies, DLT has principle limitations and underlying assumptions that have to be taken into account in an operational risk assessment.
- Although Bitcoin has generic inefficiencies, it is an innovative approach for "electronic cash" based on a game theoretical concept. And, while the consequent "eventual consistency" may be uncommon, the sources of operational risk are not, as long as the limits and assumptions are well understood and the systems is implemented with due diligence.
- The current Bitcoin ecosystem is a derivation from the idea of egalitarian peers and raises many concerns, and especially juridical questions, about liability, applicable law, etc. However, it does not generate new types of operational risk (besides misuse, fraud, etc.).
- The "TheDAO" hack made clear that current implementation of smart contracts in DLT has a fundamental flaw due to the combination of complex software (with inherent probability of errors and software aging) and the vision of an ultimately and unalterable "code is law" without any "stop button" in case of emergency.
- Any non-trivial contract between agents is subject to bounded rationality and incompleteness. Contractual relationships require governance models, intermediaries, and/or legal guidelines to cope with the "known unknowns" and the "unknown unknowns" over time as part of long-term risk management.
- DPLT is a focused option to implement byzantine fault tolerance and can improve cyber resilience and reduce manual reconciliation work, but is limited to technical measures of operational risk management.
- Any centralization towards a "utility" in global securities back-office processing would be appreciated, but this can be achieved with a set of alternative technologies. There is a significant risk to overestimate DLT beyond its technical capabilities.
- Niche application may be a first starting point for DLT based systems – especially for the register of non-exchange traded assets.

In specific, the combination of a – static – unalterable blockchain and – dynamic – contractual relationship with long-term consequences raises the question of whether "code is law" is a realistic claim. The idea of smart contracts is very mechanistic and normative, which ignores the probability of "incorrect" behavior in any complex system. For an operational risks assessment of a new technology, it is essential to distinguish between the different layers that are covered (i) by code and technology and (ii) by contracts and law (Figure 2).

These include a technology layer with possible benefits with regards to security, cyber resilience and efficiency (due to BFT and omission of manual reconciliations, etc.); a governance layer that has to cope with the complexity of – ever changing – software environments and, consequently, errors over the whole life-cycle; a standardization layer – as a core feature – that provides the lingua franca for the financial transactions (e.g., with the Legal Entity Identifier, LEI) [WFE (2016)]; a layer of contract legislation and, respectively, "trust" in intermediaries [Luhmann (1968)]; and a risk management layer that has to cover all the ex-post aspects, which are not according to the ex-ante contracts.

The risk assessment presented in this paper demonstrated that DLT can only cover the "lower" layers, which are defined by technical processes, but not those defined by contractual relationships. When technical concepts are overloaded with the expectation to solve non-technical problems, there is the risk of misunderstanding the capability of the technology. On the other hand, the discussion about blockchain is helpful as a catalyst for more discussion in the financial services industry about common standardization, shared services/centralization, and utilities for back-office operations with economies-of-scale.

REFERENCES

- Akkoyunlu, E. A., K. Ekanadham, and R. V. Huber, 1975, "Some constraints and trade-offs in the design of network communications," proceeding, SOSP '75, Fifth ACM Symposium on Operating systems principles, ACM New York, NY
- Ali, R., J. Barrdear, R. Clews, and J. Southgate, 2014, "Innovations in payment technologies and the emergence of digital currencies," Bank of England, Quarterly Bulletin 54:3, 262-275
- Attiya, H. and F. Ellen, 2014, Impossibility results for distributed computing, synthesis lectures on distributed computing theory, Morgan & Claypool Publishers
- Aven, T., 2011, Quantitative risk assessment: the scientific platform, Cambridge University Press
- Bafin, 2016, Merkblatt Depotgeschäft, Feb. 2014; www.bafin.de/SharedDocs/Veroeffentlichungen/DE/Merkblatt/mb_090106_tatbestand_depotgeschaeft.html (accessed 10.6.2015).
- Baldwin, C., and H. Poon, 2016, "Bitcoin worth $72 million stolen from Bitfinex exchange in Hong Kong," Reuters, www.reuters.com/article/us-bitfinex-hacked-hongkong-idUSKCN10E0KP (accessed 3.8.2016)
- Barrdear, J., and M. Kumhof, 2016, "The macroeconomics of central bank issued digital currencies," Staff working paper no. 605, Bank of England
- Bott, J., and U. Milkau, 2016, "Distributed ledger in payments and banking," Journal of Payments Strategy & Systems 10:2, 153-171
- Brewer, E., 2000, "Towards robust distributed systems," proceedings of the 19th annual ACM Symposium, Principles of Distributed Computing (PODC 00), ACM, 7-10.
- Brewer, E., 2012, "CAP twelve years later: how the "rules" have changed," Computer 02, 23-29
- Broadbent, B., 2016, "Central banks and digital currencies," speech, London School of Economics
- Brown, R. G., 2016, "Corda: an introduction – announcing the Corda introductory whitepaper," https://gendal.me/, posted August 24 (assessed 24.8.2016)
- Brus, L., 2016, "Ethereum to use hard fork to undo theft from The DAO," Coinfox News, July 8, http://www.coinfox.info/news/5883-ethereum-to-use-hard-fork-to-undo-theft-from-the-dao (accessed 14.7.2016)
- Buterin, V., 2016, "Thinking about smart contract security, blog, June 19, https://blog.ethereum.org/2016/06/19/thinking-smart-contract-security/ (accessed 21.6.2016)
- Castro, M., and B. Liskov, 1999, "Practical byzantine fault tolerance," proceedings of the Third Symposium on Operating Systems Design and Implementation, New Orleans, Feb. 1999, S. 173-186, USENIX Association
- Castro, M., and B. Liskov, 2002, "Practical byzantine fault tolerance and proactive recovery," ACM Transactions on Computer Systems (TOCS) 20:4, 398-461
- Cawrey, D., 2014, "Are 51% attacks a real threat to Bitcoin?" Coindesk, 20.6.2014, http://www.coindesk.com/51-attacks-real-threat-bitcoin/ (accessed 30.1.2015)
- Clack, C. D., V. A. Bakshi, and L. Braine, 2016, "Smart contract templates: foundations, design landscape and research directions," Aug. 4, 2016, https://arxiv.org/pdf/1608.00771 (accessed 24.8.2016)
- Correiam, M., G. Santos Veronese, N. Ferreira Neves, and P. Verissimo, 2011, "Byzantine consensus in asynchronous message-passing systems: a survey," International Journal of Critical Computer-Based Systems 2:2, 141-161
- Decker, Ch., and R. Wattenhofer, 2013, "Information propagation in the Bitcoin network," 13th IEEE International Conference on P2P-Computing, September
- de Rocquigny, E., 2009, "Quantifying uncertainty in an industrial approach: an emerging consensus in an old epistemological debate," S.A.P.I.EN.S 2:1
- del Castillo, M., 2016, "Ethereum executes blockchain hard fork to return DAO funds," Coindesk, 20.7.2016, http://www.coindesk.com/ethereum-executes-blockchain-hard-fork-return-dao-investor-funds/ (accessed 22.7.2016)
- Dienelt, J., 2016, "Understanding Ethereum – report," CoinDesk
- Douceur, J. R., 2002, "The Sybil attack," Proceedings of the 1st International Workshop on Peer-to-Peer Systems (IPTPS 2002); http://research.microsoft.com/pubs/74220/IPTPS2002.pdf (accessed 20.6.2016).
- Drummond, S., 2016, "Sydney Stock Exchange's blockchain system targets venture capital funds, commodities," The Sydney Morning Herald, May 19, http://www.smh.com.au/business/banking-and-finance/sydney-stock-exchange-blockchain-targets-vc-commodities-20160518-goykn9.html (accessed 20.5.2016)
- Dwork, D. and M. Naor, 1992, "Pricing via processing or combatting junk mail," in Brickell, E. F., (ed.) Advances in cryptology – CRYPTO '92, Lecture Notes in Computer Science 740
- Economist, 2015, "The trust machine," October 31, www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine (accessed 2.7.2016).
- European Banking Authority, 2014, "EBA opinion on "virtual currencies"," www.eba.europa.eu/documents/10180/657547/EBA-Op-2014-08+Opinion+on+Virtual+Currencies.pdf (accessed 10.7.2014)
- European Banking Authority, 2016, "Opinion of the European Banking Authority on the EU Commission's proposal to bring virtual currencies into the scope of Directive (EU) 2015/849 (4AMLD)," www.eba.europa.eu/documents/10180/1547217/~EBA+Opinion+on+the+Commission%E2%80%99s+proposal+to+bring+virtual+currency+entities+into+the+scope+of+4AMLD (accessed 10.7.2014)
- Eyal, I., 2014, "The miner's dilemma," ArXiv 1411.7099, available at: http://arxiv.org/abs/1411.7099 (accessed 1.2.2015).
- Finextra, 2016, "Bitfinex looks for fresh funding; spreads losses across all user accounts," August 8, www.finextra.com/newsarticle/29276/bitfinex-looks-for-fresh-funding-spreads-losses-across-all-user-acounts (accessed 8.8.2015).
- Fischer, M. J., N. A. Lynch, and M. S. Paterson, 1985, "Impossibility of distributed consensus with one faulty process," Journal of the ACM 32:2, 374-382
- Gigerenzer, G., and R. Selten, 2002, Bounded rationality, MIT Press, Cambridge, MA
- Greenspan, G., 2016, "Why many smart contract use cases are simply impossible," blog on www.coindesk.com, published on April 17, 2016; www.coindesk.com/three-smart-contract-misconceptions/ (accessed 2.7.2016).
- Grossman, S. J., and O. D. Hart, 1986, "The costs and benefits of ownership: a theory of vertical and lateral integration," Journal of Political Economy 94, 691–719
- Haar, B., 2016, "Freedom of contract and financial stability–introductory remarks," European Business Organization Law Review 17:1, 1–13

- Hart, O. D., 1995, Firms, contracts, and financial structure, Oxford University Press
- Hart, O. D., and J. Moore, 1990, "Property rights and the nature of the firm," Journal of Political Economy 98, 1119–1158
- Hearn, M., 2016, "The resolution of the Bitcoin experiment," Blog January 14, https://medium.com/@octskyward/the-resolution-of-the-bitcoin-experiment-dabb30201f7#.z8f9vtaah (accessed 19.1.2016).
- Hoepmann, J. H., 2008, "Distributed double spending prevention," 15th International Workshop on Security Protocols, Lecture Notes in Computer Science 5964, 2010
- Ito, J., 2015, "Why Bitcoin is and isn't like the internet," January 18, www.linkedin.com/pulse/why-bitcoin-isnt-like-internet-joichi-ito (accessed 30.1.2015)
- Kelly, J., 2016, "UBS leads team of banks working on blockchain settlement system," Reuters, August 24 (accessed 24.8.2016)
- Lamport, L., R. Shostak, and M. Pease, 1982, "Byzantine general's problem," ACM Transactions on Programming Languages and Systems, ACM
- Leinonen, H., 2016, Virtual currencies and distributed ledger technology," Journal of Payments Strategy & Systems 10/2, 132-152
- Lessig, L., 2000, "Code is law", Harvard Magazine 1/2000, January 1, http://harvardmagazine.com/2000/01/code-is-law-htm (accessed 26.12.2015).
- Lindsay, B., P. Selinger, C. Galtieri, J. Gray, R. Lorie, F. Putzolu, I. Traiger, and B. Wade, 1980, "Single and multi-site recovery facilities," in Draffan, I. W., and F. Poole (eds.), Distributed data bases, Cambridge University Press; also available as IBM Research Report RJ2517, San Jose, CA (July 1979).
- Luhmann, N., 1968, Vertrauen: ein mechanismus der reduktion sozialer komplexität, F. Enke Verlag, Stuttgart; in English: Luhmann, N., 1982, Trust and power, John Wiley
- Luhmann, N., 1991, Soziologie des risikos, Walter de Gruyter, Berlin; in English: Luhmann, N., 1993, Risk: a sociological theory, Walter de Gruyter, Berlin.
- Lyu, M. R., 1996, Handbook of software reliability engineering, IEEE Computer Society Press and McGraw-Hill
- Marino, B., and A. Juels, 2016, "Setting standards for altering and undoing smart contracts," in: Alferes, J. J, L. Bertosi, G. Governatori, P. Fodor, and D. Roman (eds.), Rule technologies, Lecture Notes in Computer Science 9718, 151-166
- Osipkov, I., E. Y. Vasserman, N. Hopper, and Y. Kim, 2007, "Combating double-spending using cooperative P2P systems," paper presented at ICDCS, 2007, 27th International Conference on Distributed Computing Systems (ICDCS '07), 41
- Parnas, D. L., 1994, "Software aging," ICSE '94 Proceedings of the 16th International Conference on Software Engineering, 279-287, IEEE Computer Society Press Los Alamitos, CA
- Passas, N., 2006, "Demystifying hawala: a look into its social organization and mechanics," Journal of Scandinavian Studies in Criminology and Crime Prevention 7, 46–62
- Paech, P., 2016a, "Securities, intermediation and the blockchain – an inevitable choice between liquidity and legal certainty?" LSE Legal Studies Working Paper 20/2015 (update June 2016), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2697718 (accessed 9.6.2016).
- Paech, P., 2016b, "Integrating global blockchain securities settlement with the law – policy considerations and draft principles," Draft Conference Paper, June, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2792639 (accessed 3.7.2016).
- Reuters, 2016, "UBS leads team of banks working on blockchain settlement system," Reuters, August 24; http://www.reuters.com/article/us-banks-blockchain-ubs-idUSKCN10Z147; (accessed 26.8.2016)
- Sams, R., 2015, "Bitcoin blockchain for distributed clearing: a critical assessment," Journal of Financial Transformation 42, 39-46
- Santo, A., I. Minowa, G. Hosaka, S. Hayakawa, M. Kondo, S. Ichiki, and Y. Kaneko, 2016, "Applicability of distributed ledger technology to capital market infrastructure," Japan Exchange Group, JPX Working Paper 15, August 30
- Satoshi Nakamoto, 2008, Bitcoin: a peer-to-peer electronic cash system, https://bitcoin.org/bitcoin.pdf (accessed 10.1.2014).
- Sebastián, J., 2015, "Smart contracts: the ultimate automation of trust?" in Digital Economy Outlook, October, BBVA Research, https://www.bbvaresearch.com/en/?capitulo=smart-contracts-the-ultimate-automation-of-trust&post_parent=97745 (accessed 21.10.2015).
- Siegel, D., 2016, "Understanding the DAO attack," blog, June 25, www.coindesk.com/understanding-dao-hack-journalists/ (accessed 2.7.2016).
- Simon, H. A., 1957, "A behavioral model of rational choice," in Simon, H. A. (ed.), Models of man, social and rational: mathematical essays on rational human behavior in a social setting, Wiley
- Simon, H. A., 1991, "Bounded rationality and organizational learning," Organization Science 2:1, 125-134
- Sirer, E. G., and I. Eyal, 2013, "Majority is not enough: Bitcoin mining is vulnerable," in Sadeghi, A. R. (ed.), Financial cryptography and data security, Lecture Notes in Computer Science 8437, 436-454
- Sirer, E. G., 2016, "Thoughts on the DAO hack," blog, June 17, http://hackingdistributed.com/2016/06/17/thoughts-on-the-dao-hack/ (accessed 21.6.2016)
- SWIFT, 2016, https://realworldchange.swift.com (accessed 10.5.2016).
- Turing, A. M., 1936, On computable numbers, with an application to the Entscheidungsproblem, Proceedings of the London Mathematical Society s2-42:1, 230-265
- Vogels, W., 2009, "Eventually consistent," Communications of the ACM 52:1, 40-44
- Wattenhofer, R., 2016, "The science of the blockchain," CreateSpace Independent Publishing Platform by Amazon, January 27
- WFE, 2016, World Federation of Exchanges: financial markets infrastructures and distributed ledger technology, August 25; http://www.world-exchanges.org/home/index.php/files/18/Studies%20-%20Reports/349/WFE%20IOSCO%20AMCC%20DLT%20report.pdf (accessed 26.8.2016).
- Williamson, O. E., 1979, "Transaction-cost economics: the governance of contractual relations," Journal of Law and Economics 22, 223-261
- Williamson, O. E., 1985, "Contractual man," in Williamson, O. E., (ed.) The economic institutions of capitalism, Free Press, 43-63
- Williamson, O. E., 2002, "The theory of the firm as governance structure: from choice to contract," Journal of Economic Perspectives 16:3, 171-195

Digital Finance: At the Cusp of Revolutionizing Portfolio Optimization and Risk Assessment Systems[1]

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Abstract
Advances in quantum computing and machine learning are likely to change the face of quantitative portfolio construction and risk management as we know it today, and the focal point will be optimization processes. While financial optimization theory is highly sophisticated and complex, the current state of practice leaves much to be desired and may best be described as a patchwork quilt held together by band-aids and duct tape. On the horizon, however, are potential improvements in the analytical techniques underpinning how optimization methods are used, including the promise of exhaustive searches using quantum computers and advances in pattern recognition available through structured machine learning. To understand the importance and promise of the new developments in technology for financial optimization, it is imperative to appreciate the state of current practice. Critical challenges exist in the internal consistency of volatility and correlation estimates given the mixed methods used in many quantitative practices. With the heightened occurrence of event risk coming from politics, policy, and disruptive innovation, common assumptions concerning the stability of volatility regimes and correlation estimates are in question. Moreover, event risk can create short periods when bimodal expected return distributions dominate, often resulting in underestimation of the potential for pricing gaps and volatility regime shifts. Future progress with exhaustive search optimization using quantum computers and structured machine learning offers the possibility of a much deeper assessment of the probabilities surrounding event risk, improved analysis of the potential presence of bimodal and other non-normal return distributions, and the construction of more robust portfolios to handle the extreme (or fat-tailed) risks that seem to be happening more and more often than traditional approaches tend to predict.

1 Disclaimer: All examples in this report are hypothetical interpretations of situations and are used for explanation purposes only. The views in this report reflect solely those of the authors and not necessarily those of CME Group or its affiliated institutions. This article and the information herein should not be considered investment advice or the results of actual market experience.

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INTRODUCTION

Challenges to optimization abound in the world of portfolio construction and financial risk assessment. While financial optimization theory is highly sophisticated, with detailed theoretical attention paid to model construction and critical assumptions, the current state of practice leaves much to be desired, and may best be described as a patchwork quilt held together by band-aids or the ubiquitous duct tape. On the horizon, however, are some potential improvements in the analytical techniques underpinning how optimization methods are used in both portfolio construction and financial risk management. From the promise of exhaustive searches using quantum computers to the advances in pattern recognition available through structured machine learning, financial optimization methods are about to get a major makeover. Change may be coming, and it's about time!

To understand the importance and promise of the new developments in technology for financial optimization, however, it is imperative to appreciate the state of current practice faced by portfolio managers and risk officers. Critical challenges exist in the internal consistency of volatility and correlation estimates given the mixed methods used in many quantitative practices. With the heightened occurrence of event risk coming from politics, policy, and disruptive innovation, common assumptions concerning the stability of volatility regimes and correlation estimates are in question. Moreover, event risk can create short periods when bimodal expected return distributions dominate, often resulting in underestimation of the potential for pricing gaps and volatility regime shifts. Future progress with exhaustive search optimization using quantum computers and structured machine learning offers the possibility of a much deeper assessment of the probabilities surrounding event risk, improved analysis of the potential presence of bimodal and other non-normal return distributions, and the construction of more robust portfolios to handle the extreme (or fat-tailed) risks that seem to be happening more and more often than traditional approaches tend to predict.

Our research is divided into three sections. First, we go back to the father of Modern Portfolio Theory (MPT), Professor Harry Markowitz, and provide some perspective on his contributions. Second, we take a closer look at a few of the all too common practical approaches to financial optimization that fly in the face of critical assumptions embedded in the Markowitz approach. In our analysis of the common challenges to financial optimization that often lead to vast underestimations of risk and the construction of highly sub-optimal portfolios, we draw heavily from examples and illustrations taken from the U.K.'s June 2016 referendum to leave the European Union or "Brexit." Lastly, we come back to our key themes of how two major technical advances – quantum computing and machine learning – are likely to change financial optimization practices for the better.

HARRY MARKOWITZ AND THE ASSUMPTIONS UNDERLYING MEAN-VARIANCE OPTIMIZATION

The pioneer of modern financial optimization for portfolio construction and risk assessment is without a doubt Professor Harry Markowitz, winner of Nobel Prize in Economics in 1990. What is amazing is that over 65 years after the Markowitz mean-variance optimization came into the financial world back in the early 1950s, most practically applied financial optimization problems are addressed with the creative use of band-aids and duct tape (including some especially sophisticated mathematical methods) to handle known challenges that were embedded in the key assumptions chosen by Professor Markowitz in his doctoral dissertation at the University of Chicago to make the optimization problem tractable and available for real world use.

While there is a large and highly sophisticated body of literature involving the use of mean-variance optimization in finance, we will spare the reader both the mathematics and a recitation of the academic literature in favor of an intuitive review of some of the key challenges that scholars and practitioners have spent decades addressing. Our perspective is that an appreciation of the challenges of working with optimization methods in the real world effectively makes the case as to why a revolution in optimization methods finally is on the horizon.

The brilliance of Professor Markowitz's seminal work [Markowitz (1952)] in the 1950s was to recognize the role played by risk assessment in valuing stock and analyzing portfolios, since investors were effectively constructing portfolios with considerable uncertainty about the future. Indeed, MPT effectively embraced the approach set forth by Professor Markowitz, as a key element in security analysis.

As Professor D. Sykes Wilford noted in his insightful review of the contribution of Professor Markowitz to MPT [Wilford (2012)]: "In fact, MPT is ubiquitous to all financial theory and practice. By the same token, often the implementations of MPT break many of the basic assumptions behind MPT (and Markowitz) thereby making the conclusions derived from these actions extremely misleading, and in many cases completely incorrect."

Professor Wilford's contribution was to underscore the need to take a challenging look at how practical applications of financial optimization techniques handle the sometimes heroic assumptions embedded in the basic theory. This will be our approach here as well, and in so doing, we hope to set the stage for an appreciation of how quantum computing and machine learning are going to change the practice of portfolio construction and risk assessment – taking the real world closer to the theoretical world of Professor Markowitz.

THEORY TO PRACTICE WITH FINANCIAL OPTIMIZATION TECHNIQUES

While less appreciated, one of the more important research philosophies of Professor Markowitz was his focus on practical, applicable versions of portfolio optimization. There was in the 1950s and 1960s, a controversy in academic circles over whether economics should be seeking precise and general solutions or whether good approximations were acceptable. In his Nobel Lecture in 1990, Professor Markowitz commented on his approach and this debate [Markowitz (1991)]: "We seek a set of rules which investors can follow in fact - at least investors with sufficient computational resources. Thus, **we prefer an approximate method which is computationally feasible** to a precise one which cannot be computed. I believe that this is the point at which Kenneth Arrow's work on the economics of uncertainty diverges from mine. He sought a precise and general solution. I sought as good an approximation as could be implemented. I believe that both lines of inquiry are valuable" (bold added).

The practical approach of Professor Markowitz is where we start in our intuitive analysis of the challenges of portfolio optimization. We will focus on just a few critical assumptions commonly used in the current state of practice as we set up the case for the advances that will follow from quantum computing and machine learning. The critical assumptions we will review here include: (1) use of historical data to compute estimates for expected volatility and correlations while using a forward-looking method of creating expected returns; (2) use of the standard deviation as the common measurement for volatility; and (3) instability of the correlation matrix and existence of non-normal expected return distributions. All of these challenges are exposed in rather dramatic fashion with the presence of event risk. These intuitive discussions then lead us to illustrate our analysis with examples taken from the study of the "Brexit" referendum in June 2016.

Dangers and challenges of relying on history

To implement a Markowitz mean-variance optimization system, one needs expected values – that is, expected returns, expected volatilities, and expected correlations – that are used to describe aspects of the subjective probability distribution representing the risks faced by investors. When it comes to expected returns, there is no shortage of forward-looking quantitative and qualitative approaches. When turning to the expected volatilities and correlations, however, history is often used as a guide. There is a rarely used yet profound comment by Professor Markowitz on using history as a guide that bears remembering [Markowitz (1991)]: "The calculations . . . are the same as historical returns. **It is not that we recommend this as a way of forming beliefs**; rather, we use this as an example of distributions of returns which occur in fact" (bold added).

Using history as a guide for expected volatilities and correlations absolves the risk manager of any forecasting duties, yet subjects the owners of the underlying portfolio to very large error risk. There are good empirical reasons why many financial regulators require the disclaimer that "past performance is not necessarily a guide to future performance." History is always informative, however, every episode is different, so history is simply not always a good guide for developing expectations. There are serious questions about what period of history to use, how far back to look, to what degree is it appropriate to give older observations less weight and recent observations more weight. These are all quantitative questions on the surface that require subjective analysis, and they are beyond the scope of this research. We chose to place the focus on another challenge that is less well appreciated and yet potentially very dangerous. That is, the optimization problems get worse and the likelihood of risk underestimation gets much larger when the use of a forward-looking expected return method is attached to using history for volatility and correlation estimations.

A common refrain in the computer world is "GIGO" or "garbage in, garbage out." With optimization, the so-called garbage coming into the method bounces around the system in a highly networked manner determined by the expected correlation matrix, and one is quite likely to observe "garbage in, and a landfill of waste coming out the other end" – in effect, mean-variance optimization takes GIGO to an exponentially higher power. The problem is the inconsistencies involving three types of inputs – expected returns, expected volatilities, and expected correlations.

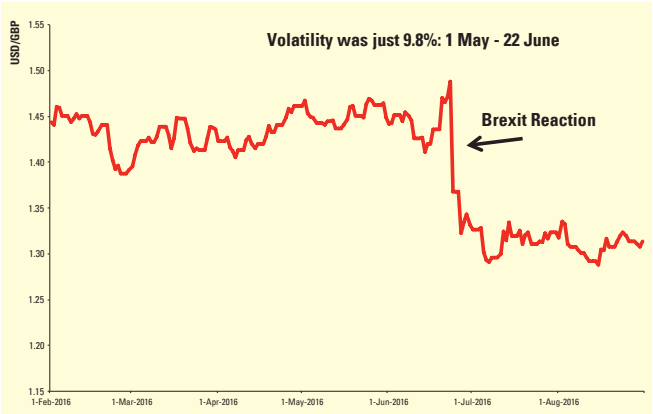
For example, if one has an aggressive expected return assumption for a given security, coupled to a historical set of data that do not reflect very much volatility, then this is asking for trouble in the mean-variance optimization space. The challenge arises from an interesting attribute of mean-variance computer systems – they actually believe what one tells them about expectations. Hence, if one provides an aggressive expected return with an expectation of little volatility, the mean-variance optimizer is going to produce a very large recommended exposure for the security. And then, the portfolio manager or risk officer will look at the output of the mean-variance optimization, remark that the output fails the real-world smell test, and either discount the method or add a set of constraints designed to create a more reasonable looking output.

This latter idea of adding constraints to optimization systems to achieve reasonable looking results is a very bad approach. Effectively, the unreasonable output has been caused by the inconsistency in the expected return and expected volatilities input into the optimizer. Rather than fix the inputs by adjusting expectations to make them more internally consistent, the common solution is to add constraints until the portfolio output passes the real world smell test.

This is like diagnosing the patient as a crazy man, and then resorting to putting the patient in a straitjacket to get the desired behavior. The much better approach, in psychoanalysis and in optimization, is to address the source of the problems directly.

One approach is to use the implied volatility in options pricing. However, efficient and useful options markets may well not exist, and some options-pricing models have built-in assumptions related to stable or flat future returns. Another, simpler band-aid is to incorporate information from the return expectations into the expected volatilities. That is, start with a measure of expected volatility, and then augment the volatility expectation based on the degree of aggressiveness of the expected return. With this approach, the mean-variance optimizer will see the aggressive return forecast, yet it will be coupled to a much larger expected volatility, so the exposure that is recommended in the optimized output will be much smaller and make more sense to the portfolio manager and risk officer.

Take the case of the U.K.'s June 2016 referendum on remaining in the European Union (E.U.) or leaving, known as "Brexit" (Figure 1). Prior to the vote on 23 June, the U.S. dollar (USD) was trading at around 1.42 against the British pound (GBP). If one thought the U.K. was going to vote to "leave," a typical forecast for the USD per GBP was 1.32 or lower. And by contrast, the "remain" camp expected a relief rally and a rise in the pound toward 1.52 (USD per GBP) or higher. The historical volatility in the three weeks before the vote was only an annualized 9.8% (standard deviation), even though market participants were looking for a one-day 7% or so move in one direction or the other depending on the outcome of the vote (i.e., a 5+ standard deviation event, one in a million event). As this case illustrates, and as the aggressiveness of the expected moves in the pound given the outcome of the vote suggested, a risk system or a portfolio construction system needed to augment the recent historical volatility to capture the risks appropriately.



Source: Bloomberg Professional (GBP)

Figure 1 – The impact of Brexit on USD:GBP exchange rate

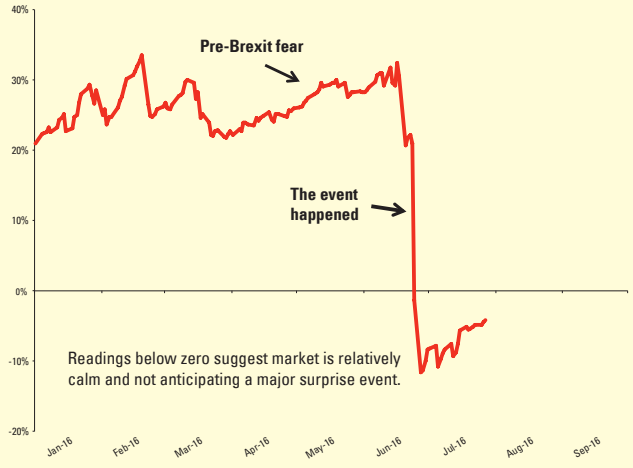
Standard deviation may underestimate volatility and potential skewness

The previous intuition, augmenting expected volatilities with information from the expected returns, raises another challenge. Is the standard deviation the appropriate proxy for the risk of the security returns in the first place? Again, and interestingly, the use of the standard deviation was chosen by Professor Markowitz back in the 1950s to represent risk because of its practical attributes. The standard deviation was straightforward to calculate from historical data and the standard deviation fit neatly into the mathematics of mean-variance optimization. There were other important side-effects of this choice. The standard deviation easily leads to embedding into the closed-form mean-variance optimization method the assumption of a normal or log-normal distribution of expected returns. Thus, we focus on at least two challenges here, (1) the standard deviation as often calculated from historical data may underestimate future volatility, and (2) the probability distribution of returns may well have considerable skewness (that is, fat-tailed event or "black swan" potential).

There are a couple of duct tape solutions available. First, the risk officer can embrace the need to take a forward-looking view of potential risks and incorporate them into the quantitative inputs for expected volatility. That is, when the future looks especially risky, despite the current calm state of markets, risk managers may choose to qualitatively augment their estimates of future volatility. We highly recommend this approach, as risk officers should not be able to hide behind historical calculations when such approaches are well known to underestimate risk and to understate the probability and frequency of highly skewed market events.

Second, one can look at alternative approaches for volatility measurement, such as looking at intra-period swings in prices. For example, if one is willing to assume a normal distribution of returns, then there is a deterministic mathematical relationship between the intra-period high/low price spread and the period-to-period standard deviation [Garman and Klass (1980); Parkinson (1980)]. If these two measures start to deviate in a meaningful way, then a market indicator can be constructed which incorporates the information from intra-period trading activity that may point to market participants worrying about more future volatility potential than the standard deviation suggests.

Again, by illustration, "Brexit" provides an interesting case study. In the weeks and months leading up to the "Brexit" referendum, as already noted, volatility, as measured by the standard deviation of daily percent changes in the USD:GBP exchange rate, suggested only modest risks more typical of "business as usual" activity.



Values over 20% indicate increased worries about the possibility of future fat-tailed events.
Note: worries are often caused by a recent past event that was not expected
Source: CME Economics calculations

Figure 2 – British pound - market worry indicator (considers intra-day dynamics)

By contrast, in the pre-vote period, the intra-day price swings, as measured by the daily high and lows recorded in the nearby British pound futures contract price as traded on CME Group's Globex® electronic platform, suggested much higher risk. And, when the adjusted intra-day high-low price spread[2] is well-above the volatility estimate given by the standard deviation of closing price changes, then one has an indication that market participants are worried about a skewed or fat-tailed event occurring.

Interestingly, once the vote occurred and the outcome was known, the difference in volatility measures from these two techniques disappeared (Figure 2). Essentially, market activity reflected the fact the event had occurred and that another similar event was not expected. That is, the storm was a big one, but once it had passed by, the "worry" indicator slipped into neutral.

Instability of correlations and possibility of non-normal return distributions

Market participants quite often have to deal with the prospects of event risk. For example, corporation A makes a bid to acquire corporation B. However, the bid, even after being accepted by corporation B, needs regulatory approval, which may well be quite controversial. The event of the regulatory decision may be binary and result in the termination or consummation of the announced deal. Before the regulatory decision is announced, the stock prices of corporations A and B will reflect the probabilities of the deal terminating or consummating, meaning that the market price of the stock before the deal will not fully reflect the announced deal price if the probability of termination is greater than zero. After the regulatory decision, the stock price moves instantly to reflect whether the deal is going through or ending. Political event risk can look much the same, as it did with the binary "Brexit" vote. What we are describing here is the likelihood that event risk creates the possibility of bimodal return probability distributions [Putnam (2012)]. A distribution with two modes, where one mode is usually lower and far away from the higher mode, is a strikingly different subjective probability distribution than the normal distribution which is embedded in many risk assessment and portfolio construction systems.

During the pre-event stage, market prices of securities likely to be impacted by the event will move when expected probabilities of the binary outcomes shift. This means that the typical drivers of market prices, and thus observed correlations, may be highly distorted by the very different drivers of the shifts in subjective probabilities related to the event in question. That is, in more typical times, earnings expectations might drive the prices of stocks A and B. Once the acquisition is announced, the earnings matter much less, and the ebb and flow of news and views about the regulatory process that will approve or deny the acquisition take precedent.

As can be appreciated, the apparent increasing frequency of event risk, especially related to political events and policy decisions, is complicating the challenges of portfolio construction and risk assessment. A common practical solution, and one we endorse, is stress-testing with various scenarios reflecting the nature of the event risk about which one is worried. Critically though, the scenarios should be assigned subjective probabilities [Karagiannidis and Wilford (2015)]. It is pathetically easy to ask 20 questions or develop some interesting scenarios, but stress-testing has no meaning or useful application if subjective probabilities are not attached to the scenarios. Again, we see that the risk officer has to be forward-looking and probabilistic.

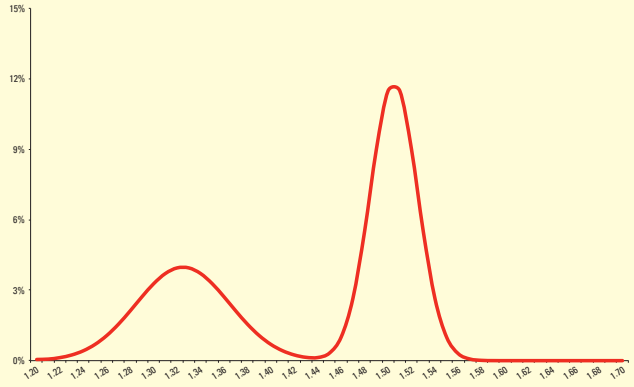
In addition, some market participants may be drawn to adopt options strategies to manage risk related to upcoming events. Options are favored in this regard because they embed a view of volatility in their price. We are strong supporters of options as a tool to manage event risk. However, we note that some additional sophistication may be required when event risk is present. Options behave differently when confronted with event risk than one might suspect if using an options pricing model derived from the basic Black-Scholes approach. We mention this because it highlights one of our key themes – namely, watch out for embedded assumptions. The Black-Scholes options

2 Adjusted for the difference in volatility measurement between standard deviation and high-low swings.

pricing method [Black and Scholes (1973); Merton (1973)] in its original and basic form makes a number of heroic assumptions designed to simplify the mathematics and allow one to use an options-replicating approach to value the option.

When event risk is present, two critical assumptions are likely to be violated and both have profound implications for the price of the option and the implied volatility expectation embedded in the option price. Event risk raises the prospect of both an instantaneous price jump and a major shift in the volatility regime after the event occurs. That is, one can sometimes observe deceptively calm markets as they wait on the event to happen, such as the release of an important piece of economic data, a merger-and-acquisition regulatory decision, a political election, or referendum. Once the outcome is known, though, the price jumps with no intervening trading to its new equilibrium, reflecting the new reality based on the event outcome, and the volatility regime also shifts to reflect the new post-event reality. Basic Black-Scholes assumes no price jumps (i.e., continuous trading) and no volatility shifts (i.e., homoscedasticity). When these two assumptions are violated, traditional delta hedging strategies will fail miserably and basic options models will underestimate volatility. Fortunately, there are many options pricing models available, although quite complex, that deal with these known challenges [Cox et al. (1979)]. Unfortunately, many risk assessment systems do not use these complex option pricing models and instead embed assumptions of normal distributions, no price jumps, no volatility shifts, and stable correlation structures. No wonder these systems are "surprised" by how many "100-year" floods seem to occur in just one or two decades, instead of the expectation of one per century.

As an aside, relating to previous discussions, price jumps are especially confusing for volatility measurement systems that only look backwards. The price jump creates a one or two-day period where the standard deviation calculation will be extreme; sometimes four or five standard deviations from previous history, and then it settles into a new pattern that is elevated from previous history but not off the charts. From a behavioral finance perspective, what market participants appear to do is to start to discount the event – meaning that its impact on expectations of future volatility starts to diminish, and sometimes rather quickly unless there is good reason to think lightning will strike twice in the same place. Any historically-based volatility measurement system needs to consider whether older data should be more-heavily discounted, or be given equal weight. For example, if one uses a fixed time period for the look back, say three months, then there will be a spike upward when the event occurs in the volatility measure, followed by an "unexplained" reversal when the three-month period ends and the price-gap day drops out of the backward-looking volatility calculation. Bayesian techniques easily handle time decay parameters, as do exponentially-lagged time decay systems. We highly recommend them.



Probability of specific expected exchange rate. Total area under the curve equal 100%.
Source: CME Group Economics.

Figure 3 – Pre-Brexit vote: USD per GBP hypothetical expected probability distribution

Back to considering bimodal distributions and their challenges, and again, "Brexit" is a good example of the potential for a bimodal expected return distribution prior to the vote date (Figure 3). As noted earlier, a "leave" vote was expected to weaken the British pound and "remain" vote was expected to lead to a relief rally and a strengthening pound. What market participants were trying to do was gauge the probabilities of one outcome versus the other. Since the range of probabilities ran more or less from a coin flip to about 60/40, this was a classic case of a bimodal expected return distribution. Of course, once the vote occurred and the outcome was known, the new expected return distribution collapsed almost instantly back into a typical single-mode probability distribution.

Moreover, the process of collapsing back into a single-mode expected return probability distribution had the ability to disturb correlations for a few days. On the 24th and 27th of June 2016, the Friday and Monday after the UK's vote to leave the European Union, the British pound fell 7% and 2%, respectively, while other risky assets, such as equities, also declined, with even the U.S. S&P500® Index falling 3% and 1%, respectively, while most European equity indexes had sharper falls on the 24th. In the weeks afterwards, though, U.S. equities resumed their climb to new highs, while the British pound did not recover, although it stopped falling and traded in a relatively narrow range. In effect, during the disruption, correlations between the British pound and equity indexes were sharply positive, and then fell back toward zero in the weeks after the referendum. Portfolio construction or risk analysis that failed to consider the possibility of a bimodal expected return distribution collapsing back into a single-mode distribution after the event would have underestimated

potential volatility, not necessarily have anticipated a gap or price jump as the outcome was announced, and would have missed some very critical correlation shifts.

FUTURE OF FINANCIAL OPTIMIZATION

Two evolving techniques for data analysis are likely to greatly improve risk assessment and portfolio construction – namely, exhaustive search using quantum computers and advances in pattern recognition available through structured machine learning. We will start with a discussion of optimization with quantum computers, although this approach is going to take another five years or so before the computers move from the experimentation phase to being large enough for operational use. Machine learning is already here and gaining ground fast on traditional risk assessment techniques.

Quantum computing is on the way

Quantum computers can be purpose built, and there are a number of experiments on-going in academic labs. To move from the lab to the real world, there is a commercially available quantum computer using an annealing process to solve optimization problems offered by D-Wave Systems of Vancouver, Canada. 1QBit, another Vancouver-based company, is creating software that allows one to utilize the new quantum computers without having to be a quantum computing expert to leverage the best known methods for interacting with quantum hardware. Their software development kit (SDK) enables the rapid and systematic development of higher-level applications that are compatible with both classical and quantum processors. In additional, major computing companies, such as Google, Microsoft, and IBM are known to be experimenting in various ways with quantum computing.

The difference in how quantum computers work compared to classical computing is quite amazing and fascinating. Classical computers have bytes that hold a zero or a one. Quantum computers have qubits that hold a zero or a one as well as a second piece of information that can be intuitively thought of as a probability that the information is a zero or a one. To solve an optimization problem, the quantum computer does not add, subtract, multiply, and divide like a classical computer; instead it uses a process known as quantum annealing to seek the lowest energy state based on how the information in the qubits is arranged. That is, the second piece of information in the qubits allows for quantum effects, including tunneling, not possible in classical computers. Tunneling is the concept in quantum physics of a particle moving through a barrier that would not be possible in a classical system. Suffice it to say, explaining quantum computing is well past the scope of this research, however, for optimization, the demonstration of quantum effects represents a huge step forward.

Optimization with quantum computers offers the promise of solving certain problems that have traditionally been challenging for classical computers using a process that exhaustively searches problems known as "quadratic unconstrained binary optimizations," or qubos. In a classical computer, a complex optimization problem such as a qubo is solved by way of iteration to achieve a close, but estimated answer. In a quantum computer, exhaustive search finds the exact answer. For many uses, the estimated optimal solution from a classical computer may work fine, if the practitioner is artful in how the problem is set up and how the embedded assumptions are handled. However, the promise of quantum computing is to free the researcher from having to make some difficult and often wrong simplifying assumptions. In finance, these difficult optimization problems appear in areas such as asset clustering, cash flow modeling, taxation, and portfolio risk decomposition. We should caution, though, that appreciating the characteristics of the return distribution and how it changes will remain critical to developing robust, forward-looking risk assessments. Quantum computing is going to offer some incredibly important new tools for risk analysis and portfolio construction; however, it is unlikely to provide good answers without an expert at the helm.

Machine learning is here

Machine-learning techniques are essentially a highly sophisticated and advanced pattern recognition system. They constitute methods that involve cleaning (harmonizing) the data, building the model on known data (also known as "training" phase), optimizing the model, and then applying the model on unseen data (often called "testing" phase). The beauty of these algorithms is that they need not be programmed for all the data out there. They learn as and when they see new datasets and evolve. All the machine learning algorithms are categorized into one of these two categories:

- **Supervised learning:** the datasets that belong to supervised learning techniques already have a "label" (outcome/prediction variable) attached to them. Most of the classification and regression problems are categorized as supervised learning techniques.
- **Unsupervised learning:** these algorithms aim at the descriptive nature of the data rather than classifying them. Data exhibits certain characteristics and patterns over a period of time (in case of time-series data) and techniques like clustering and association rules help identify them.

One can develop algorithms for machine learning that are unstructured or structured. The unstructured systems are essentially "frequentist" methods, where the data is asked to speak for itself without expert advice. The unstructured methods are likely to be most popular; simply because they are easy to use and open-source software is available. Unstructured machine learning is great for descriptive analytics; however, as one moves into the world of predictive systems,

the unstructured methods are likely to appear extremely successful in back-testing and suffer from a myriad of problems in actual practice – not unlike the challenges facing current practices in financial optimization when history is not necessarily a good guide.

Machine learning has been heavily linked with "big data." Initially, much of the research in finance is aimed at discerning new trends and augmenting security returns forecasts with all kinds of new information not previously available – hence, the term "big data." Data is growing at an enormous rate. "Big data" is usually characterized by the three basic Vs – volume, variety, and velocity. (There are of course other Vs added over time – value, veracity, etc.) The datasets can be from different sources (i.e., variety), can be in motion (real-time data demonstrating velocity), can use different data architecture, and they can still inform a machine learning process. Apache has a lot of open-source projects that have gained popularity in recent years. Apache Spark, an in-memory distributed computing platform is worth mentioning. Spark can scale financial modeling and optimization which includes calculating Value-at-Risk (VaR) to fit models, run simulations, store, and analyze results in the cloud.[3]

Structured machine learning methods allow for different types of expert information to guide the learning process. The combination of expert advice and sophisticated pattern recognition systems offers tremendous process for forecasting financial variables – from returns to volatilities to correlations and beyond. And, machine learning is not necessarily tied to the straitjacket of time series data, so pattern recognition processes can be much more creative in how the historical data is interpreted.

Pattern recognition with financial data does come with some special challenges, and one of the biggest is that the data is exceptionally noisy. With classical statistical regression techniques, one observes the noisy data by finding only relatively weak fits for the modeling of daily returns. With machine learning, the existence of relatively noisy data will put a greater premium on how one sets the various parameters that filter the pattern or how one adds expert advice to the system. This will be essential for the forward-looking results to add substantial value, and it will not be easy.

The advances from machine learning for quantitative finance are already making themselves felt in sales forecasting and marketing techniques; however, this is just the beginning of a revolution. For financial optimization, structured machine learning promises more robust forecasting tools, for expected returns, and using more diverse measures of volatility for risk assessment, while allowing for very creative assessments of stylized (structured) correlation patterns. The era of parallel and distributed computing is here, which makes it possible for computations to scale and provides the ability to make predictions at a granular level. Hence, financial optimization will look totally different in just a few years as the new tools permeate the industry and change an age-old mindset about portfolio construction and risk assessment.

REFERENCES

- Black, F. and M. Scholes, 1973, "The pricing of options and corporate liabilities," The Journal of Political Economy 81:3, 637-654
- Cox, J. C., S. A. Ross, and M. Rubinstein, 1979, "Option pricing: a simplified approach," Journal of Financial Economics 7:3, 229-263
- Garman, M. B., and M. J. Klass, 1980, "On the estimation of security price volatilities from historical data," Journal of Business 53:1, 67-78
- Karagiannidis, I., and D. S. Wilford, 2015, "Modeling fund and portfolio risk: a bi-modal approach to analyzing risk in turbulent markets," Review of Financial Economics 25, 19-26
- Markowitz, H. M., 1952, "Portfolio selection," The Journal of Finance 7:1, 77–91
- Markowitz, H. M., 1991, "Foundations of portfolio theory," The Journal of Finance 46:2, 469-477
- Merton, R., 1973, "Theory of rational option pricing," Bell Journal of Economics and Management Science 4, 141-183
- Parkinson, M., 1980, "The extreme value method for estimating the variance of the rate of return," Journal of Business 53:1 61-65
- Putnam, B. H., 2012, "Volatility expectations in an era of dissonance," Review of Futures Markets, March
- Wilford, D. S., 2012, "True Markowitz or assumptions we break and why it matters," Review of Financial Economics 21, 93 – 101

3 Reference - https://www.infoq.com/presentations/spark-financial-modeling

Safety in Numbers: Toward a New Methodology for Quantifying Cyber Risk

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Abstract
For financial institutions, safeguarding against cyber attack is now about more than just protection – increasingly it means managing cyber risk effectively across the organization. In modern, diffuse networks, such as those in most large banks, allocating risk across multiple network nodes (defined here as IT infrastructure, assets, and points of access) is vital to developing comprehensive strategies for managing cyber risk. Central to this is quantifying the risk. We believe that current scoring and statistically oriented models for cyber risk quantification are based on flawed assumptions, and fail to answer several key questions. We propose a methodology for quantifying cyber risk that incorporates the physical network in the organization, and the behavior and characteristics of individuals and processes in that network – including the actions they take to mitigate cyber risks. In addition, as allocating and attributing risk are central to modifying the behavior of institutions and individuals, enabling organizations to easily attribute and allocate risk to specific nodes and edges of the network is central to our method. This paper provides a high-level summary of the approach, and highlights how it differs from, and improves on, existing models of cyber risk quantification.

INTRODUCTION: BEYOND PROTECTION

Financial institutions (FIs) are waking up to cyber risk, but often treat it as less important than other types of risk. They tend to concentrate on cybersecurity, or protection: safeguarding information by preventing, detecting, and responding to cyber attacks, and identifying, assessing, and prioritizing potential threats. But to protect against the growing number of cyber attacks worldwide, they now have to manage their cyber risk.

FIs have standards[1] for dealing with cyber risk, and often apply them widely. But these standards, most of which are fairly basic, are really only a starting point. By focusing largely on cybersecurity, FIs are neglecting several vital elements of managing cyber risk: locating areas of high risk (systems, processes, and so on), identifying the cause of that risk, quantifying the risk, and developing proper insurance and capital adequacy strategies to cope with it. Being able to accurately allocate and attribute cyber risk is essential if FIs and individuals are to change the way they deal with it.

We define "cyber risk" as the risk of losses due to the failure or lack of cybersecurity systems. Crucially, cyber risk is complex – multidimensional, dynamic, and often hard to manage.

This is distinct from cybersecurity. As with many terms in risk management, definitions of cybersecurity vary. At a basic level, cybersecurity is the technology and processes used by an organization to protect its IT systems from malicious cyber attacks. Many definitions go further, to include protecting systems from any damage or unauthorized data access, whether it is malicious or the result of errors and system failures.

The National Institute of Standards and Technology (NIST) defines cybersecurity as "the process of protecting information by preventing, detecting and responding to attacks." We have expanded on this definition, by building on concepts developed by the Federal Financial Institutions Examination Council (FFIEC). In our definition of cybersecurity, we broaden the concept to consider issues around data privacy and breaches that disrupt an FI's operations, business, and reputation.

Box 1 – Cybersecurity and cyber risk

MEASURING THE THREAT IN MODERN NETWORKS

Diffusion is a central feature of modern networks: how people behave in the digital world is no longer just about them. A data breach at a credit card company does not just affect the company, but its customers, its vendors, and its customers' vendors. Similarly, when a hacker or cyber criminal targets a network or individual's computing assets for a distributed denial-of-service (DDoS) attack, the breach does not just affect the owner of the hijacked asset. Individuals and targets with little connection to the victim can suffer too, simply because they were unfortunate enough to be on the same network. Cyber risk is shaped by the behavioral and commercial characteristics of all the components in an organization, across increasingly complex networks and architectures of "nodes," which include the FI's assets and its network access points.

To manage cyber risk effectively, organizations must first be able to measure it. Existing methods for quantifying cyber risk tend to calculate a value for cyber risk across an FI's entire organization. They also often rely on small amounts of data about infrequent cyber events, which not only increases the risk that datasets are skewed by a single extreme event, it also relies on past events to calculate future losses.

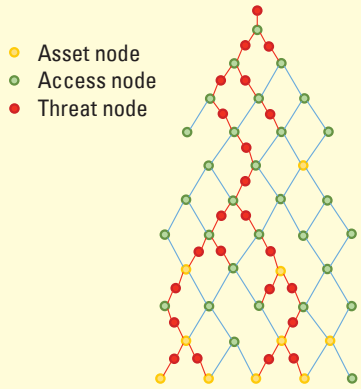
By quantifying cyber risk at a more in-depth level, FIs can manage it in a more optimal and flexible way, targeting specific areas, processes, and people. The data they gather can also help in stress-testing IT systems, and in meeting regulators' demands for information about cyber and data security.

1 Among them the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) Information Technology 27001 and 27002 framework (collectively ISO 27001/27002); and the National Institute of Standards and Technology (NIST) Framework for Improving Critical Infrastructure Cybersecurity Version 1.0 (the "NIST Framework").

A NEW APPROACH

To address the limitations of current approaches, we have developed a new methodology for quantifying cyber risk. It uses an FI's physical IT network as a base to create "exposure network," via which cyber risks can be attributed to specific network locations. The methodology enables FIs to develop a customized approach to assessing and quantifying cyber risk. It scales well, and can be used to calculate cyber risk for networks of any size.

It employs tree-like structures to represent attacks on a system (see Figure 1). "Attack trees," which consist of multiple levels of connected nodes, are combined to create an exposure network. The overall network structure we use is derived from network monitoring and analysis systems (such as NetFlow), and takes into account IT infrastructure, threats, mitigating factors (such as antivirus and malware detection software), and assets (such as confidential records and customer data).



Note: A "threat node" is a node with a resident threat that could be transmitted to other nodes.
Source: Chartis Research

Figure 1 – A simple attack tree, showing the route of a potential cyber threat through a network of assets and access points

EFFECTIVE CYBER RISK MANAGEMENT: COVERING ALL THE ELEMENTS

For most firms, suffering a cyber breach is not a question of if, but when; or even how often. To operate effectively and stay stable – a state now increasingly demanded by law – they must manage their cyber risk. Table 1 summarizes the key elements of cyber risk management.

By considering all aspects of cyber risk, firms can:

- Identify potential system weaknesses (and evaluate them).
- Identify the specific areas most affected by cyber risk.
- Quantify risk in various locations.
- Use insurance (where relevant) to cover high-risk areas.
- Select and design appropriate strategies for managing cyber risk.
- Include cyber risk management in broader strategies and frameworks linked to wider operational risk (including financial crime, reputational risk, and customer relationship management), liquidity and credit risk, enterprise stress testing, and capital adequacy.

The current approach taken by most FIs is shown in the shaded areas of Table 1. So while they identify potential threats, and assign an overall value to them, they neglect the crucial elements of attribution, insurance, strategy, and quantification.

Cyber risk management strategy and framework	**Risk identification**	**Risk assessment and evaluation**	**Attribution** (locating areas of high cyber risk and identifying the cause of that risk)	**Quantification** (measuring risk)	**Insurance** (insuring against losses from cyber attacks; mitigating the cost, if not the event)	**Ongoing monitoring and auditing**

Note: the shaded areas show most firms' current approaches, which focus more on identifying and evaluating risk, rather than managing it.

Source: Chartis Research

Table 1 – The key elements of cyber risk management

QUANTIFYING CYBER RISK: WHY AND HOW

Quantification is a key pillar of cyber risk management – put simply, you can't manage what you don't measure. And not only does quantifying cyber risk accurately help FIs manage it, it also enables them to answer some key business questions:

- How can we persuade the board to spend money on cyber risk management before it is too late, rather than waiting till after we suffer a catastrophic cyber attack?
- Where should we spend our budget for cyber risk management (software, hardware, training)?
- Cyber risk management is an expanding industry, but how do we know we have spent our money wisely?
- How do we ensure that employees and other stakeholders take cyber risk management seriously?
- How do we ensure that once risks are identified, they are attributed to the correct cause?
- How do we stress-test IT systems?
- How do we accurately calculate the impact of cyber risk on our operational risk capital?

VULNERABLE TO ATTACK: THE PROBLEM WITH EXISTING APPROACHES

Standard cyber risk quantification models share a problem that is common to general operational risk frameworks: they tend to be statistical methods with a very high dimensional fit and a very high sensitivity to initial conditions. Most "valuation" models provide a statistical analysis of the whole organization to give a single, firm-wide value for cyber risk. A finer level of scrutiny is either non-existent, or poorly handled.

Existing approaches range from purely statistical analysis of incidents in the firm itself (or in comparable firms) to a more systemic analysis of the physical network structure. Popular approaches tend to focus on event statistics and frequency-based models, models that are based on the fundamental assumptions that cyber crimes are regular and repeatable. However, we believe this view is inaccurate: cyber crime is irregular, unpredictable, and constantly changing; historical cyber crime events are not necessarily a good indicator of future ones.

What is more, when FIs quantify or evaluate risk they fail to take into account an organization's network characteristics, behavioral issues, and operational and commercial characteristics.

- **Network characteristics:** connections between nodes or groups of nodes, locations of mitigating factors in the network, and the general network architecture.
- **Behavioral issues and operational characteristics:** the culture at the FI, the experience/training of its staff, and its consideration of cyber risk when it defines its processes and best practices.
- **Commercial characteristics:** the company's insurance, liabilities, contractual arrangements, etc.

Valuation models are vulnerable for a number of reasons:

- They depend on high dimensional fitting models, which are based on complex mathematics involving large numbers of polynomials.
- They depend on low-frequency events.
- They use data from past events to predict future losses (cyber crime changes relatively quickly, however, so this kind of anlysis works best with recent data).
- They use one-dimensional event frameworks, which are not suitable for complex long-running and highly compounded risks, such as cyber risk (which combines IT, business, and information risk) or conduct risk.
- They have no mechanism to link specific behavior to low-frequency events.

Developers and users of valuation models could learn much from firms in other safety-critical industries, such as energy companies – many of which have specific techniques for managing their risk. And cyber risk teams often lack the communication standards that their counterparts in market and credit risk have taken for granted, with standard quantification strategies such as Value-at-Risk (VaR) and expected shortfall.

Our new methodology looks to rectify this. By identifying the physical, commercial, and behavioral aspects of networks, we can analyze complex network behavior, and model the impact not only on the FI in question but on every entity in its information network.

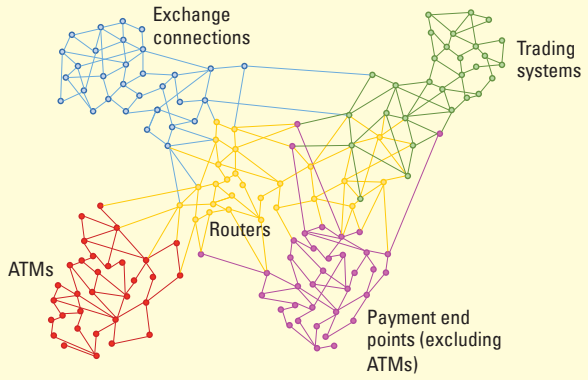
TOWARD A NEW METHODOLOGY: BOTTOM-UP VERSUS TOP-DOWN

The method we propose aims to:

- Simulate how likely cyber attacks are to propagate in the presence of standard mitigants (such as anti-virus software and network barriers).
- Compute the VaR from the simulated loss distribution.

This "bottom-up" approach captures and aggregates all relevant enterprise processes, giving risk professionals a comprehensive evaluation of a firm's cyber risk exposure. It contrasts with "top-down" techniques, which consider the whole organization, and which may incorrectly identify some risks, or incorrectly estimate correlations between individual risks.

Our approach provides insight into the relative and absolute economic costs of cyber attacks, and it can operate on physical computer networks at any level of detail, and aggregate as many attack trees as required. It also allows regulators to specify benchmark or reference architectures for different lines of business (such as retail brokerage, exchange infrastructure, payment infrastructure, etc.).



Source: Chartis Research

Figure 2 – An example of an exposure network, in which each node represents an aggregation of multiple nodes

EXPOSING RISK TO MANAGE RISK

Our methodology uses "exposure networks" to pinpoint and attribute risk in an FI. By combining attack trees, an exposure network identifies a network of connected nodes. Each connection between nodes has a set of properties that are distinct from the two nodes that create it, essentially breaking down overall cyber risk into smaller categories. A typical exposure network for a single FI is shown in Figure 2.

The methodology builds on the concept of exposure networks developed in a wide variety of financial markets.[2] To develop the concept, the probability of specific events is used to define the network edges and topology. Once created, exposure networks can be used to identify specific areas that are exposed to high levels of cyber risk and, through the connections to other nodes, identify whether the risk originates from other areas, or if it could spread to other connected nodes.

Exposure networks are powerful because they enable us to create more realistic networks by enhancing them with a variety of commercial, behavioral, and related characteristics. Hence, for example, we could enhance the basic sub-networks included in our methodology to include behavioral characteristics. These might include the decision to regularly run anti-virus software or modify exposure based on the availability of legal remedies. And, as we have effectively generated attack trees of unlimited depth, this allows us to model the true complexity and multidimensional nature of cyber risk.

To test the idea that network structure affects cyber risk, we created a sample network, belonging to a universal bank with four equal divisions (retail banking, transactional banking, investment banking, and retail brokerage). The results of the analysis highlighted big differences in cyber risk VaR between the four divisions. Retail banking accounted for most of the cyber risk that our sample bank was exposed to: between 55% and 77% of the total, depending on the strength of the mitigation applied to the network.

If we assume that the universal bank held $250 bln in notional assets, the total cyber risk VaR was calculated at $234 mln, of which retail banking accounted for more than half, at $129 mln. The retail brokerage came next with $48 mln, followed by investment banking ($45 mln) and transactional banking ($12 mln).

Box 2 – Putting theory into practice

2 Amini, H., R. Cont, and A. Minca, 2016, "Resilience to contagion in financial networks," Mathematical Finance 26:2, 329–365

CONCLUSION

FIs already widely apply standards for cyber risk, but these are often a basic minimum, and provide only an initial structure for tackling the issue. Cyber risk is intricate and multidimensional: it depends on the physical, behavioral, and commercial characteristics of all the components of an organization, linked in a complex interconnected network. Current models for quantifying cyber risk can produce an overall value for it, but they struggle to identify the sources of risk. Ultimately, these gaps in functionality make cyber risk management solutions less effective.

In our new methodology for quantifying cyber risk, a firm's physical IT network is used as a base to create exposure networks with nodes that consist of IT infrastructure, threats, security, and assets. The various properties assigned to nodes allow the network to capture all aspects of cybersecurity more completely. Not only does the methodology give a holistic view of a firm's cyber risk, it also offers a customizable approach to assessing and quantifying cyber risk.

One key strength of our methodology is that it can be scaled – any number of attack trees can be used to generate exposure networks; only with very large networks will there be limits in the computational power available. Even at the bigger end of the scale, techniques to aggregate nodes (or remove insignificant ones) can reduce the computational burden, allowing us to use even larger exposure networks, and even allowing us to create exposure networks that span multiple firms, if necessary. Another key benefit of the methodology is that it can focus on network sections of any size or structure; by removing system sections that are not of interest, we can remove them from the analysis, so that it focuses only on the relevant areas.

A central focus of the methodology is attributing and allocating risk to specific processes and sectors, which allows the responsibility for risk to be assigned effectively – identifying who should be tasked with managing and reducing it. Allocation and attribution provide actionable, dynamic views of the cyber risks within combined physical and network structures, and are essential in ultimately modifying the behavior of firms and individuals.

Potential and Limitations of Virtual Advice in Wealth Management

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Abstract

Technological developments and changing customer preferences are placing demands upon the classical way that private banking clients and wealth management are advised by banks. This article analyzes how the traditional advisory model, whereby the client adviser and the customer interact in the form of a personal dialogue, could be altered by means of virtual advisory models. Based on survey results by wealth management clients in Switzerland, Germany, and Austria, current preferences are analyzed in terms of advice characteristics, and future potential as well as obstacles to the virtual consultation are discussed. A hybrid advisory model offered by established wealth managers appears to be the most promising advisory model for the main customer segments in wealth management.

POTENTIAL AND LIMITATIONS OF VIRTUAL ADVICE IN WEALTH MANAGEMENT

Technological developments and changing customer preferences [Chung-Chi and Jyh-Shen (2012), Date et al. (2013), McKinsey & Co. (2016)] are placing demands upon the classical way that private banking and wealth management clients are advised by banks. This article analyzes how the traditional advisory model, whereby the client adviser and the customer interact in the form of a personal dialogue, could be altered by means of virtual advisory models. In the process, it is important to make a clear distinction from other studies that do not explicitly and exclusively relate to the private banking/wealth management segment. The private banking/wealth management segments typically deal with customers who possess free financial assets of at least €500,000. Most remarks in this article refer to the private banking/wealth management markets in Germany, Austria, and Switzerland and use a representative and regularly conducted survey of high-net-worth clients in the three countries as a data base [Cocca (2016)].[1] While the conclusions of this study can applied to other wealth management markets, it is necessary to take local characteristics into account. Starting from the analysis of the present-day embodiment of a negotiation process in wealth management, the potential for extensive virtualization of this process will be discussed.

INVESTMENT ADVISORY SERVICES

Today's structured advisory process

The classic advisory process in wealth management [Tilmes and Schaubach (2006), Bowen et al. (2008), Collardi (2012), Maude (2010)], which is utilized by wealthy clients, includes the following four phases, which rotate around the central question of "how to invest the client's liquid assets." In the first phase, a comprehensive analysis of the investment needs and objectives of the client is performed. Among other aspects of this process, the risk profile in particular is recorded, which also has high regulatory significance (suitability and appropriateness test in the context of MiFID (Markets in Financial Instruments Directive) regulations). Economically speaking, it is important to consider that the demand function is recorded at this stage. Not all customers are able to identify their investment needs themselves. The identification and formulation of investment needs, for example, is an ability that distinguishes experienced client advisers. As a result, on the basis of the established investment and risk profile, an investment strategy is defined that determines in particular the strategic asset allocation in the plain vanilla asset classes (cash, stocks, bonds) or the relevant currencies in the second phase. In the third phase, the implementation of the defined strategy by means of suitable products occurs. Continuous monitoring and any possible adjusting of the portfolio (rebalancing) represent the fourth ideal phase.

Nowadays, it is common practice that this so-called "structured advisory process" [Mogicato et al. (2009)] is digitized inwardly to varying degrees while barely being digitalized outwardly. The consultant has in-house IT banking systems that, on the basis of customer data (investment and risk profiles), automatically generates an investment proposal in which the current strategic and tactical investment opinion of the bank is expressed. This investment proposal is discussed after a personal dialogue, and adjusted if necessary. In this process, it has become quite common that, by means of simulation software, the client adviser can show the customer how changes to their portfolio in back-testing can affect its return and risk characteristics. What these largely computerized internal processes have in common, though, is that they are only available to the client adviser. While there is an interface between the customers and their advisers, there is no direct access to the bank's internal software-based systems. This architecture allows for strong inward standardization, with a high degree of perceived individualization generated by the human contact externally [Brost (2006)].

Essentially, when creating an investment proposal, the bank's internal system conducts a type of portfolio optimization that is linked to the CRM system (customer data) and the product database. Typically, the bank generally also then provides information about capital market developments (from the bank's own research department or from third parties) and suggests reallocations in the portfolio in the case of market developments (from the bank's own portfolio management). Here, as well, the trend is in the direction of switching or reinvestment proposals being increasingly displayed directly from the banking system for each portfolio on the IT system, with these then being personally communicated from the adviser to the customer.

Nowadays, the contact between customer and bank primarily occurs through personal contacts and personal interaction with the client adviser. On average, wealth management customers have around 17 contacts with their client advisers per year (see Figure 1). Approximately three quarters of these are telephone calls and e-mail contacts. On average, two to three personal conversations are held per year. Video conferencing or video-enhanced telephone calls (Skype, among others), however, are immaterial. As these data show, the penetration of pure virtual forms of interaction with the client adviser is also already widespread in the upmarket customer segment, if one counts phone calls and e-mail. If virtual interaction

1 A total of 369 individuals were surveyed (100 in Germany, 114 in Austria and 155 in Switzerland). The main criterion for participation in the survey was disposable investment capital: over €500,000 in Germany and Austria and over CHF 900,000 in Switzerland. The extensive questionnaire included more than 100 singular questions and allowed, therefore, for a very deep understanding of clients' preferences and behavioral characteristics.

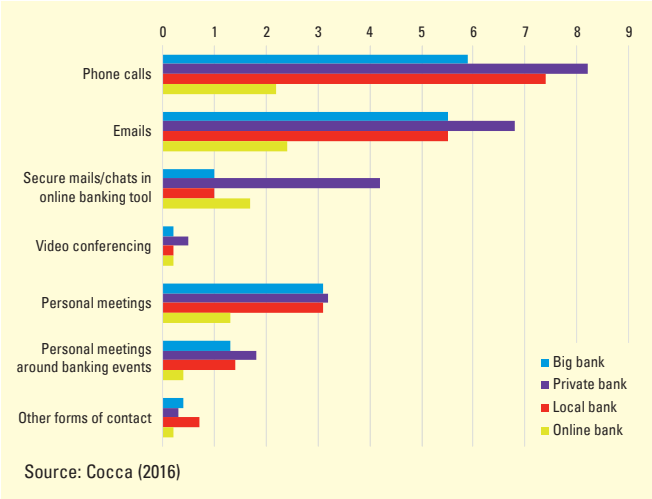


Figure 1 – Form and number of contacts with client advisers per year (compared according to banking groups)

is defined more specifically and includes newer forms of interaction, such as chat or video calling, the result turns out to be sobering. This form of interaction is essentially insignificant in this customer segment. It is clear, though, that face-to-face meetings are of great importance. In terms of quality and the density of interaction, an email cannot realistically be compared with a personal conversation. In any case, it is clear that the interaction is already very much multi-media today, and contact with the client adviser takes place in various forms throughout the year.

Advisory concept

Advisory, as a concept, is in the eye of the beholder; different people have different definitions for what constitutes advisory [Handler (2007)]. For the present work, the minimal definition provided Titscher (2001) can ultimately be used. Based on this, any form of advice that is provided under a defined adviser client relationship, thereby effecting a targeted modification of an existing starting point to a desired goal, can be understood as the professional, external services of a consultant to a client. A legal definition of terms can be modeled on the provisions of the MiFID, which states that "investment advice" means the provision of personal recommendations to a client, either upon its request or at the initiative of the investment firm, in respect of one or more transactions relating to financial instruments (Article 4 (4)). Can these definitions actually include the nature of the advisory business for wealthy individuals? From a psychological or sociological perspective, the term of advisory requires more [Sickendiek et al. (2008)]. Information and communication forms have changed, day-to-day activities are more risky and unpredictable, understanding does not readily occur on its own, trust can quickly be put into question and has to be actively produced, similarities no longer seem self-evident, and identities are fragile. A lot is set in motion: planning takes place in increasingly uncertain and complex planning environments, decisions often have to be made despite the lack of a decision-making basis, and orientation needs to take place amid increasing complexity. However, the actions under these conditions still have to be able to remain professional, efficient, and effective. In this context, seeking advice can be helpful and, sometimes, downright essential. Advice is always embedded in contexts, day-to-day activities, and living environments; hence advisory services need professional expertise, as well as good communications skills. Consulting not only means mastering action techniques; it is also always a contextually produced blend of action competence and reflexive knowledge.

In today's environment, problem-solving calls for cultural and contextual knowledge, knowledge of paradoxes and ambivalences, as well as knowledge of fractures and errors. It is important to anticipate and integrate the viewpoints of others (for example, legal developments, tax laws), to plan and agree an action plan jointly, to impart knowledge, to deal with lack of knowledge, and overcome resistances – these are all components of a comprehensive understanding of wealth management advisory. Advisory is, therefore, not a simple problem-solving process that provides short-term solutions to successfully deal with a question or a problem; rather, it helps to create sustainable change and results. Consequently, this advisory perspective is much broader and strives to achieve what advisory could, or should, be: an offer of education for those seeking advice. This aspect of knowledge transfer as well as the diverse psychosocial aspects receive too little attention in the traditional definition of advisory. It seems important to grasp these dimensions of the advisory concept, though, in order to consider the question of the virtualization of advisory beyond the merely trivial. Already in these definitional embodiments, it is apparent that advisory related to wealth management has, at first glance, a close connection to the concept of "investment advice." However, the next section will demonstrate that wealth management should be viewed as more than just the provision of "investment advisory."

ADDITIONAL SERVICES IN WEALTH MANAGEMENT

Complex additional services

Advisory services, as described above, is the most important service, as measured in terms of net income, that a classic wealth manager provides. However, wealth management also includes a number of other important services, especially in circumstances when clients have assets that are significantly greater than those of retail or affluent customers. When dealing with high and ultra-high net-worth

individuals, the following additional services can be significant [Reichenstein (2006), Reittinger (2006), Kruschev (2006), Hallmann and Rosenbloom (2009)]:

- Discretionary asset management
- Financial planning
- Complex asset allocation (foundations, trusts, etc.)
- Estate planning
- Retirement planning
- Tax planning

Within these services, the advisory takes place in a much more complex context and is dependent on the knowledge of legal and tax-related conditions in the jurisdiction that is relevant for the customer. It also requires a deep understanding of cross-border regulations. The degree of complexity of the legal norms and tax legislation, taking into account the constant dynamics and evolution of such provisions, is very high [Saad (2014)]. In addition, the services offered in wealth management in these customer segments mix with services from other banking fields (investment banking, commercial banking, institutional asset management). Unlike a pure Markowitz portfolio optimization, which can rather easily be described by algorithms, this advisory content places high demands on the ability to crosslink knowledge and apply it to a customer situation with a high degree of specificity. These complex forms of advisory services are now provided almost exclusively in personal consultations and, also because of the high individual costs that arise on the part of the consultant, are charged separately, with specific pricing models. Given the complexity of these requirements, and the environment within which such consultation is provided, the advisors need to possess in-depth knowledge of investment advisory, and also be able to identify where and how to obtain the best advice for the client.

Additional value generating functions

Extending the view of the entire consultation process by upstream and downstream functions can offer some additional perspectives on the potential for digitization. Consequently, customer acquisition and the related customer allocation to a client adviser (client acquisition, adviser selection, and matching) could be subject to technologically driven changes. From a regulatory point of view, the overall "on-boarding" phase is also of central importance. Finally, the aggregation of the overall financial situation can also be incorporated in this consideration as quite relevant.

Client acquisition, adviser selection, and matching

The assignment of a client adviser to a new client is largely random and unsystematic in today's environment, which is surprising given its importance in influencing whether the client decides to have a long-term relationship with the bank or not. In private banking, customer acquisition primarily takes place through referrals [Maude (2010)]. This means that affluent customers share their own perceptions and experiences in their social network. In this process, both professional and interpersonal factors at the level of sympathy play an essential role. The assessment of what makes a good adviser is, therefore, individual and subjective. If the chemistry between Customer A and Consultant Z works well, this does not at all mean that the recommended Customer B also corresponds to Consultant Z. Today, this subject is still given little attention, and the assignment of a customer to a client adviser is determined either by the recommendation relationship or, often, quite randomly, with a client adviser being assigned to a potential customer mainly due to time constraints. In addition, the customer rarely has the ability to make an informed decision, because they are not able to choose from a variety of client advisers corresponding to their professional and interpersonal preferences.

From the outset, though, it is difficult to assess which customer characteristics best fit, at least on paper, to a given adviser's characteristics. The right match is not trivial, as Cocca (2010) shows. Basically, there seems to be a tendency towards "like attracts like," at least in terms of the criteria of age and – even more pronouncedly – gender. In any case, the personal "chemistry" between the client and the consultant plays a very important role. The sympathy that one feels towards their consultant (and probably vice versa) dictates whether the client demands a change of advisor or not. As in real life, there has to be a spark between a consultant and a customer in order for there to be a prospect of a long-term relationship. As in real life, this process certainly cannot be institutionalized. 13% of private banking customers actually want another client adviser [Cocca (2010), Cocca (2014)] – which is a remarkably high proportion. Bearing in mind that, in private banking, a bank gains an average of around 1% to 3% of net new customers per year, this indicates that the growth of around six financial years is at stake. However, considering the guidance-related aspect that is crucial for the desire for a change in consultants, it is evident that customers who are ready for change express themselves negatively, especially in terms of sympathy and the allocation of speaking time during a consultation. Around 80% of customers who want a change in consultant indicate that the client advisers generally speak most during customer conversations, and around 60% do not like their client advisers. These dissatisfied customers are a latent migration risk for the bank. For this reason, it is worth every investment in the recognition of this potential for dissatisfaction and in the improvement of the assignment of the "right" customer advisor to a customer. This "matching" process could be helped tremendously through the use of social media. Consultants can be rated by the community, and be assigned to a customer on the basis of relevant professional (training, experience, expertise, etc.) as well as purely private criteria (hobbies, religion, languages, etc.).

On-boarding

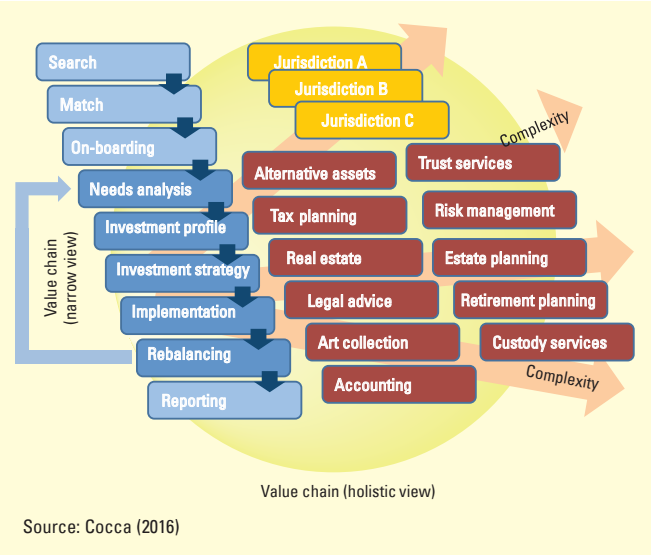
On the part of the bank, a further partial step in customer acquisition, which still receives little attention in discussions about the change potential of digitization, is of great importance, and that is customer identification as part of the on-boarding process [Dwivedi (2016), Thomson Reuters (2016)]. In this regard, key regulatory requirements are to be met that demand that the know-your-customer (KYC) approach and which, based on risk, require clarifications of the background of the client and their financial circumstances. In the context of a virtual bank environment in which a bank draft should be performed more frequently and easily, the question arises as to whether each bank has to perform clarifications regarding regulatory requirements, from the above-mentioned suitability tests to the fulfillment of money laundering provisions, for each potentially new customer. For more complex customer situations, an account opening in wealth management may take several months until all the investigations have been performed. Taking advantage of digital opportunities, it is conceivable that each client be checked by a non-bank entity with respect to the compliance with all these rules, and that a central personal identity be generated that each bank can access when the corresponding customer wants to begin or considers beginning a customer relationship. In this way, the customer identification process would be much more efficient and would also be improved in terms of quality by means of specialization.

Holistic wealth management

Throughout the entire consultation process, the focus on the entire wealth of an individual is a central aspect of holistic advisory. In this process, the main question is which provider has the overall view of the customer's assets. This may well be called the "Holy Grail" of wealth management advisory. For high-net-worth clients, this function can be fulfilled by the family office, an independent asset manager, or the main bank. An enormous challenge remains, however, for a complex fortune to generate such a consistent overall view, which allows continuous control based on current market data across all asset classes. In addition, it is usually the customers themselves who avoid such a concentration of power with a provider that holds all the information and pulls all the strings. An independent entity that performs such an aggregator role by using digital technology would be beneficial in ensuring optimal advisory results. Examples such as MINT, which makes such an offer for the retail and affluent spec, demonstrate the potential of the approach. However, it quickly becomes apparent just how difficult such an implementation is as soon as complex investments with alternative asset classes and different jurisdictions are involved.

The entire perspective on wealth management services

Figure 2, which provides a visual manifestation of the diversity of advisory services provided in wealth management, demonstrates that the current perspectives of robo-advisers are based almost exclusively on a narrow view of the advisory process and not the full range of conventional advisory activities, or interfaces and overlaps between the general topics being adequately considered.



Source: Cocca (2016)

Figure 2 – Wealth management value chain

POTENTIAL FOR VIRTUALIZATION

Standardization versus complexity

In order to provide a service virtually, it has to be possible to map it in software, an algorithm, or a different kind of expert system [Guinan et al. (2016)]. To some degree, this requires the service elements to be standardizable. The level of complexity of advisory services in the financial industry is very different. Thus, the degree to which a rendered service can be offered completely virtually differs as well. What kind of financial advisory customers will prefer to receive advice based on an algorithm or provided in person is a question of individual preferences. It is conceivable that certain easily standardized services can be provided more cheaply by an algorithm, whereby comparative cost advantages can be achieved compared to the service provided by client advisors. It is not readily apparent, though, whether it is possible to capture a large market share in advisory services in such a trust-based business as wealth management by offering the service solely via algorithms. The most likely scenario is that specific issues are increasingly automated by algorithms and thus offered as a commodity, while traditional service providers could be forced into more complex advisory services. However, such predictions have to consider that wealth management advisory has a high degree of complexity when knowledge and expertise have to

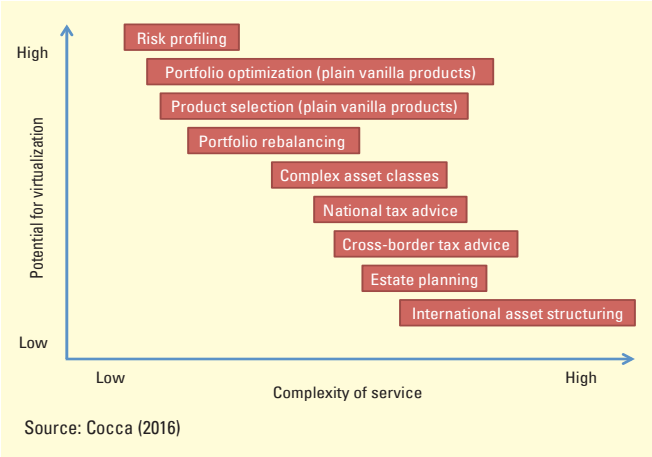


Figure 3 – Potential for virtualization

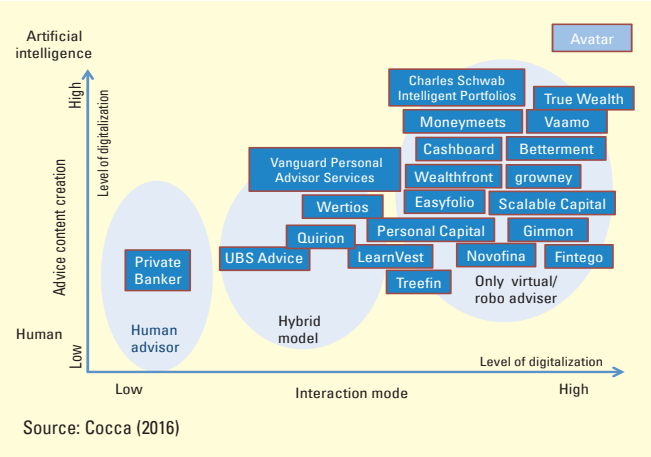


Figure 4 – Virtualization dimensions

be applied, such as from other disciplines. The combination of legal, tax, and financial issues, for example, is hardly suitable for mapping by algorithms, since each case has so many degrees of freedom and requires such case-specific solutions that standardization can hardly be achieved efficiently. An additional layer of complexity is also created by the frequently encountered relevance of various jurisdictions, leading to more complex asset structuring (see Figure 3).

Efficiency of human interaction

Given the available software solutions for financial planning, the potential for the virtualization of advisory services could be high. Once the algorithms have to represent more complex issues, however, the required technical expertise for entering the data increases. Thus, a limiting factor that cannot easily be solved by digitization is that a certain measure of expertise is required in order to feed a more complex algorithm with data. In such a case, the (human) adviser often plays an important intermediary role. Through their knowledge, the advisors are able to manage the relationships in a simpler and more comprehensible language. Their experience also helps manage issues that can be confusing for the average customer. One can learn from experiences of other industries that have only partially been addressed by digitization. The medical services industry is a good example. Those subtle interaction signals that are expressed in a personal interview through language, facial expressions, and posture, demand the involvement of an individual. Is the customer uncertain? Is there something that they have not really understood? Why do they hesitate? What seems to be bothering them? The importance of reading body language, which to this day has not been mastered by technology, should not be underestimated.

Dimensions of virtualization

Conceptually, the issues facing digitization in the wealth management advisory industry can be divided in the following manner:

- **Virtualization of the interaction:** this refers to the configuration of the communication channel between the advising entity and the customer. The communication can be performed physically and personally (one-to-one meeting) such that the consultant and the client meet in a conference room of the bank and have a conversation. A virtualization of this communication environment can now take place such that a conversation with the client adviser is performed through a digital channel, whereby it can be decided whether a pure text, voice, or image transmission is involved.
- **Virtualization of the advisory content:** The content of the consultation can be virtualized to varying degrees. Here, the central question is whether the advice has been created by a human intellectual performance or an information processing procedure based on a programing code: for example, an expert system or other algorithm.

From these two dimensions, the conceptual forms of advisory shown in Figure 4 can be created. The traditional private banker who personally meets the customer and provides advice based upon his/her experience and knowledge represents the basic model. A first evolution of this advisory model is the hybrid advisory model, in which the customer relationship is still dominated by the client adviser but the customer can make use of personal meetings as well as e-mail, chat features, or video telephony. Moreover, the customer has the ability to use certain analytical or simulation programs, such as via an app or webpage. This corresponds to a changed communication and interaction behavior that can be observed today on a large scale

[Kitces (2016)]. A second stage of evolution is the elimination of a personal consultant. The resulting "robo-adviser" is an information processing system that automatically generates the advisory content. Consequently, the interaction only takes place over a virtual channel. As media technology and artificial intelligence develop more in this area, another conceivable future developmental stage could be advisory represented by an avatar, which could connect the capacity of processing information with a quasi-human face.

RELEVANT CONSIDERATIONS BEYOND VIRTUALIZATION

Trust

Trust is a key element in wealth management. Advisory only has a perceived and demanded value when the advised party has a strong sense of trust. Financial matters seem to demand a higher level of trust than other consumption decisions. Trust in wealth management reflects many aspects, the most important being gained expertise in a field, capital strengths, and general reputation of an institution or the person representing it. A non-negligible element of trust, particularly for very wealthy clients, is the question of liability: who will be legally liable in the case of misadvising. This liability capital will depend on the financial strength of an institution, which makes it difficult for small companies to do business with very wealthy clients.

Regulation

Certain regulatory requirements make digital advisory, clearly structured, appear attractive to service providers. The thorough digital processes that clients have to follow allows for an uninterrupted verifiability of compliance with legal requirements [i.e., MiFID (Markets in Financial Instruments Directive)]. In such an environment, customers cannot behave in a way that is not compliant, and consequently the services provided by the bank will always be compliant. However, a virtual customer relationship may undermine the KYC approach in another area; namely, in a regulatory as well as a business-policy sense. In terms of regulation, a pure virtual customer relationship makes it possible to ensure that the customer is compliant any given time through electronic monitoring. However, adequate attention might not be given to certain important information that can seem suspicious to a trained client adviser. Big data allows for the profiling of customers and the prognosis of future customer behavior, but, especially in dealing with very wealthy clients, the question arises as to whether the personal relationship with the customer and the knowledge of a customer does not also include valuable information regarding their preferences and potential future needs. Moreover, a customer may feel more willing to talk about the consequences of the sudden passing away of their wife when the long-time adviser to the family addresses this delicate issue with due care, whereas a robo-adviser might send a change of text of the testament contract by e-mail on the basis of the calculated probability of such a scenario.

Service integration

In future virtual banking solutions, consideration has to be given to the enormous complexity of interfaces between financial services. Today's robo-advisers or online brokers offer only a very small portion of the range of services. The advantage of an established wealth management provider, for example, is the facilitating of interfaces for upstream or downstream services. This problem arises particularly if the services need to be integrated across national borders or the service does not include plain vanilla products. It is precisely in wealth management, though, that such questions appear with great regularity, bringing with them a very flexible and, therefore, expensive IT infrastructure – not least of all with many human interfaces and low straight through processing rates. The development of a fully integrated financial services offering, for example, provides enormous potential, but also represents a major challenge. This is somewhat demonstrated by the large number of FinTech companies that are currently active in the market and that offer solutions in a barely identifiable number of niches. The question of who can bring together a comprehensive total offering is currently in the background, but it is likely to be very relevant in the future. Established banks have certain advantages in this respect.

The relevance of human interaction

The central question seems to be how important human interaction is to an adviser, especially when it comes to advising wealthy individuals in financial matters. A view of empirical findings from other advisory industries that have similarities to the financial sector can be helpful in this regard. Medical advisory, for example, can be described as comparable to wealth management advisory, due to (1) the complexity of the provided advisory services, (2) the potential importance of the advisory for the individual, (3) the great importance that is attached to the trust, and (4) because a variety of online services is being developed in the area. A number of studies in this field [Cotten and Gupta (2004) and Fox and Rainie (2000)] find that a person who is healthier and happier is more likely to search for answers to medical issues online, while those who are severely ill visit a doctor. A dominant theme in the literature is the factors that influence consumers' trust in the information or advisory offered online [i.e. Sillence et al. (2006)]. Although internet usage occupies an increasingly important role, particularly during the information gathering phase, the doctor and the personal conversation with him/her remain the primary source of information and advisory [Sillence et al. (2007)].

In addition to the use of virtual advisory in the health sector, the use of legal advisory also seems to have parallels with financial advisory. Progress in this area can also be recognized, but some evidence suggests that major challenges still exist when it comes to approximating

or replicating the advisory provided by a person with a machine [Bench-Chapon (2015)]. Another area of research that seems to be relevant is the field of human computer interaction (HCI), where studies have been conducted into how trust is, and can be, generated between man and machine [Cheskin (1999), Schneiderman (2000), Olson and Olson (2000), Corritore et al. (2003), Derbas et al. (2004), Marsh et al. (2004), Riegelsberger et al. (2005), Wang and Emurian (2005), Robinette (2015)]. It seems that despite the technological advances, there is still a long way to go before we get to a stage where information systems or robot advisors are able to replicate the kinds of advice that a human being is able to provide [Waern and Ramberg (1996), Torrey et al. (2013), Kim and Gambino (2016)]. The challenge lies both at the level of content-related information processing (the meaning, linking, and evaluation of information) [Alvarado-Valencia and Barrero (2014), Parkes and Wellman (2015)] as well as in the form of interaction (recognition of voice, gestures, and facial expressions). In addition, the extent to which sensitive data (financial advisory also undoubtedly involves very sensitive data) is exchanged in the same manner with a machine as with a human partner is still not clear. This will particularly play a central role when technology has advanced so far that avatars will be able to be involved in a real advisory situation with customers [Pickard et al. (2016)].

From these research fields, conclusions can be derived which are also important for financial advisory:

- The complexity of the consultation content is high when it comes to covering a wide range of advisory topics; and not just single, easily standardized elements.
- Trust in the quality of the provided advice is still a problem in virtual environments where advisory is replaced by a machine. A person seems to still trust a human counterpart more than a machine.
- In interaction, the machine is far from able to replicate the subtle and varied communication and interaction patterns of a person.

Today's client preferences

Based on the collected customer data [Cocca (2016)], attitude towards and use of online advisory is illustrated. The analyzed customer data support a generally high technological affinity[2] of private banking customers, regardless of banking services. Approximately two-thirds of respondents gladly use digital options for information and communication in everyday life. That alone does not automatically mean that online services related to wealth management and investment advisory will explicitly be in demand. The relationship between general technology affinity and the current use of online banking services shows a mixed picture:

- No significant statistical correlation results between the general affinity for technology and the effective use of online wealth management services.
- There is a significant statistical relationship between the general affinity for technology and the occasional use of online banking to transmit orders/stock orders to the bank.
- There is no significant statistical relationship between the general affinity for technology and the regular virtual interaction with the client adviser.
- The wealthier the person, the more important a human interlocutor/adviser is.
- The older the person, the more important a human interlocutor/adviser is.
- The higher the level of expertise, the higher the affinity for technology.
- The lower the risk aversion, the higher the affinity for technology.

If the general affinity for technology is placed in relation to statements about future behavior, a much stronger relationship is evident. A statistically significant correlation exists with the statements "I can well imagine receiving consultation from my client adviser primarily online," "I can well imagine performing financial transactions and investment transactions with the bank primarily online," "I can well imagine performing financial transactions and investment transactions – regardless of my bank – primarily online." Respondents are open minded in terms of a hypothetical use of future virtual offers. These prospective statements should always be taken with some caution, though, since they are hypothetical. Other findings from the data analysis paint a more nuanced picture of the "digital future." The main results can be summarized as follows:

- About two-thirds of the surveyed private banking customers are open minded in terms of the use of online financial services, but personal contact with their client advisers is just as important to them. For a clear majority of the customers, there is no question of the use of a pure online service offering.
- Around 30% of respondents can imagine using a purely online service offering. Especially in younger private banking clients (young in this context means less than 60 years of age[3]), the proportion rises to 45%.
- The observed generation gap (younger respondents have a greater affinity for technology than do older respondents) is also not unexpected. This shows that, for younger private banking customers, online financial services have become even more important than personal contact, although the latter is still meaningful. What is surprising is the fact that the generation gap closes more quickly than is generally expected. A comparison of the

2 The question is as follows: "In everyday life, I gladly use new options for information and communication offered by the internet ("true" - "not true," score 0-10)?
3 The average age of a private banking/wealth management client is 60-65 years.

results of previous surveys shows that, in some areas, the older customer groups (over 70 years of age) have meanwhile nearly caught up with younger ones in terms of technological affinity.

- Another interesting result of the analysis that is so far generally not recognized is that technological affinity in private banking is very much gender dependent: male private banking customers have a significantly greater affinity for technology than their female counterparts. This does not mean that women have no affinity for technology, rather that the proportion among men was significantly greater. This finding could have implications for the design of online financial services.
- It is also evident that the self-assessment of personal risk tolerance and one's own knowledge of financial matters has a significant positive relationship to technological affinity in general, as well as to the hypothetical use of online services in the future.

The data support the finding that new technological possibilities are undoubtedly becoming increasingly important in private banking. An answer seems to be appearing to the question regarding the extent to which age-related conservatism superimposes technological affinity at a young age in the case of private banking customers. The age gap observed in the past regarding the use of new technological opportunities in private banking is fast disappearing, since now even the older generations of customers have developed a significant affinity for technology.

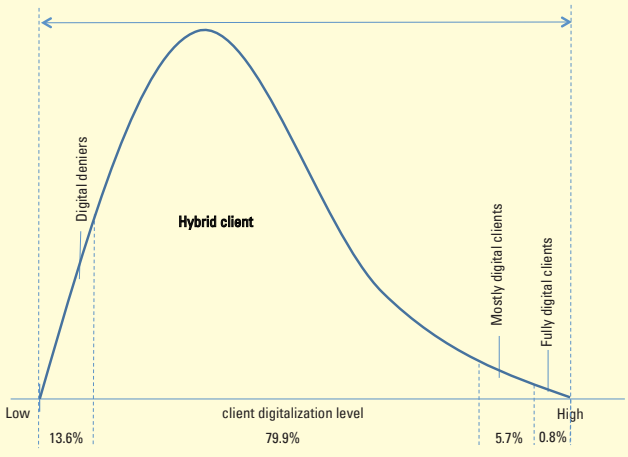
To place the previously developed differentiated image in an overall context, the totality of the surveyed customers, which is representative of an average customer book in private banking, is illustrated in segments by means of the degree of digitization. In this regard, four relevant segments that differ in terms of the degree of digitization (i.e., how they make use of online private banking services today) can be distinguished:

- **Digital deniers:** the client has a personal adviser and does not use any virtual banking channels.
- **Hybrid client:** the client has a personal adviser and uses virtual banking channels for services related to wealth management.
- **Mostly digital:** the client has no personal adviser and more than half of his/her wealth is with an online bank.
- **Fully digital:** the client has no personal adviser and all of his/her wealth is with an online bank

Figure 5 now shows how the customer base is distributed: 13.6% are digital deniers, 79.9% are hybrid customers and 6.5% are digital customers today.

Digital deniers also display the following characteristics in the group comparison. They have higher average age, proportion of women, average wealth, and individuals who are risk averse, and lower proportion with good/very good knowledge and overall technological affinity.

Digitals, on the other hand, have the following characteristics. They have lower average age, percentage of women, average wealth, and individuals who are risk averse, and have higher proportion with good/very good knowledge and overall technological affinity.



Source: Cocca (2016)

Figure 5 – Degree of digitalization of wealth management customers

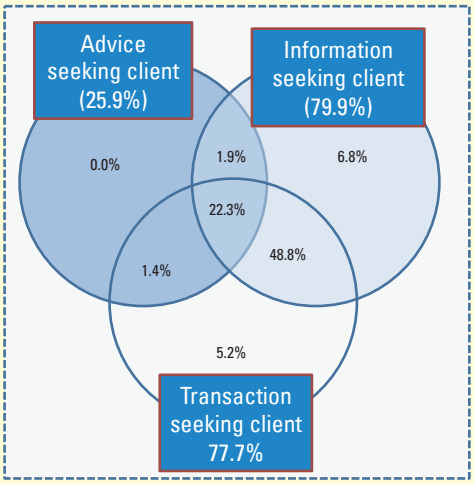
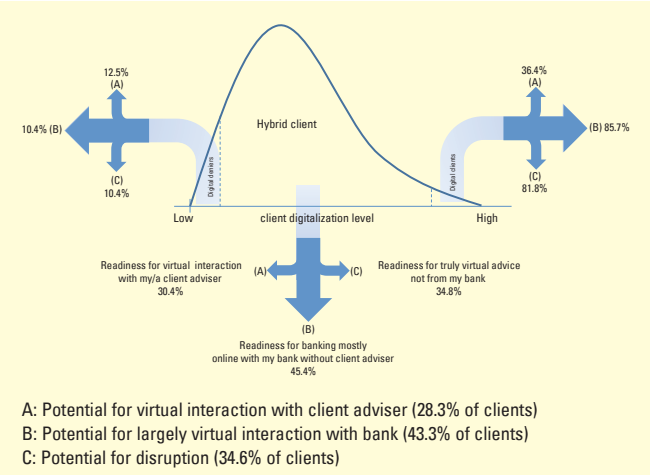


Figure 6 – Use of online services by hybrid customers

Hybrid customers can be analyzed further with respect to their use of online services and their quantitative distribution. In this process, the following types of use can be distinguished:

- **Information seeking client:** i.e., enquires about portfolio information or becoming informed about markets and investment opportunities.
- **Advice seeking client:** i.e., stay in touch with the client adviser and is advised by the client adviser via the internet.
- **Transaction-seeking client:** i.e., give the adviser instructions or send trading orders.

Figure 6 shows the quantitative distribution of these types of use, including the intersections. As a result, it is clear that in the case of hybrid customers, online services are mainly used for obtaining information and transmitting transaction. However, only 25.9% use the online channel to remain in contact with the consultant or to seek advice.



A: Potential for virtual interaction with client adviser (28.3% of clients)
B: Potential for largely virtual interaction with bank (43.3% of clients)
C: Potential for disruption (34.6% of clients)

Figure 7 – Use of online services by hybrid customers

In a prospective consideration, the question of which tendencies the various customer segments show in terms of making use of virtual wealth management services in the future can now be investigated. In this regard, a distinction is made between readiness for virtual interaction with a client adviser, readiness for banking mostly online with their bank but without a client adviser, and readiness for truly virtual advice not from their bank.

Figure 7 shows how these three dimensions respond for the three segments according to the survey results:

- Among the **digital deniers**, only 12.5% of respondents said that they could imagine interacting virtually with their client adviser in the future. Moreover, only 10.4% can imagine dispensing with the client adviser and generally interacting online with the bank. The proportion is the same with regards to people who can imagine completely virtual consulting from a third party.
- Among the **hybrid customers**, only 30.4% of respondents said that they could imagine interacting virtually with their client adviser in the future. As many as 45.4% can imagine dispensing with the client adviser and generally interacting online with the bank. Moreover, 34.8% can even imagine completely virtual consulting from a third party.
- Among the **digitals**, 36.4% of respondents could imagine interacting virtually with their client adviser. As many as 85.7% can imagine dispensing with the client adviser and generally interacting online with the bank, while 81.8% can even imagine completely virtual consulting from a third party.

Dimension A, therefore, represents the potential of a primarily virtual interaction with the customer advisor. Dimension B shows the potential for an elimination of the client adviser, while dimension C represents the disruption potential if customers are willing to make use of completely virtual consulting by a third-party. To assess the potential of these dimensions, the totals of A, B, and C are presented across all segments. As shown in Figure 7, a fundamental potential arises for future forms of online advice, which is in the range of 30% to 40% of today's customer base. Potential in this regard refers to customers who, from today's perspective, can imagine making use of such a service.

ROBOADVISER & CO.

The manifestation of virtual advice concepts is best seen today in the area of robo-advisers. A robo-adviser is an online investment platform that provides automated online investment advice and uses algorithms to determine asset allocations and automated rebalancing for investors. Each client's portfolio is structured to achieve optimal returns at every level of risk. A key investing approach used by robo-platforms is to invest in low-cost ETFs that minimize embedded investment costs. The "robo" part of their name refers to the fact that no human contact is involved. At the heart of today's players in the field of virtual advice is a more or less complex proprietary algorithm. In most cases, the firm's investing strategy involves the use of Modern Portfolio Theory to design customized ETF portfolios. The average portfolio size at companies like Wealthfront or Betterment is in the range of 20T to 40T U.S.$. This could be an indication that today's rather simple virtual forms of advice are directed to retail clients that have most likely never had access to a dedicated wealth adviser. Moreover, most concepts are directed at ETF investments

and, therefore, build on a low-cost selling proposition, eventually giving access only to ETF investments for low wealth clients in a cost-effective manner.

Looking at the overall wealth management market, some providers have achieved a relevant size in particular markets with an affinity for technology (such as the U.S. or U.K.) within a relatively short time. However, the current total market share of the wealth management market attributable to robo-advisers is well below 1%. Companies like Betterment (U.S.$ 3.2 bln assets under management (AUM)), Wealth Front (over U.S.$ 2 bln AUM) and Nutmeg (U.S.$0.5 bln AUM), which are among the pioneers of robo-advisory services, have yet to show whether they have succeeded in maintaining their initial high growth rates. Among the established providers, the offerings of Charles Schwab, Vanguard (Vanguard Personal Advisor Services) and UBS (UBS Advice), among others, can be mentioned. According to estimates, these companies now manage significant client assets on a virtual platform (or according to a hybrid model). It is observed that, when it comes to offering more complex services or when the client's assets are very substantial, even robo-advisers turn to a financial adviser.

At one robo adviser, for example, you might have financial planning questions that involve budgeting, developing a financial plan, buying or selling a home, planning for a newborn, planning for retirement, or developing a college savings plan for a child. For all of these questions, you'll have access to a financial advisor. At another robo adviser, clients with an account balance of U.S.$ 500k or greater can schedule a one-time personal consultation with one of the firm's in-house financial advisers. Moreover, what is striking is the linking of the robo-adviser with the discussion of the advantages of passive versus active investing. The question of who uses robo-advisers today can probably best be answered by looking at the market positioning of most providers. It seems that customers who, due to their small asset sizes, have never enjoyed the benefit of extensive wealth management advisory that are the most active users of rob-advisors. Robo-advising offers a viable, low-cost investment solution that is within reach of even new investors who are starting out with small investment amounts. Investors with complex estate, business, or tax circumstances may particularly benefit from the more customized guidance of a traditional financial adviser. The offer of robo-advisers, therefore, seems to be intended for retail and affluent customers [EY (2016)]. For classical wealth management clients, the traditional human adviser provides the kind of personal, hands-on service that investors consistently seem to prefer. Investors' preference for human advice is further evidenced by the decline of self-directed investors – those who want to handle their own portfolios and are not looking for advice. Since 2010, the population of self-directed investors has declined from 45% to 38%, even as the tools for monitoring and managing portfolios have steadily improved [Smith (2016), Cocca (2016)].

The "natural" limit in the development of robo-advice could be that simple risk-tolerance questionnaires, which serve as the core of robo-advisers' client-discovery process, do not get to the heart of understanding the entirety of an investor's financial needs and goals and how their investment portfolio works in the context of their complete financial circumstances. Fein (2015) also evaluates whether robo-advisors meet a high fiduciary standard of care and act in the client's best interest. Based on a detailed review of user agreements for three leading robo-advisers, Fein concludes that robo-advisers do not live up to the Department of Labor's (DoL's) requirements. From a regulatory point of view, it is often unclear where the boundaries lie between a personal recommendation and information/execution only, and whether this is transparent enough for the end-user. These regulatory challenges could become more important as the use of robo-adviser increases. The regulators could take the view that robo-advisers are failing to perform the same level of due diligence that authorized advisers have to conduct, since by their very nature robo-advisers are working from questionnaires that are filled out electronically and that are largely go unchecked in terms of whether the information is accurate.

CONCLUSION

Contrary to some spectacular perspectives, which are generally attributed to FinTech firms at present and in the specific context of virtual advisory in wealth management, the following key aspects of the potential of virtual advisory can be formulated:

- **Mastering complexity:** currently, robo-advisers are only able to manage a financial decision with low complexity in a virtual environment. Crucial to success in wealth management will be the ability to offer more complex financial services in a cross-border context and in a virtual form or, by means of technology and innovation, to change the basic architecture of a service and simplify it to such an extent that it will be easier to digitalize it [Deutsche Börse (2016)]. Of relevance will be the degree of improvements in the technical capability of hardware and software, as well as the extent by which national and international regulatory and legal systems converge or diverge.
- **Building trust among the target group:** financial consultancy requires a very high level of perceived customer trust towards the advisers and the institution. This can manifest itself in the form of reputation capital or high capital strength and, thus, of recoverable assets in the case of legal disputes. For start-ups, this represents the biggest challenge. Conversely, established wealth managers can use their existing reputations to place a "hallmark" on a hybrid or purely virtual offer. It, therefore, appears most likely that the most successful offers will come from

established providers. A mixed form in the sense of a reputation transfer would exist if a strong brand from the virtual consumer sector (i.e., Amazon, Google, etc.) would try to expand into the financial sector by working with FinTech companies.

- **Financial expertise as a hurdle:** advancing into more complex financial services could be technically possible but has as yet not been tackled. A limiting factor could be the knowledge (or time) that is necessary for such use.
- **Replacing the customer advisor:** if it is possible to produce an advisory experience with pure virtual offers and to have the "old consultant" forgotten by means of new features or solutions, then self-directed and finance-literate customers could be serviced to a large extent with such an offer.
- **Segment-specific offers:** advising clients from the affluent segment appears most promising from today's perspective, since the greatest similarity exists between the investment advisory obtained today and the offer of a virtual investment consultancy. The response to the needs of HNWI or UHNWIs has to be looked at more critically. As observable to some degree in online brokerage, it is conceivable that HNWI or UHNWI customers might dedicate a (small) portion of their assets to online trading. The majority of the assets, though, remains in traditional advisory models, which provides a clear potential for hybrid advisory models in the upscale customer segments.
- **Pricing model:** what all current robo-adviser offerings have in common is that they try to offer a standardized service over a virtual channel at significantly more attractive terms, thereby attacking the fees, and fee structures, of established providers. The threat to traditional wealth managers is that, on average, a large portion of revenues is derived from highly standardized services that can be easily digitized. Hence, a highly relevant portion of income is at stake.
- **Hybrid model favored:** from today's perspective, it can be noted that, despite the increased use of technology, personal contact with a client adviser is still important, or very important, for the majority of private banking/wealth management customers. This could mean that a hybrid, bank-centric model can be expected to have the greatest potential for the future.
- **FinTech challenge:** the increasing number of FinTech offerings in wealth management is a positive development from the perspective of promoting innovation. Based on the issues explored in this article, it is not expected that the market share of such offers will rise substantially in the medium term. The confusion resulting from the large number of providers is a problem in terms of market fragmentation and will eventually allow only a few to gain a foothold in the market. Since the combination of established brand strength and existing customers with the innovative strength of a FinTech company combines the benefits "of both worlds," FinTech companies should not be seen so much as competitors to established operators, but rather as strategic cooperation partners. Private banking providers, therefore, face the challenge (or opportunity) of developing existing business models by means of integrating innovative solutions from the "FinTech" sector. This proves that it is generally up to the established private banking providers to meet the digital needs of their increasingly technology-friendly clientele.

REFERENCES

- Alvarado-Valencia, J., and L. Barrero, 2014, "Reliance, trust and heuristics in judgmental forecasting," Computers in Human Behavior 36, 102–113
- Bench-Chapon, T., 2015, Knowledge-based systems and legal applications, London: Academic Press
- Bowen, J., P. Abram, and J. Powell, 2008, Breaking through: building a world-class wealth management business, San Martin: CEG Worldwide
- Brost, H., 2006, "Standardisierung versus individuelle fertigung im private banking," in Brost, H., and M. Faust (eds.), Private banking und wealth management, Munich: Bankakademie Verlag
- Chung-Chi, S. and C., Jyh-Shen, 2012, "The antecedents of online financial service adoption: the impact of physical banking services on internet banking acceptance," Behaviour & Information Technology 31:9, 859-871
- Cocca, T., 2010, Beratungsqualität, Zurich
- Cocca, T., 2014, LGT Private Banking Report, Zurich
- Cocca, T., 2016, LGT Private Banking Report, Zurich
- Collardi, B., 2012, Private banking: building a culture of excellence, Singapore: John Wiley & Sons
- Corritore, C. L., B. Kracher, and S. Wiedenbeck, 2003, "On-line trust: concepts, evolving themes, a model," International Journal Human– Computer Studies 58, 737–758
- Cotten, S., and S. Gupta, 2004, "Characteristics of online and offline health information seekers and factors that discriminate between them," Social Science & Medicine 59, 1795–1806
- Date, H., S. Hundewale, A. Kammani, and R. Safeena, 2013, "Combination of TAM and TPB in internet banking adoption," International Journal of Computer Theory and Engineering 5: 146-150
- Derbas, G., A. Kayssi, H. Artail, and A. Chehab, 2004, "TRUMMAR: a trust model for mobile agent systems based on reputation,, Proceedings of IEEE/ACS International Conference on Pervasive services (ICPS'04): 113–120
- Deutsche Börse, 2016, Future of FinTech in capital markets, http://bit.ly/295dwkL
- Dunbar, I., 2016, "Robo-advice - short term fad, or the future of financial advice?" Equity 30, 1: 8-9
- Dwivedi, A., 2016, "Know your customer - an anti money-laundering perspective," http://ssrn.com/abstract=2765492
- EY, 2016, "Advice goes virtual – how new digital investment services are changing the wealth management landscape," http://bit.ly/1Rwykh2
- Fein, M. L., 2015, "Robo-advisors: a closer look," http://ssrn.com/abstract=2658701
- Fox, S., and L. Rainie, 2000, "The online health care revolution: how the web helps Americans take better care of themselves," Pew Internet & American Life Project, http://pewrsr.ch/2dvbYAH
- Guinan, P., R. Kafka, and S. Parise, 2016, "Solving the crisis of immediacy: how digital technology can transform the customer experience," Business Horizons 59:4, 411-420
- Hallman, V., and J. Rosenbloom, 2009, Private wealth management: the complete reference for the personal financial planner, New York: McGraw-Hill
- Handler, G., 2007, Integration systemischer elemente in die klassische beratung, Wiesbaden: Deutscher Universitäts-Verlag
- Kim, J., and A. Gambino, 2016, "Do we trust the crowd or information system? Effects of personalization and bandwagon cues on users' attitudes and behavioral intentions toward a restaurant recommendation website," Computers in Human Behavior 65, 369–379
- Kitces, M., 2016, "The future of financial planning in the digital age," CFA Institute conference proceedings Quarterly 2, 7-22

- Kruschev, W., 2006, Vermögensverwaltung, in Brost, H., and M. Faust (eds.), Private banking und wealth management, Munich: Bankakademie Verlag
- Marsh, S., P. Briggs, and W. Wagealla, 2004, "Considering trust in ambient societies," International Conference for Human–Computer Interaction (CHI 2004) Extended Abstracts, https://core.ac.uk/download/pdf/4149581.pdf
- Maude, D., 2010, Global private banking and wealth management: the new realities, Chichester: John Wiley & Sons
- McKinsey & Company, 2016, "How wealth managers can transform for the digital age," http://bit.ly/2bUDaJY
- Mogicato, R., G. Schwabe, P. Nussbaumer, E. Stehli, and M. Eberhard, 2009, "Beratungsqualität in banken. Was der kunde erwartet. Was der kunde erlebt," Institute of Informatics, Zurich: University of Zurich
- Olson, G. M., and J. S. Olson, 2000, "Distance matters," Human–Computer Interaction 15, 139–178
- Parkes, D., and M. Wellman, 2015, "Economic reasoning and artificial intelligence," Science 349, 267-272
- Pickard, M., C. Roster, and Y. Chen, 2016, "Revealing sensitive information in personal interviews: is self-disclosure easier with humans or avatars and under what conditions?" Computers in Human Behavior 65, 23–30
- Reichenstein, W., 2006, "After-tax asset allocation," Financial Analyst Journal 62:4, 14-19
- Reittinger, W., 2006, "Financial planning im wealth management," in Brost, H., and M. Faust (eds.), Private banking und wealth management, Munich: Bankakademie Verlag
- Riegelsberger, J., M. A. Sasse, and J. D. McCarthy, 2005, "The mechanics of trust: a framework for research and design," International Journal of Human-Computer Studies 62, 381–422
- Robinette, P., 2015, "Developing robots that impact human-robo trust in emergency evacuations," Dissertation, The Academic Faculty, Georgia Institute of Technology
- Saad, N., 2014, "Tax knowledge, tax complexity and tax compliance: taxpayers' view," Procedia - Social and Behavioral Sciences 109, 1069-1075
- Schneiderman, B., 2000, "Designing trust into online experiences," CACM, 43: 57–59
- Sickendiek, U., F. Engel, and F. Neumann, 2008, Beratung: eine einführung in sozialpädagogische und psychosoziale beratungsansätze, Wiesbaden: Juventa
- Sillence, E., P. Briggs, P. Harris, and L. Fishwick, 2006, "A framework for understanding trust factors in web-based health advice," International Journal of Human-Computer Studies 64, 697–713
- Sillence, E., P. Briggs, P. Harris, and L. Fishwick, 2007, "How do patients evaluate and make use of online health information?" Social Science & Medicine 64, 1853–1862
- Smith, S., 2016, "No: investors need—and want—the human touch," Wall Street Journal, 28 February, http://on.wsj.com/1QQ7LWn
- Thomson Reuters, 2016, "Digital innovation in client onboarding and KYC: in a digital world, don't get left behind, http://tmsnrt.rs/2dB7zxC
- Tilmes, R., and P. Schaubach, 2006, "Private banking und private wealth management - definitionen und abgrenzungen aus wissenschaftlicher sicht," in Brost, H., and M. Faust (eds.), Private banking und wealth management, Munich: Bankakademie Verlag
- Titscher, S., 2001, Professionelle beratung – was beide seiten vorher wissen sollten, Frankfurt/Wien: Ueberreuter Wirtschaftsverlag
- Torrey, C., S. Fussell, and S. Kiesler, 2013, "How a robot should give advice," HRI '13 Proceedings of the 8th ACM/IEEE international conference on Human-robot interaction: 275-282
- Waern, Y., and R. Ramberg, 1996, "People's perception of human and computer advice," Computers in Human Behavior 12, 17–27
- Wang, Y. D., and H. H. Emurian, 2005, "An overview of online trust: concepts, elements and implications," Computers in Human Behavior 21, 105–125

Overview of Blockchain Platforms and Big Data

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Abstract
An emerging trend in industry and research is the need to deal with increasing complexity and volume of data when performing analytics. This has led to the rise of the topic of "big data" systems within the financial technology sector, which we explore in this paper within the context of emerging blockchain technologies. Both big data and blockchain technologies have witnessed significant innovations, emerging new concepts, and use cases in a relatively short time. We discuss in this article these technologies in general, survey some projects and products that combine the two areas, and present a use case for these technologies in coming regulatory requirements for auditing and reporting under MiFID II.

BIG DATA

The term "big data" initially appeared around the mid- to late-1990s,[1] and has since come to represent a label given to areas that require analysis, processing, modeling, or analytics on huge datasets that cannot be processed by traditional database systems. One complication with such a generic label is that it has often been questioned exactly what constitutes big data, as any generic definition will by its very nature tend to be subjective and may vary between industries and disciplines. Rather, we prefer to think of big data as a set of new techniques and analytical practices that can be applied to large sets of data that result in insights and deeper understanding of the relevant topic.

Some authors and technology experts have attempted to define key attributes of big data. For instance, in 2001, in a research note by Doug Leany from the Meta Group, the term "3Vs" was introduced to describe the three basics of big data, which included:

- **Volume:** the quantity of the data.
- **Velocity:** speed of data generated, usually for real-time availability.
- **Variety:** the different sources of data.

Later, two other Vs were added:

- **Variability:** the consistency of the data
- **Veracity:** the quality of the data.

Currently big data trends continue to emerge in a variety of new fields, from marketing to social media and especially within the financial services industry. Most are used for data analytics and insights. There are tools and specific in-memory databases like, for example, KDB+[2], designed to process and analyze billions of records in real-time. In this context, we particularly focus on a specific, but important, topic within the financial services sector that is becoming much more relevant today as a result of MiFID II regulations, and making this a more of a big data problem to solve; namely, the capture and storage of trading events, trade reports, and transaction reports for five years, and be able to report this data back to the regulator on demand.

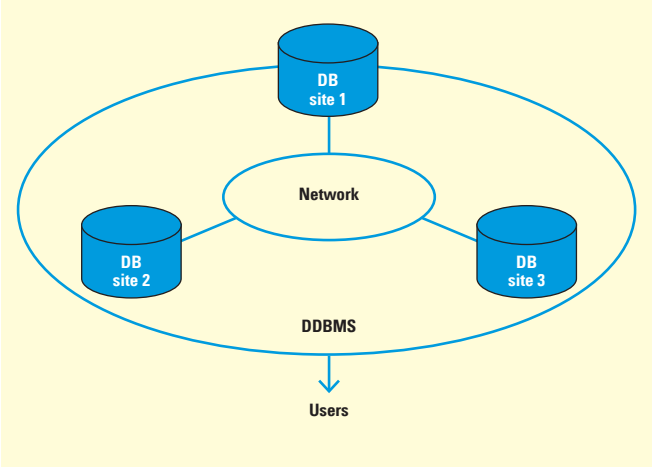


Figure 1 – Distributed database architecture

DISTRIBUTED DATABASE SYSTEMS

Distributed databases are a subset of the distributed systems field in computer science, where components on different physical locations interact via a network in order to achieve a common goal. A distributed database system is a collection of databases that adhere to the above, the databases each reside at physically separated locations and communicate with each other over a common network. Each node is managing its own set of data via DBMS independently of the other nodes, and all databases are managed by a distributed database management system (DDBMS), which is responsible for synchronizing between the nodes, ensuring all nodes have the full data and the integrity of the data, and loading balancing between the databases for data retrieval. To summarize such functionality, the DDBMS handles all databases as if they are all stored on a single location in a completely transparent way for the end user [Özsu and Valduriez (2011)].

BLOCKCHAIN

Discussions on blockchain technology are provided in Peters et al. (2015) and Peters and Panai (2015). In general, the terminology of this new field is still evolving, with many using the terms block chain (or blockchain), distributed ledger, and shared ledger interchangeably. Formal definitions are unlikely to satisfy all parties, but for the purposes of this article the key terms are as follows.[3] A blockchain is not a database but it can conceptually be thought of as acting like a database in the sense that it is a ledger that takes a number of records and puts them in a block (rather like collating them on to a single sheet of paper). Each block is then "chained" to the next block, using a cryptographic signature. This allows blockchains to be used

1 For example, in 1997 it was referred to at the Institute of Electrical and Electronics Engineers (IEEE) conference on visualization.
2 http://www.kx.com
3 These will be discussed in greater detail below.

like a ledger, which can be shared and corroborated by anyone with the appropriate permissions. There are many ways to corroborate the accuracy of a ledger, but they are broadly known as consensus (the term "mining" is used for a variant of this process in the cryptocurrency Bitcoin). If participants in that process are preselected, the ledger is permissioned. If the process is open to everyone, the ledger is unpermissioned (see discussions below). The real novelty of blockchain technology is that it is more than just a database – it can also set rules about a transaction (business logic) that are tied to the transaction itself. This contrasts with conventional databases, in which rules are often set at the entire database level, or in the application, but not in the transaction.

A blockchain is not exactly a database

In terms of applications of blockchain technology, one could argue that we are still in the exploration phase. It is prudent to be cautious about claims that this technology, particularly in its "permissioned blockchain" form when being used in fields as diverse as banking, insurance, or accounting. In particular, it would be useful to explore exactly what advantages blockchains have compared to well-understood transaction recording technologies, such as databases. In fact, one could think of a blockchain as a technology for creating structured repositories of information, often termed a ledger in blockchain parlance. This can be strongly linked to similar understanding of a database, for instance, when talking about a ledger for financial assets. This, of course, could be represented in a database table, where in the simplest form each row represents one asset type owned by one particular entity. It has a number of attributes, one per column indicating information such as the owner's identifier, an identifier for the asset type, and the quantity of that asset.

We can think of blockchain in the simplest form as a technology that allows for such ledgers to be managed with multiple participants. In simple forms of blockchain technology, each participant will in some cases also run "nodes" in the blockchain network which hold a copy of the database. Their role is then to transmit transactions to other nodes in a peer-to-peer fashion. These transactions, from multiple participants, can occur in a blockchain typically without requiring the trust of all the participants. This brings us to considerations such as those discussed in Peters and Panai (2015), which considers data integrity and governance issues via the blockchain technology's ability to offer disintermediation.

So, we learn that a blockchain is a technology that allows us to utilize a database with multiple non-trusting participants, but does not necessarily require a trusted intermediary. Versions of the blockchain architecture, such as those developed in Bitcoin, remove the requirement for trusted intermediaries by extending the definition of a transaction, i.e., a modification to the database entry, to include a proof of authorization and proof of validity. This relates to the data integrity protocols discussed in Peters and Panai (2015), as several approaches can be adopted to achieve this in blockchain technologies. Upon this extended definition of a transaction it allows for the removal of intermediaries, since now transactions can be independently verified and processed by every node in the network that maintains a copy of the database.

To move beyond this simple description and understand further the differences between blockchain and standard database technologies, we first discuss the types and capabilities of modern databases. Depending on the nature of the data one is storing, there are five genres of databases [Redmond and Wilson (2012)]:

- **Relational databases**, such as SQL and variants, which are based on set theory and implemented as two-dimensional tables.
- **Key-value stores**, which store pairs of keys and values for fast retrieval.
- **Columnar databases**, which store data in columns, and can have more efficient representations of sparse tables compared to relational databases.
- **Document databases**.
- **Graph databases**, which model data as nodes and relationships.

Databases can be centralized (residing at a single site) or distributed over many sites and connected by a computer network. We will focus on the latter, given the closer proximity to the blockchain concept.

Distributed databases and blockchain

A number of emerging blockchain platforms are beginning to utilize connections between the blockchain ledger and some version of a distributed database for secure off-chain data storage. It is, therefore, useful to recall the difference between a blockchain and a distributed database.

A distributed database is a database in which portions of the database are stored in multiple physical locations and processing is distributed among multiple database nodes.

A centralized distributed database management system (DDBMS) integrates the data logically so that it can be managed as if it were all stored in the same location. The DDBMS synchronizes all the data periodically and ensures that updates and deletes performed on the data at one location will be automatically reflected in the data stored elsewhere.

Distributed databases can be homogenous or heterogeneous. In a homogenous distributed database system, all the physical locations have the same underlying hardware and run the same operating systems and database applications. In a heterogeneous distributed

database, the hardware, operating systems, or database applications may be different at each of the locations.

The objective of a distributed database is to partition larger information retrieval and processing problems into smaller ones, in order to be able to solve them more efficiently. In such databases, a user does not, as a general rule, need to be aware of the database network topology or the distribution of data across the different nodes. It should also be noted that in a distributed database, the connected nodes need not be homogeneous, in terms of the data that they store.

Because of the design of these databases and the replication of data across different nodes, such a database has several advantages [Elmasri and Navathe (2014)]: (1) better reliability and availability, where localized faults do not make the system unavailable; (2) improved performance/ throughput; and (3) easier expansion.

In every distributed database, however, there is the issue of how modifications to the databases are propagated to the various nodes that should hold that data. The traditional approach is a "master-slave" relationship, where updates to a master database are then propagated to the various slaves. However, this means that the master database can become a bottleneck for performance. In multi-master replication[4] modifications can be made to any copy of the data, and then propagated to the others. There is a problem in this case also, when two copies of the data get modified by different write commands simultaneously.

A blockchain could be seen as a new type of distributed database that can help prevent such conflicts. In the same way that the Bitcoin network will reject a transaction where the Bitcoin balance to be transferred has already been "spent," a blockchain can extend the operation of distributed databases by rejecting transactions, such as delete a row, that have already been undertaken by a previous transaction (where a modification is a deletion, followed by the creation of a new row).

A second difference between blockchains and distributed databases lies in the ability to create self-enforcing contracts that will modify the blockchain's data. Many permissioned blockchains have a built-in virtual machine, such that one can execute pieces of computer code on the network. If this virtual machine is Turing-complete, this means that the machine can potentially solve a very large set of problems, which is very useful for executing more complex transactions on the network, possibly conditional on the state of certain off-chain variables.

The proliferation of databases as data stores has spawned considerations regarding data-related aspects, such as security, confidentiality, and integrity. We argue that discussions around these issues will be important for blockchain technologies too, if they are to be successful in a business enterprise setting. In the following section we discuss these security aspects in depth and comment on blockchain attributes with regard to them.

So far we can conclude that blockchains are a sensible technology when we wish to consider a set of databases that are to be shared by multiple participant contributors all of whom can modify the database directly, in an environment in which no trust is required between members of the network. Furthermore, we can see that blockchains further differentiate themselves from direct database solutions when we begin to consider transactions of multiple participants that interact or have dependencies on transactions of other blockchain member participants in non-trivial manner with each other.

BLOCKCHAIN TYPES

There are several types or "flavors" of blockchain, and in this section we will provide a short review of each.

Permissionless ledgers

A blockchain with no single owner, such as the one used in Bitcoin, is defined as unpermissioned or permissionless ledger. This type of ledger allows anyone to contribute to the chain, i.e., no one has the power to prevent others from adding data to the chain, and everyone holds the exact same copy of the ledger. The integrity of the chain is, therefore, determined by the consensus of all participants. However, this makes the ledger challenging to govern.

Permissioned ledgers

A blockchain with one or many owners, where a limited number of participants have the power to approve a new record added to the ledger, is a permissioned ledger. The governed structure of this type of ledger makes the consensus process much simpler and these ledgers are usually faster than unpermissioned ones.

Distributed ledgers

Distributed ledgers are like a distributed database and are spread across multiple sites and networks. Records are added continuously one after the other, and not by blocks. This type of ledger requires more trust in the validation of the operation over the ledger. The global financial transactions system, Ripple,[5] for example, uses a list of trusted validators in order to prevent transaction fraud.

4 http://www.multichain.com/blog/2015/07/bitcoin-vs-blockchain-debate
5 https://ripple.com/

Public blockchains

A public blockchain, generally considered to be "fully decentralized,"[6] is a blockchain that anyone in the world can read, add transactions to, and participate in the consensus process. These chains are secured by cryptoeconomics – the combination of economic incentives and cryptographic verification, where the influence on the consensus process is aligned to the size of economic resources a participant brings to the chain.

Shared ledgers

A shared ledger is a term coined by Richard Brown, formerly of IBM and now Chief Technology Officer of the Distributed Ledger Group, and typically refers to any database and application that is shared by an industry or private consortium, or that is open to the public. It is the most generic and catch-all term for this group of technologies. A shared ledger may use a distributed ledger or blockchain as its underlying database, but will often layer on permissions for different types of users. As such, "shared ledger" represents a spectrum of possible ledger or database designs that are permissioned at some level. An industry's shared ledger may have a limited number of fixed validators, who are trusted to maintain the ledger. The face that a number of trusted participants can validate transactions can offer significant benefits.

Fully private blockchains

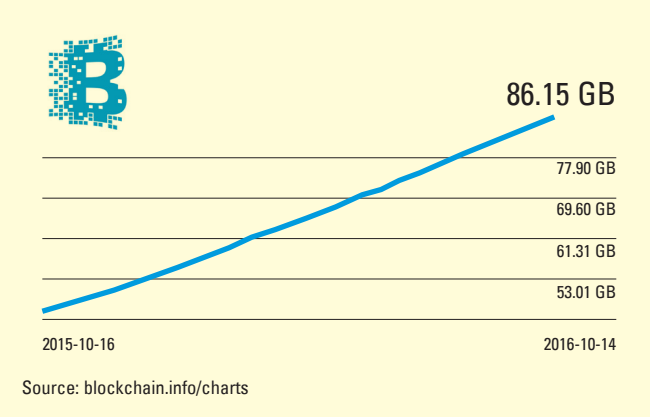
A ledger where all write permissions are controlled by one organization is considered a private ledger. Read permissions can be made public. These types of ledgers are useful for auditing purposes, as we see in our usage case presented later in the article.

Smart contracts

Smart contracts are contracts whose terms are recorded in a computer language instead of legal language. It can be designed to enact legal contracts or regulations. Smart contracts can be automatically executed by a computing system, such as a suitable distributed ledger system in response to changes in the ledger, in real time.

THE ROLE OF BLOCKCHAIN TECHNOLOGY IN BIG DATA

Big data in finance usually describes Petabytes (1 Petabyte is 1000 Terabytes) of trading data that are used for analytics generation. For example, the first level of the order book for all European markets [trades, bid and ask, see Gould et al. (2013)], will generate a capture file of about 5 GB a day. To put that in perspective, the size of the Bitcoin transaction database is a bit less then 85GB, with average block size of around 0.75MB (as of October 11, 2016) (Figure 2).[7] Blockchain as it currently stands is not built for large datasets and big fast data insertion and queries. Several solutions are now emerging, which use blockchain features for very large sets of data, for example by extending a distributed database functionality or by offloading data to an offline data storage.



Source: blockchain.info/charts

Figure 2 – Blockchain size

Big data blockchain solutions

Certain problems require the save and storage of large amount of data; from real time marketing analysis online, to trading monitoring and indication systems. Usually, databases, either classic or distributed, and data warehouses will be used for this task, as they provide the capacity, latency, and scalability needed from a big data solution. As shown above, a blockchain is not a database, but it carries with it a data storage and some interesting characteristic such as immutability, which can be a necessity for some applications. In addition to immutability, there are all the SQL language features that are part of the traditional database systems, the ease and fast insert operations, and a timely select function with different filters. A usable blockchain big data solution will need to provide all these basic properties as a prerequisite.

There are several approaches for this problem, we will review the main ones with a representative for each of the options.

Blockchain on top of distributed database

One interesting and innovative idea is using an existing distributed database technology with added blockchain functionality. The distributed database is by nature an excellent big data storage. It can scale horizontality and increase capacity and throughput by adding

6 https://blog.ethereum.org/2015/08/07/on-public-and-private-blockchains
7 http://www.blockchain.info

shards (or nodes), it has a rich query language, like T-SQL (Transact-SQL) or NoSQL, and a built-in permissioning management. Adding blockchain features seems very natural as both share a distributed architecture, and blockchain can add immutability, the option to have a decentralized control mechanism, and a common well-known way of handling trail of digital assets. We will demonstrate a potential usage for this technology in our architecture for event capture data storage. The main features will include:

- High throughput and capacity
- Low latency
- Permissioning mechanism
- Querying language
- Decentralized system
- Immutability

BigchainDB

BigchainDB[8] is a big data solution that takes a distributed database and adds blockchain properties on top of it. It features a full NoSQL query language and aims for a performance of 1 million writes per second, which should meet known financial systems requirements. Classic blockchain performance is not in the same bracket as this type of database, as it can handle only a few transactions per second, and confirmations can take up to ten minutes. On a modern distributed database, capacity and throughput are a given with the scalability of the system. McConaghy et al. (2016) describe in detail BigchainDB, its performance, and case studies.

Modern applications collect huge amount of data from users in real time. Think about Amazon, Facebook,[9] Google and the like, which collect, analyze, and monitor huge amounts of data within minutes. Financial companies also save large amount of datapoints for trading analyses and reporting. This will increase immensely in the near future with the MiFID II regulation. Distributed databases store petabytes (1,000,000 GB) of data and can be easily extended. The Bitcoin blockchain, on the other hand, currently stores only 85GB of data, which for some people in the community seems too big. BigchainDB uses RethingDB[10] as the base for its distributed database.

Blockchain and offchain distributed hash tables

A distributed hash table (DHT) provides a look-up service similar to a key-value hash table, but does so in a decentralized distributed manner. The key-value pair can be stored in any participating node and the key-value mapping is then maintained by all nodes. This allows a DHT to scale on a very large number of nodes. DHT, which was in part originally motivated by peer-to-peer (P2P) systems, can be used to build complex infrastructures like distributed file systems, P2P file sharing, and content distribution. There are three key properties of a DHT:[11]

- **Autonomy and decentralization:** all the nodes construct the system without any centralized governance.
- **Fault tolerance:** the system will continue to work as usual when nodes are added/removed or suffer a from a failure.
- **Scalability:** the system can scale up to millions of nodes and continue to work as normal.

Enigma

Enigma[12] is a new decentralized computation cloud platform from MIT with guaranteed privacy [Zyskind et al. (2015)]. Enigma offers privacy by distribution of data between nodes, where no node has access to the data in full. Computation is run on the nodes without the need to reveal the full information to other nodes. Since data is not replicated on each node, it gives the platform the ability to scale horizontally.

Some of the main features that Enigma offers users as a blockchain platform are privacy and scalability.

In terms of privacy, this is achieved in Enigma through its use of a secure multi-party computation model. In this framework, queries are done in a distributed way without a governing trusted third-party being required. Furthermore, the computation is split between different nodes and no single node has access to the other nodes' data. Each node only sees part of the data that has no value or meaning on its own.

With respect to scalability, this is achieved by the fact that data is not being replicated to every node in the network. The computation is being done on a small subset of nodes that hold different parts of the data. This enables Enigma to run more demanding computations and require significantly less storage requirements.

The off-chain nodes feature allows Enigma to store large sets of data, and in a way constructs a distributed database in which each mode has its own distinct view on the data.

One of the possible applications for Enigma is as a distributed personal data store, which fits our usage case for personal trader data information.[13]

8 https://www.bigchaindb.com
9 https://code.facebook.com/posts/229861827208629/scaling-the-facebook-data-warehouse-to-300-pb/
10 https://www.rethinkdb.com
11 http://www.cs.princeton.edu/courses/archive/spr11/cos461/docs/lec22-dhts.pdf.
12 http://enigma.media.mit.edu/
13 See discussion in Section 8.7 of the Enigma document, where it states: "Store and share data with third parties while maintaining control and ownership. Set specific policies for each service with private contracts. Identity is truly protected since the decision to share data is always reversible - services have no access to raw data, all they can do is run secure computation."

Enigma design

The framework of Enigma offloads private and intensive computation work from an existing blockchain to an off-chain network. It also provides a scalable Turing complete scripting language for handling private contracts (with private information). An Interpreter will break down the execution of this private contract, which in addition to privacy also improves the run time of the code.

Through the use of off-chain processing and storage it is possible for Enigma to solve data capacity problems; it enforces the privacy of computation by allowing each node to execute code without leaking data to the other nodes and solves scalability problems when heavy computation is needed on the chain. Enigma performs the heavy computation on the off-chain and broadcast the results to the blockchain.

The off-chain storage creates a distributed database, where every node has a distinct view of the data. It is possible to store large public data in the off-chain and link it to the blockchain. The distribution is based on a Kademlia DHT protocol, which was modified for Enigma.

In Enigma, the blockchain acts as an interface between the off-chain DHT architecture that stores references to data in a decentralized manner and the actual data of interest, which is first encrypted on the client side before storage and access protocols are enacted in the blockchain or on off-chain distributed data-bases. However, since the Enigma blockchain does not replicate the data over all nodes in the network, instead only requiring a small subset of such nodes to perform each computation over different parts of the data, it achieves efficiency gains. The off-chain storage of data occurs with off-chain nodes constructing a distributed database.

Zyskind et al. (2015) explain how Enigma offers a combination of off-chain storage and blockchain storage for data. In this structure, each node will have a specific unique view of what they term "shares" in the total data (a portion of the total data) as well as the encrypted data, where the share is set up in such a manner as to guarantee privacy preservation and fault tolerance. In addition, this architecture also allows for large public data storage that may be linked to the blockchain and unencrypted for all participants to access. The manner that this is achieved in a network architecture is known as Kademlia DHT [Maymounkov and Mazieres (2002)] with enhancements for the Enigma use case.

USAGE CASE – EVENT CAPTURE ARCHITECTURE

In recent years, financial firms have seen enhanced scrutiny and oversight by the regulators that are stepping up their demands for trade and transaction reports, transparency and best execution proof, order trail, and auditing data. Trading venues and brokers are obligated to provide reports with many more fields, capture a lot more events, and store the collected data for a period of five years in an accessible secure manner. This is already producing massive datasets and the increasing requirements has led many analysts to suggest that such data requirements for storage of trade activity is likely to continue to grow. The security and data integrity of these records is also a critical feature to be considered [see discussion on these matters in the context of blockchain in Peters and Vishnia (2016)].

The classic way to achieve the above reporting and storage requirements would be to store the data in a database; relational or a NoSQL database [Tauro at al. (2012)] like MongoDB [Chodorow (2013)] via a big data warehousing solution. We will present here an architecture for storing the event capture data in a secure immutable way using blockchain technology. This new architecture will provide the regulator with easy access, on demand data queries without the risk of data being tempered or lost, and for the reporting entities a common simple manner for storing the data and replying to regulator queries.

Reportable events and data points

Trading firms and venues will need to provide to the regulator, on demand, under the European Securities and Market Authority Regulations, all relevant event capture data. This data can be an order event like Ack, fill, cancel, etc., market data points like bid/ask for best execution proofing, algorithmic trading decisions, order initiator, and

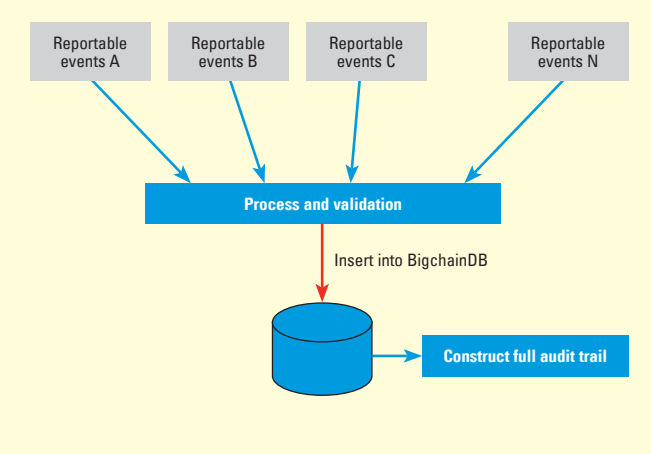


Figure 3 – Event capture storage architecture with BigchainDB

many more trading life cycle events (at time of writing a full event list is yet to be confirmed). The data also needs to be time stamped and synced [RTS 25, Article 4; ESMA (2015)] with precision of at least one millisecond. This is a hard demand to follow when aggregating trading data from different systems. Of course, each trading entity will have different amounts of data to collect and store, but even for a medium-sized company this sums up to a very large set of data. Needless to say, all this data should be stored safely and securely and yet be accessible rapidly on demand to select groups, such as the regulator and the event capturing entity.

Data storage

We suggest, for example, using a blockchain database such as BigchainDB in order to store all event capture data in distributed block chain database. Trading events occur very fast, with high throughputs in random times of the day. A tradition distributed DB will be sufficient to handle these events and provide rich and easy-to-use query capabilities. However, for the regulations we also need to make sure the data is immutable, and to be maintained by different market participants. We also want to have a decentralized control with a read-only user (the regulator). A "classic" blockchain will not be able to cope with the amount of data, size, and throughputs, that this challenge presents. However, a combination of blockchain immutability property and the decentralized nature of a distributed database give us a clean solution to meet the demands of the regulators.

CONCLUSION

In this article we present the case of usage for blockchain technologies with big data. We think that in the coming future a big data solution will have to cater for blockchain features in order to be considered complete in its offering. Several possible implementations are already out in the market by smaller FinTech companies, but we think in the long term bulge bracket database companies will start offering blockchain features integrated within their products, whether as part of the core product or as an add on.

REFERENCES

- Back, A., M. Corallo, L. Dashjr, M. Friedenbach, G. Maxwell, A. Miller, A. Poelstra, J. Timón, and P. Wuille, 2014, "Enabling blockchain innovations with pegged sidechains," white paper, Blockstream
- Chodorow, K., 2013, "MongoDB: the definitive guide," O'Reilly Media, Inc.
- Elmasri, R., and S. B. Navathe, 2014, Fundamentals of database systems, Pearson
- European Securities and Market Authority, 2015, "Regulatory technical and implementing standards – Annex I," September 28, ESMA/2015/1464
- Maymounkov, P., and D. Mazieres, 2002, "Kademlia: a peer-to-peer information system based on the XOR metric," International Workshop on Peer-to-Peer Systems 2429, 53-65
- McConaghy, T., R. Marques, A. Müller, D. De Jonghe, T. McConaghy, G. McMullen, R. Henderson, S. Bellemare, and A. Granzotto, 2016, "BigchainDB: a scalable blockchain database," white paper, BigChainDB
- Özsu, M. T., and P. Valduriez, 2011, Principles of distributed database systems, Springer Science & Business Media
- Peters, G. W., and E. Panayi, 2015, "Understanding modern banking ledgers through blockchain technologies: future of transaction processing and smart contracts on the internet of money," working paper
- Peters, G. W., and G. Vishnia, 2016, "Blockchain architectures for electronic exchange reporting requirements: EMIR, Dodd Frank, MiFID I/II, MiFIR, REMIT, Reg NMS and T2S, Dodd Frank, MiFID I/II, MiFIR, REMIT." Available at SSRN: https://ssrn.com/abstract=2832604
- Peters, G. W., E. Panayi, and A. Chapelle, 2015, "Trends in crypto-currencies and blockchain technologies: a monetary theory and regulation perspective," working paper
- Redmond, E., and J. R. Wilson, 2012, Seven databases in seven weeks: a guide to modern databases and the NoSQL movement, Pragmatic Bookshelf
- Tauro, C. J., S. Aravindh, and A. B. Shreeharsha, 2012, "Comparative study of the new generation, agile, scalable, high performance NOSQL databases," International Journal of Computer Applications 48:20, 1-4
- Zyskind, G., O. Nathan, and A. Pentland, 2015, "Enigma: decentralized computation platform with guaranteed privacy." Available at: http://web.media.mit.edu/~guyzys/data/enigma_full.pdf

Transformational

The Rise of the Interconnected Digital Bank

The Emergence of Regtech 2.0: From Know Your Customer to Know Your Data

U.S. Regulation of FinTech – Recent Developments and Challenges

Strains of Digital Money

Banking 2025: The Bank of the Future

Banks Versus FinTech: At Last, it's Official

The Un-Level Playing Field for P2P Lending

Blockchain in a Digital World

FinTech in Developing Countries: Charting New Customer Journeys

The Rise of the Interconnected Digital Bank

Ben Jessel – Managing Principal, Capco

Abstract

A new innovation called the API (application programming interface) economy is enabling organizations, including banks, to build new services far more quickly and easily than in the past. Thanks to APIs, digital integration can be achieved as easily as a click of a button. This presents a unique opportunity for banks to build new digital experiences and offerings for their customers by digitally bolting together their own services with those of partner organizations to provide customers with a far richer set of experiences than they have been able to provide in the past. Furthermore, a number of leading banks are using this innovation to share their data and services with the public, creating an open platform that will enable a global team of developers to build new applications on top of the banks' infrastructure. This will make it possible for banks to embed their services into the fabric of the next generation of mobile applications. However, this innovation also poses a number of threats to the banking industry. Firstly, digitally providing information on banks' products could lead to product commoditization. Secondly, as the API economy also blurs the lines between financial services and other industries, it also breaks down the barriers to entry for non-banking institutions, which will raise key questions for banks about what it means to be a bank and what their business model should be in this new environment.

INTRODUCTION

The nature of banking is changing. A new generation of tech-savvy digitally connected customers is looking to banks to provide more than just the narrow set of financial products that they have been traditionally offered in the past. Banks know that they must move away from being order-takers of commoditized financial products and reassert themselves as organizations that are relevant and indispensable to their customers in a digital age.

But it is hard for banks to make this change, because they are under enormous regulatory and cost burdens. Many banks run on old banking systems that were not designed for the digital age, which means that launching new products and services into the market takes time and can be prohibitively expensive.

Banks need to do something, as the current environment is not conducive to business as usual. Low interest rates across most of the developed economies, and in certain cases even negative rates of interest, mean that the returns banks receive from their traditional products tends to be low. In addition, customers are far less loyal to their banks than they used to be in the past, and are far more comfortable seeking out the cheapest deals and better online experiences, even if they are from their competitors. Increasingly, this competition is emerging in the form of well-funded agile fin-tech (financial technology) organizations in the payment space, account aggregators, new mobile banks, and even social and e-commerce giants entering banking (some examples are provided in Figure 1).

In this article, we explore how banks are fighting back to keep their customers by building new digital offerings that aim to provide customers with what they have been asking for; namely, products, services and tools that bring together not just financial offerings from the bank, but non-financial ones from other organizations. These services and tools mark a more intimate relationship with banks' customers, helping them in a far more holistic way than they have been able to in the past. These new digital experiences will help their customers manage the big decisions and events in their lives, such as getting married, moving home, having a baby, planning further education, paying off student debt or planning wealth transfer.

Figure 1 – New entrants challenging traditional banks

We will introduce a digital innovation, called "the API economy,"which is enabling banks to bring these new services to market in a way that is significantly faster and cheaper than ever before. We will also look at how banks are using this approach to establish themselves as digital banking platforms that can be built upon by a global community of developers who will be building the next generation of mobile applications, in the same way that Apple, Google and Facebook have achieved with their platforms.

This article also examines a modern technology architecture concept – called the two-speed architecture, or digital mid-tier – that enables banks to overcome some of the constraints of their ageing rigid banking technology that is held together by a "spaghetti" of integration that often prevents banks from being able to innovate effectively.

We will explore how this innovation creates opportunities for banks to pursue new business models, and penetrate higher growth market segments outside of financial services. Finally, we will review what the key characteristics are that make banks successful in architecting and delivering a successful strategy that harnesses the API economy.

CUSTOMERS TO BANKS: "WE NEED TO TALK ABOUT OUR RELATIONSHIP"

In the past, banking was truly personal. Previous generations were on first name terms with their bank managers and spoke to them personally when they needed help in navigating significant events in their lives.

Compare that to today when 75% of consumers in the U.S. consider their banking relationship as merely transactional, as opposed to a relationship that is based on financial advice and value added services.[1]

A large part of the change has been because the dramatic adoption of web and mobile technology has shifted customers' expectations, enabling them to be more informed and self-directed. To put that

1 http://www.thefinancialbrand.com /PwC

Customers want	Banks provide
• Services that are relevant to their lives • Access to services in their preferred channels • Support and help understanding their finances and making decisions • 24/7 availability and connectivity • Help to reach their dreams – everything is possible • Services to stay relevant as things change – evolve and adapt to their needs	• The products and services they want to provide • Products and support through the channels they prefer • Advice and guidance on how to access their current services • Slow, unresponsive technology disconnected from the technology customers use day to day • No personalized help and support to customers • Services that appeal to older generations only that have not changed in decades

Figure 2 – The banking services gap

seismic change into context; since 1991, Silicon Valley has put three billion web browsers into the world[2] and nearly three million mobile applications into customers' hands.[3] Mobile has become ubiquitous, with adoption growing at a rate of 1000% since 2014.[4]

A particularly powerful aspect of modern applications is that many perform an aggregation role; instead of being tied to providing services and information from one particular organization, these applications aggregate from many providers. This is a fundamentally different model to what banks currently provide, but is one that customers have become accustomed to, and what they now expect from their banks (Figure 2). This in part explains why customers are increasingly shunning the limited and proprietary financial information and tools provided by their banks in favor of financial mobile apps provided by non-banking organizations.

These new apps not only provide powerful financial planning features that help customers prepare for major life eventsCustomers Banks d goals, but also perform this highly valued aggregation role that pulls together financial information, products and services across accounts at different banks, trusts and other financial institutions.

The aggregation can also be seen in the blending together of financial transaction services with social media; Snapchat and Facebook, for example, have integrated payments into their offerings. Stocktwits, a twitter like application that provides both stock prices as well as social media commentary around stocks, integrates with Robinhood, offering stock trading capabilities.

The banks' ability to meet changing customer expectations and the emerging fin-tech challengers is constrained; there is limited investment available to put towards innovative customer offerings in today's financial and regulatory climate and many banks have core banking systems that were not designed for the world of the access-anywhere, anytime demands of today's customers.

As will be discussed below, a new innovation called "the API economy" offers banks the opportunity to leapfrog their competition and overcome their technology and budgetary constraints.

THE API ECONOMY – DIGITAL LEGO BLOCKS FOR ONLINE SERVICES

In 2002, Jeff Besos, CEO of Amazon, issued "The API Mandate,"[5] which meant that every team in the company had to expose their data and functionality through a "service interface." This meant that all business units in Amazon had to be accessible digitally through an API, and had to publish, in a catalog, information about the digital services they would provide and how they can be accessed.

This put Amazon on a journey to become a "service oriented" organization. A service-oriented approach is a design concept involving architecting an organization in a way that provides business capabilities as discrete functional components that can be accessed digitally using common standards, allowing business services to be bolted together and orchestrated, in much the same way a child would build a house out of Lego blocks.

This approach can make an organization far more agile as it removes a lot of complexity around integration, whether it is integration between units within the business or between different organizations.

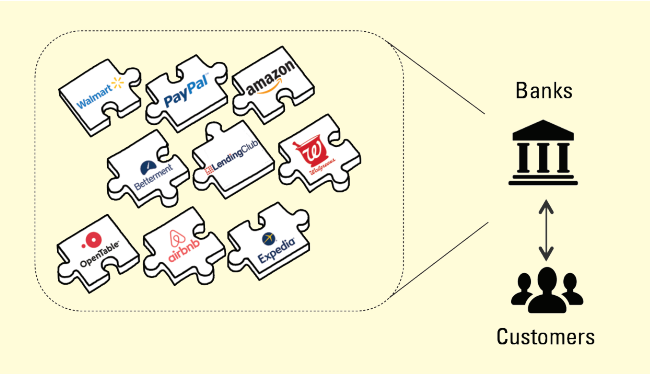


Figure 3 – Meeting customer needs

2 https://en.wikipedia.org/wiki/List_of_web_browsers
3 http://www.statista.com/topics/1002/mobile-app-usage
4 http://www.ibm.com/middleware/us-en/knowledge/hybrid-integration/api-economy.html
5 https://gigaom.com/2011/10/12/419-the-biggest-thing-amazon-got-right-the-platform

Business and technology architects refer to the process of loosening and simplifying the tight bonds between organizations as "de-coupling."

Individuals or organizations accessing business services through these service interfaces do not have to know what the underlying technology or business process is that delivers the service or even if the service is being provided from within or outside of the organization, they only need to be concerned with providing the right information when invoking digital service and having an appreciation of what the service will provide to them when invoked and what information, if any, they expect to receive back.

It is a hard concept to come to terms with, so let us illustrate the point with a business service that everyone is familiar with; Google. When you perform a Google search in your browser, you are digitally invoking a business service provided by another organization. A Google user has a clear expectation that if they enter a search term, Google will provide and send back data about information on the web that contains the search term. It monetizes this service through advertising.

The user does not need to know about the inner workings of how Google actually provides this service, nor do they have to integrate into Google's business; the web provides that infrastructure already. They just need to know the web address to access.

A service-oriented approach is about architecting business services so that accessing them is as easy as performing a Google search. It is that simplicity that makes this approach so powerful. Furthermore, it is an approach that has gathered significant momentum over the years, to the point that there many thousands of organizations providing services in this way. This phenomenon is now so prevalent that the term "the API economy" has been coined as a collective term to describe organizations that expose their services externally through APIs.

The power of the API economy is that it enables anyone to quickly and cheaply create new offerings and experiences by digitally bolting together services from a range of API-enabled organizations, with API standards and protocols providing the digital "glue."

Whereas traditionally, integrating with other organizations was a significant and expensive undertaking, now with the API economy banks can build new offerings quickly and simply by picking from a library of publicly available third-party services to integrate with. In some cases, integration is as simple as "dragging and dropping" the logos of API providers into an integration tool, and clicking "integrate," proving that the process of business integration today can be as simple as clicking a mouse.[6]

Some of the 15,595 publicly available APIs[7] have become the cornerstone of highly profitable companies. Uber, valued at U.S.$62 bln,[8] has been masterful at exploiting the API economy; Uber is underpinned by the marriage of a mapping solution (Google Maps) with a billing engine (Braintree), both integrated though APIs.[9] Uber, in turn, has integrated its API[10] with a range of other API economy organizations. For instance, if you book dinner with Open Table or fly with United Airlines you are reminded to book a ride with Uber as part of your reservation.

The payments segment has arguably led the charge in adoption of the API economy in financial services. Stripe, recently valued at U.S.$1.75 bln,[11] is a payments provider that has API integration as the core component of its business model. It provides a payments infrastructure that is accessed through API calls and is used by household brands such as Open Table and Best Buy.

Recently, Stripe's competitor, Dwolla, demonstrated just how dramatically the API economy can improve speed to market. Dwolla was able to integrate their white label bank transfer API into an Instagram ad platform using the Dwolla ACH payment API in two weeks with one developer.[12]

The API economy has become very profitable for some firms and many commentators and analysts believe that profitability accelerating. Salesforce.com, for example, generates half its U.S.$2.3 bln annual revenue through its APIs.[13] Analysts estimate that the API economy will become a U.S.$2.2 trn market by 2018[14] and that during the next two to three years the number of enterprises having an API program could rise by 150%.[15]

Shamir Karkal, head of open APIs at BBVA, a European headquartered global bank, appears to support this view by stating that "… right now there is some talk about [APIs], but in five to 10 years they will become a facet of doing business online that everybody has to do or end up being left in the dust."[16]

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6 https://medium.com/@dan_abramov/the–future–of–drag–and–drop–apis–249dfea7a15f – .j1qj51gz4
7 http://www.programmableweb.com/category/all/apis (at the time of writing, not counting the proprietary ones that are not publicly advertised)
8 http://investorplace.com/ipo–playbook/uber–ipo–valuation
9 http://getmondo.co.uk/blog/2015/11/05/why–api–driven–banking–matters
10 https://developer.uber.com/showcase
11 http://www.crunchbase.com/organization/stripe
12 http://www.dwolla.com/updates/case–study–instagram–ad–platform–leverages–dwolla–api–for–payouts
13 http://www.forbes.com/sites/ciocentral/2012/08/29/welcome–to–the–api–economy/ – 5d4ef2ea6d39
14 https://www–03.ibm.com/press/us/en/pressrelease/48026.wss (IBM own estimates)
15 Ovum, 2014, "Realizing the business value of APIs," October
16 http://www.americanbanker.com/news/bank–technology/want–to–open–your–bank–to–apis–not–with–that–mainframe–you–dont–1080374–1.html

It is no surprise that European banks are making waves in this area, considering that the European Union (E.U.) is a major driving force in encouraging banks to embrace the API economy. The E.U.'s Payment Services Directive 2 (PSD2), calls for banks to open up their APIs to third parties by January 2018, providing open access to regulated third parties to customer account information, transaction information, and payment initiation.[17]

EXPANDING HORIZONS – HOW THE API ECONOMY OPENS UP NEW MARKETS FOR BANKS

Banks have the ability, through the API economy, to integrate third-party services from outside the financial services domain and offer them to customers, which is what many customers have been asking for. Banks can monetize this in a number of ways, such as through referral fees or by offering paid-for customer and transaction data services.

This enables banks to enter a marketplace that is far larger, and potentially more profitable, than the financial services sector; the U.S. retail economy is approximately 20 times the size of the U.S. retail banking industry and is growing at a faster rate (Figure 4).[18]

Take mortgages as an example. Whereas traditional banks offer a mortgage product today, in today's API economy-enabled world they can also build out a home buying solution that integrates many different services, such as assisting customers in finding properties through Zillow.com, attorneys through Legalzoom.com, removal firms from Moving.com, with a furniture recommendations engine that is tailored to the customer based on the buying behavior observed in their checking account history.

This offers an enormous opportunity for banks to build end-to-end planning tools, that can generate commissions for referrals to third-parties such as brokers, attorneys, builders and removal firms. The CIBC's Hello Home™ offering demonstrates how banks are starting to move up the value chain – in this case, with mortgages. In the summer of 2016, Chase, the consumer and commercial lending arm of JPMorganChase & Co., launched a digital car shopping and financing tool for its customers in partnership with TrueCar Inc., which provides a direct auto lending offering to its millions of clients in the U.S. as well as the ability for showcasing the vehicle inventory of key dealers in the U.S. The offering works by customers searching for a car and the platform presenting them with nearby dealerships that have the vehicle in inventory. Chase has about 14,000 dealerships in the U.S. on board.[19] The customer completes the financing process online and the transaction at the dealership.[20]

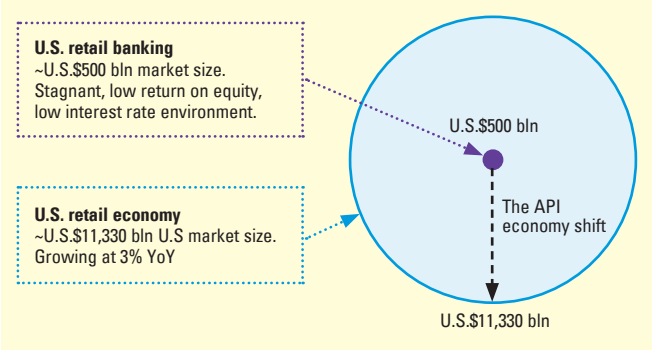

Figure 4 – Embracing the API economy to penetrate a market twenty times that of retail banking

BANKING AS A SERVICE (BAAS) AND HEADLESS BANKING – STANDING ON THE SHOULDERS OF GIANTS

For some banks, building better integrated applications is just the first step in a much more significant journey. A number of forward thinking banks have realized that the API economy provides them with the ability to scale their digital footprint in a way that significantly exceeds what their financial resources would otherwise allow them to achieve.

These banks are looking to emulate the success of Apple and Google by building a platform and ecosystem that is similar to Apple's App Store and Google Play. The App Store and Google Play are platform strategies that provide a global community of programmers and designers with a development ecosystem within which to write applications. This creates a virtuous circle whereby developers are incentivized to build applications for the platform and the platform becomes more valuable the more applications are built for it.

This is how Apple has been able to grow the App Store into a vault of over 1,500,000 applications in seven years with 1000 new applications coming online each day. This platform strategy is a major reason why iPad and iPhone are the compelling platforms that they are today.[21]

17 http://europa.eu/rapid/press-release_MEMO-15-5793_en.htm?locale=en
18 http://www.bea.gov/iTable/iTable.cfm?ReqID=51&step=1 – reqid=51&step=51&isuri=1&5114=a&5102=1
19 http://www.businesswire.com/news/home/20160825006303/en/Chase-Launches-End-to-End-Digital-Car-Buying-Service-Customers
20 http://www.autonews.com/article/20160829/FINANCE_AND_INSURANCE/160829877/chase-launches-direct-lending-with-dealers
21 http://www.businessofapps.com/app-store-statistics-roundup

In the same way, a number of leading banks are encouraging the global developer community to create applications based on services provided by their open banking API platforms. In this way, banks can ensure that their banking services can become increasingly embedded within the fabric of the next generation of mobile applications so that they become ubiquitous in the digital age.

Banks are betting that this strategy will create a virtuous circle; the more applications that are developed in the bank ecosystem, the more compelling the bank's offering becomes to its users and the better the bank will be at attracting and retaining customers. The more customers that the bank has, the larger the incentive for app developers to build on their platform, and so on.

Citi holds an annual "Citi mobile challenge," whereby participants are granted access to data and transaction services through its API gateway across a breadth of their bank, including Global Consumer Banking, Corporate Payments, Capital Markets Trading and Revenue Analytics, and Client Relationship Management. In 2014, Capco won "The most innovative social giving solution" with a mobile app that allows users to make micro-donations by "rounding up" credit card payments to the dollar and routing the spare "change" to charities and causes they have an emotional connection with.

Case study: Citi mobile challenge

This platform approach also reflects a far more realistic allocation of skillsets. Banks have now come to accept that the people with the skills required to build modern digital experiences are far more interested in working for startups than for banks. Far better, therefore, to have banks focus on what they do best – managing financial infrastructures – and leave the development of modern mobile digital applications to Silicon Valley-based organizations that can recruit and retain talent with technical and user experiential acumen.

For these reasons, U.S. banks like Citi and Capital One, European banks like BBVA, Credit Agricole, Fidor Bank and solarisBank as well as Indian banks such as Yes Bank[22] are now pursuing this platform ecosystem strategy.

Fin-techs have a strong incentive to build on these banks' platforms as a key hurdle for these organizations has been the need to have a banking license and maintain core banking infrastructure, which is expensive. The platform approach provides a way around this. In fact, when Finleap launched solarisBank in March 2016 in Germany, it purposely marketed it as a "technology company with a banking license," with the primary objective of providing online banking services to non-bank fin-tech providers. In the process they coined a name for this approach "Banking-as-a-Platform" or BaaP.[23]

At around the same time, Capital One launched its DevExchange API platform, which has been heralded as the first true open banking platform in the U.S.[24]

While Spanish bank BBVA's API platform is still in alpha (available for experimentation to the public but in early stages of production readiness), it has in the past few years opened up its platform to provide a limited set of its services and anonymized transaction data for the purposes of hackathon events.

The BBVA Innova Big Data Challenge hackathon in 2013 was a potent demonstration of how API platforms can provide astonishing business scalability; BBVA provided access to anonymized data covering over 30 million transactions and 2 million cards used in 200,000 stores – a treasure trove of information.

Over two months, 780 developers across 19 countries participated in the event, making 6.7m calls to the BBVA API, contributing €2.9m of development time and resulting in 144 applications delivered. The value of the free development effort alone must have gone some way towards returning BBVA's investment in their open API platform.[25]

BRINGING BANKING TO MILLENNIALS

For BaaP to be effective, it has to address the challenge of millennials, a significant segment of the banking customer population that has a high degree of mistrust of banks and is far more likely to use a pre-paid card than to have a bank account. In a recent poll, 22% of millennials stated that they that would never open a bank account[26] and 71% stated that they would rather go to the dentist than listen to what their bank manager has to say.[27] No wonder, then, that the two youngest adult generations in the U.S. account for 80% of U.S. prepaid card owners.[28]

Millennial banking and the underbanked is a key focus for Capco, which is why we created a proof of concept to demonstrate the feasibility of using the API economy to build a mobile digital bank that can be based on a pre-paid card, instead of a checking account, while providing the standard features and functionality of a checking account (Figure 5).

22 https://www.finextra.com/news/announcement.aspx?pressreleaseid=62030
23 https://www.finleap.com/pr/pressrooms/show/124131/finleap–creates–powerful–fintech–ecosystem–with–solarisbank?locale=en
24 http://www.programmableweb.com/news/capital–one–launches–first–true–open–banking–platform–u.s./2016/03/11
25 https://www.abe–eba.eu/downloads/knowledge–and–research/EBA_May2016_eAPWG_Understanding_the_business_relevance_of_Open_APIs_and_Open_Banking_for_banks.pdf
26 http://www.bankingmyway.com/save/savings/gen–y–says–no–thanks–banks
27 http://www.millennialdisruptionindex.com/
28 http://www.businessinsider.com/the–rise–of–reloadable–prepaid–cards–could–affect–the–way–millennials–approach–banking–2015–11

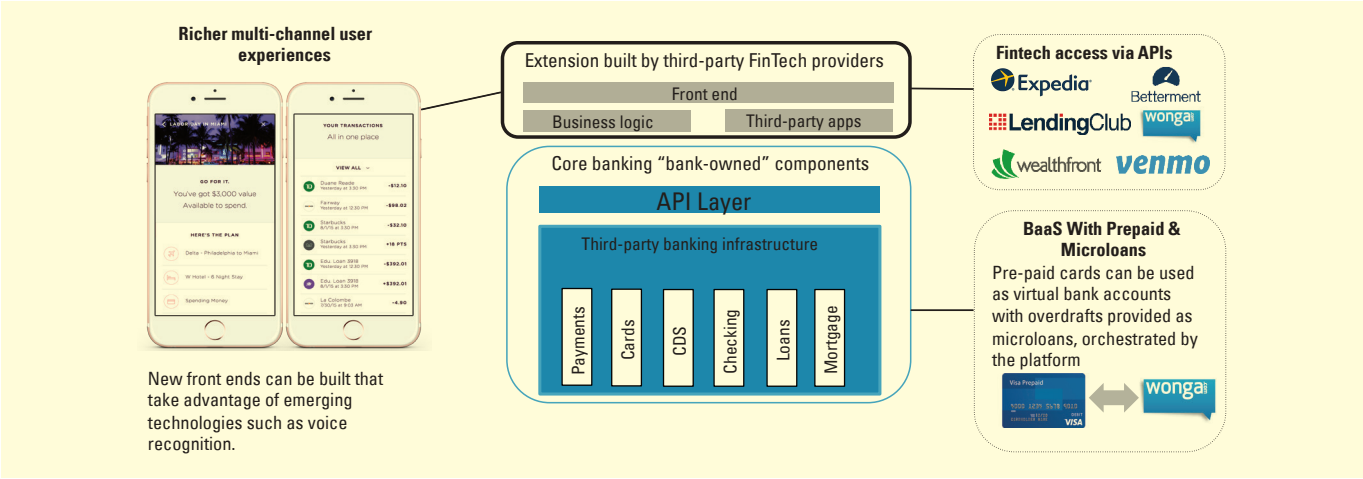

Figure 5 – Headless banking/banking as a platform

We built a front end that was a chat-based user interface that used artificial intelligence, and integrated this into a publicly available API of a prepaid card provider, enabling the user to move money to and from the pre-paid card, make payments, and check balances. We used an API economy-enabled lending platform, "wonga," to provide on-demand micro-loans as an alternative to an overdraft facility. We also integrated flight shopping features to enable the customer to financially plan for – and book – a vacation, all through a single mobile app.

One of the key advantages of this approach is that it reduces some of the frictions inherent within the account opening process; a pre-paid card requires far less information to be collected about the user than a traditional bank account.

Not only is that attractive for millennials who have no patience for form filling, but it also makes it possible to better serve the under-banked segment. This segment tends not to be able to meet some of the account opening requirements of a traditional bank account, such as identity documents or in certain circumstances even a fixed abode. With this approach, this group can be provided with services that are just as good – if not better – than a checking account. Lack of FDIC insurance is a limitation with this approach, but not one that is particularly relevant to the user segment that this proposition targets.

ENABLING THE API ECONOMY WITH A TWO SPEED ARCHITECTURE AND DIGITAL MID-TIER

For banks to open up their data and services via APIs is not a trivial undertaking. A bank that chooses to expose its APIs to the public needs to be able to provide a reliable infrastructure that can be updated frequently with new features. Yet many years of acquisition, point solutions and custom development has created a mess for banks with a mishmash of siloed applications tied together with complex "spaghetti" integration.

In addition, core banking systems were built for internal bank operations and stability, as opposed to digital channels that are customer focused and need to be updated frequently. A model that is gaining traction, that enables banks to overcome these challenges, is the "two-speed architecture." Also known as the "digital mid-tier."

The two-speed architecture is about making it possible for banks to have an agile digital capability without the need to make changes to core systems every time a new digital feature or service is introduced.

It does this by separating a bank's systems into a set of discrete conceptual layers and within these layers (such as a presentation, channel and core banking layer) packaging functions and features into individual modules that communicate through each other in a manner similar to that of the API economy – through de-coupled service interfaces. These components are called "micro-services" (so-called because each unit provides a small, discrete feature of an overall business service) and can be integrated and orchestrated to form an end-to-end composite business service.

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<tr><td></td><td colspan="12">USER EXPERIENCE</td></tr>
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<tr><td colspan="6">Core banking system adapters</td><td colspan="6">Other enterprise system adapters</td></tr>
<tr><td rowspan="2">Enterprise application</td><td colspan="2">Customer</td><td colspan="2">DDA</td><td colspan="2">Payments</td><td colspan="2">Product master</td><td colspan="3">BPM</td><td colspan="3">Cross-channel support</td></tr>
<tr><td colspan="2">Lending</td><td colspan="2">Cards</td><td colspan="2">Wealth</td><td colspan="2">Security</td><td colspan="3">BI & analytics</td><td colspan="3">Ancillary/other</td></tr>
<tr><td>Other apps</td><td colspan="2">Email</td><td colspan="4">Document management</td><td colspan="4">Image processing</td><td colspan="4">Other support applications</td></tr>
</table>

Figure 6 – Activating an omni-channel architecture built around a digital mid-tier

Separating functionality into micro-services allows new services and functionalities to be introduced in a way that isolates the changes to a small area of the banking platform – changes to presentation of services can be made in a presentation layer of the architecture, which is isolated from core banking systems in the core banking layer. Furthermore, the bank's technology can be completely agnostic to whether micro-services are being provided by the bank's internal organization or externally.

Minimizing integration and driving modularity like this not only reduces risk but also the cost of building new services for banks.

Whereas, previously banks often had to do "open heart surgery" on their core banking platforms to build and integrate services, the ability to modularize services means that is it possible to limit changes to smaller discrete set of components on parts of the banks' systems that are ring-fenced from their other systems, such as their core banking systems. The risk of breaking things in the bank, when introducing changes, the argument goes, becomes confined to the risk of a small feature failing as opposed to introducing a system-wide issue that takes down the whole bank. Far better to introduce a change that temporarily breaks the bank's online transaction history search feature than having it bring down the whole digital self-service channel in its entirety.

The ability to introduce new features quickly while minimizing risk is key – banks' internal change processes are geared towards introducing new features infrequently within quarterly release windows. This is the antithesis of the approach used by modern digital organizations. Digital commands a far higher velocity of change with customers expecting new features to be introduced on a far shorter timescale; weekly and in some cases, daily.

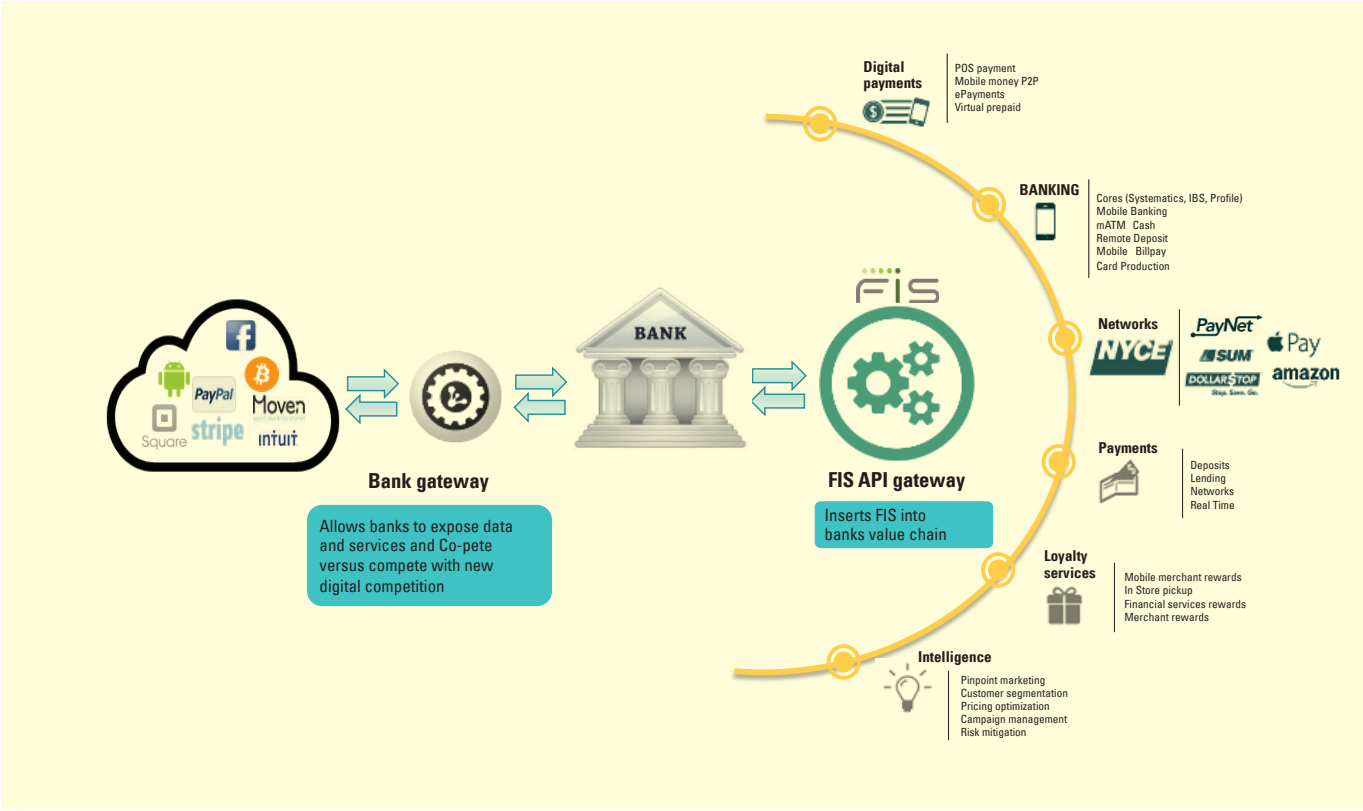


Figure 7 – FIS API gateway

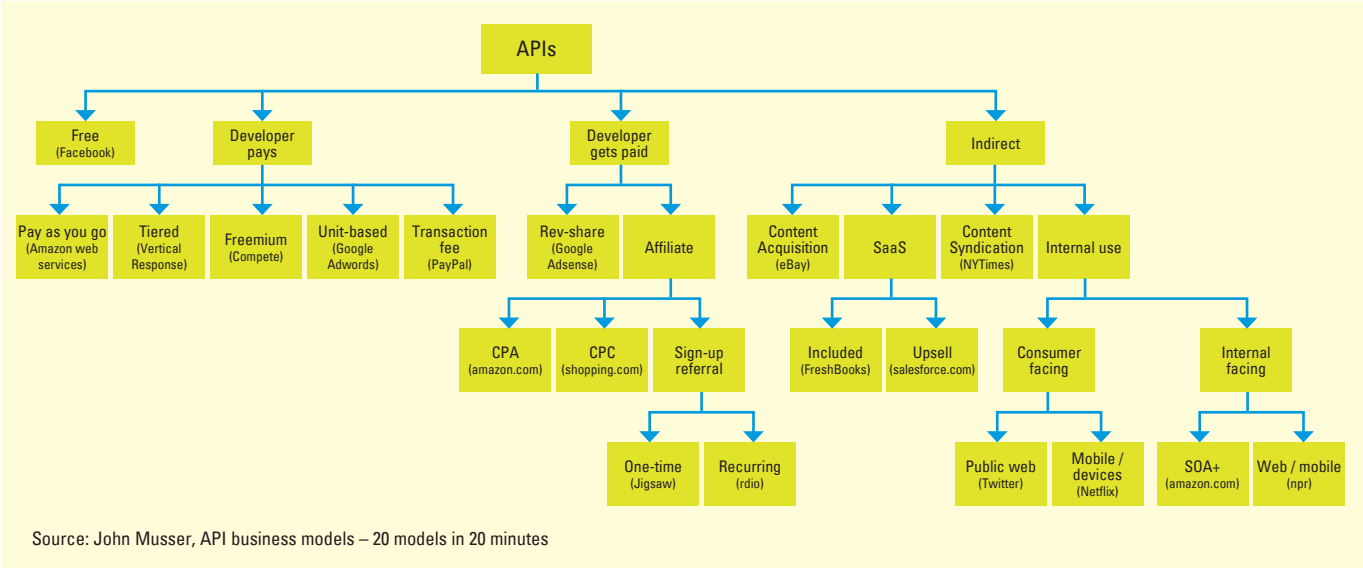
The two-speed architecture's approach to isolating banking and digital technology enables the bank to simultaneously work to the long timelines associated with core banking releases while also being able to pick up the pace and introduce new digital features on a far more compressed release cycle.

A key benefit to breaking down functionality and features into micro-services is that it significantly reduces the extent to which new changes need to be tested, since rather than having to regression test every element of the banking platform to validate that a new feature has not introduced an issue, the only testing that is required is on the interfaces of the micro-service. Furthermore, this form of testing lends itself well to being automated through continuous integration tools (a core tenant of Development Operations, also known as DevOps), which further reduces the cost and risk of introducing new services.

THE BUILDERS OF THE NEXT GENERATION INTERCONNECTED DIGITAL BANK

The market for providing infrastructure and tools for the API economy has matured and entered into a consolidation phase, with established technology service providers acquiring API economy startups. In 2013, Computer Associates acquired Layer 7. Two years later, in 2015, Apigee went public raising U.S.$87 mln for its API gateway product that is used by organizations such as Twitter, Netflix and AT&T. In 2016, Intel sold Mashery to TIBCO and Redhat acquired 3scale, another leading API provider. In the same year IBM acquired the API building software provider, Strongloop.

One of the most significant recent developments has been IBM's announcement of its Harmony offering in 2015, which is a matchmaker for developers looking to develop APIs. It provides an intelligent



Source: John Musser, API business models – 20 models in 20 minutes

Figure 8 – Monetizing the API economy

cloud-based API matchmaking technology that enables developers to automate the process of finding an API to meet a given need, anticipate what a developer will require to build new apps, make recommendations on which APIs to use, show API relationships, and identify what is missing.

Another notable API economy provider, Swagger, has had significant success as both an open source specification and set of tools that standardize and accelerate the creation of API services and specifications.

In the fin-tech space, we are seeing major financial infrastructure providers unveiling new services that enable banks to integrate their offerings with fin-tech providers.

This year, Fidelity Information Systems (owner of Capco) announced the development of the "FIS API gateway layer" that intends to integrate its core banking products with the API economy. This will provide API economy enablement for many major U.S. and overseas banks, which to an extent will remove the need for many banks to develop their own in-house gateway.

AVOIDING THE PITFALLS OF A MATURING TECHNOLOGY

As with the advent of any new technological innovation, there are maturity issues that are in the process of being overcome around the areas of security, interoperability, and data privacy.

By exposing services to the outside world, banks risk unintentionally providing hackers with insights into their data structures and protocols as to how their systems and architecture works. Banks need to double down on efforts to secure their architecture.

Open source and API usage are the subject of ongoing litigation in the U.S. and other countries. Legal and regulatory rulings concerning protection of intellectual property, copyright enforcement, and fair use will likely have a lasting impact on the API economy. Banks need to understand what has been used to create APIs, what they are exposing, and how their data and services will be consumed.

While the API economy has been a key enabler of interoperability, there are few standards that are in effect today. The Banking Industry Architecture Network, the Open API Initiative (OAI), and Open Payments Ecosystem (OPE) have been driving forces in establishing new standards. As with any new technology innovation, there are tribal schisms around standards in the developer community (such as SOAP versus REST), but on the whole this has not impeded the progress of the technology as a whole.

TAKING A BUSINESS FIRST APPROACH TO ADOPTION

While the API economy is an innovation that has been borne out of technological innovation, successful organizations are the ones that approach it first and foremost from a business perspective.

Banks need to learn the lesson from the mistakes that were made when services-based approaches emerged in the form of the Service Oriented Architecture (SOA) movement in the 1990s. Then, many organizations rushed to buy SOA technology without having a clear overall services strategy in place. Many, later, became significantly limited by their chosen technology. This was a contributing factor to the movement ultimately failing to live up to expectations.

From a business perspective, the API economy is ultimately about an innovation that equips banks with the opportunity to be more expansive in terms of the markets they decide to participate in, the products they offer, and the customers that they seek to attract and retain (Figure 8). It gives them far more options in terms of how they monetize their services, be it in the business of selling data and access, generating referral fees from product recommendations, or through adopting a toll-gate model for developers building applications on their platform. How a bank will make money in this digitally connected world requires significant thought.

A key factor that is often overlooked is how this innovation changes the nature of the skills within the technology and business organizations of the bank. Whereas, in the past banks traditionally took requirements from the business and built systems with teams of developers, in the new world, where services can be bolted together with a click of a button, banks need to plan for a new type of employee that is a hybrid business analyst and API integrator.

The nature of service management also changes. In a world where the bank is supporting a service that is actually fulfilled by many other organizations, how do you effectively set, monitor, and manage service level agreements and triage issues?

Organizations need to rethink the nature of change. In the days when digital was nascent, banks approached change through the process of annual planning cycles and quarterly releases with technology teams tending to have an arms-length relationship with the business, communicating through functional specification documents. In this new digital paradigm, where time to market is so much shorter, banks will need to transform and become much more organizationally agile and internally integrated around change. This will require a new internal operating model and a different delivery culture. New internal operating models will need to support just-in-time funding, the ability to fail fast, with more tightly integrated business and technology teams integrating in small agile teams with customer testing integrated into the process.

In addition to these technical and legal considerations is the issue of commoditization. When banks open up their platforms, they are essentially making it possible for information about their product rates and features to be aggregated digitally, hence enabling clients to compare their rates vis-à-vis their peers much more accurately and shop around for the best rates.

Whereas in the past customers tended to stay with banks even though they offered uncompetitive products, owing to inertia or lack of information, once customers are provided with data, and most critically tools that can remove frictions and potentially automate their allocation and selection of replacement products, banks may find themselves in a race to the bottom in terms of pricing. However, the genie is now metaphorically peeking its head out of the bottle, so banks may find a defensive approach becomes increasingly ineffective.

CONCLUSION

In this paper, we have argued that the advent of the API economy and BaaP provides a significant opportunity for banks to profoundly change the way they engage with customers and offer services that build far more intimacy with their end users.

We demonstrated how this innovation also poses a threat to banks by blurring the lines between industries, enabling well-funded non-banks with a younger, and more engaged user base to enter the financial space and augment their offerings with financial services.

As a result, banks will find it increasingly hard to operate in a pure financial services vertical and must innovate – potentially outside the financial services sector – to stay relevant. They will also be at risk of commodization as new aggregation services that offer bank rate comparisons and the ability to change products at the touch of a button become more prevalent.

Financial institutions face an existential choice and do not have the luxury of time that they may have had in the past. As we have seen with other technology led changes in industries such as transport and hotels with Uber and Airbnb, adoption has been far more rapid and change far more profound. Banks must, therefore, make a quick, but considered, decision concerning the model that they decide to adopt.

If they play offensive, they can embed themselves into the life of their customers, providing goods and services that transcend the

boundaries of the bank's traditional offering. They may decide that the increased loyalty that they will gain from their customers with this approach outweighs the risk of commodization inherent with opening up their platform.

Another approach is the platform/infrastructure play, whereby they focus on providing API services that will enable a global community of developers to weave their services into the next generation of applications, and that this approach is worth the risk of being relegated to the role of a behind-the-scenes core financial infrastructure provider.

Alternatively, they may play defensive by not opening up their environment, and instead rely on customers remaining because of inertia and lack of information. Although, as we have seen earlier, this may work for the older demographic, the younger generation are likely to vote with their feet, especially given the recent, albeit short-lived, foray by Amazon into student lending services[29] and Facebook and Snapchat's entry into providing payment services that integrate into their social platforms.

It is obviously the banks' choice which option they select, however, the speed of change has made the time they have to make these decisions less than it might seem at first glance.

29 http://www.forbes.com/sites/maggiemcgrath/2016/08/31/amazon-prime-and-wells-fargo-end-their-student-loan-discount/#242da4fb230c

The Emergence of Regtech 2.0: From Know Your Customer to Know Your Data

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Abstract

The regulatory changes and technological developments following the 2008 Global Financial Crisis are fundamentally changing the nature of financial markets, services, and institutions. At the juncture of these two phenomena lies regulatory technology or "RegTech" – the use of technology, particularly information technology, in the context of regulatory monitoring, reporting, and compliance. RegTech to date has focused on the digitization of manual reporting and compliance processes, for example in the context of know-your-customer requirements. This offers tremendous cost savings to the financial services industry and regulators. However, the potential of RegTech is far greater – it could enable a close to real-time and proportionate regulatory regime that identifies and addresses risk while also facilitating more efficient regulatory compliance. We argue that the transformative nature of technology will only be captured by a new approach that sits at the nexus between data, digital identity, and regulation. The development of financial technology ("FinTech"), rapid developments in emerging markets, and recent pro-active stance of regulators in developing regulatory sandboxes, represent a unique combination of events, which could facilitate the transition from one regulatory model to another.

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INTRODUCTION

Regulatory and technological developments are changing the nature of financial markets, services, and institutions in ways completely unexpected prior to the 2008 Global Financial Crisis (GFC).[2] "FinTech," which refers to the use of technology to deliver financial solutions, is one aspect of these fundamental changes. The rapid evolution of FinTech demands a similar evolution of RegTech.[3] "RegTech" is a contraction of the terms "regulatory" and "technology," and describes the use of technology, particularly information technology (IT), in the context of regulatory monitoring, reporting and compliance.[4] Automation of processes allows for better and more efficient risk identification and regulatory compliance.[5]

Recently, two painful pressure points have come to bear on the financial services industry, which support our vision. On the expense side, post-crisis fines have exceeded U.S.$200 bln,[6] and the ongoing cost of regulation and compliance has become a primary concern industry-wide.[7] On the revenue side, competition from FinTech companies is expected to put U.S.$4.7 tln of revenues at risk.[8] These factors are driving the development of RegTech. As with FinTech,[9] the GFC represented a turning point in RegTech development.[10] However, the factors underlying, and the beneficiaries of, RegTech are quite different. FinTech growth has been led by start-ups (now increasingly partnering with, or being acquired by, traditional financial institutions),[11] while RegTech developments are primarily a response to the huge costs of complying with new institutional demands by regulators and policy-makers.[12]

For the financial services industry, the cost of regulatory obligations has dramatically increased, such that 87% of banking CEOs in one survey consider these costs a source of disruption.[13] This provides a strong economic incentive for more efficient reporting and compliance systems to better control risks and reduce compliance costs. Furthermore, massive increases in the volume and types of data reported to regulatory authorities[14] represent a major opportunity for the automation of compliance and monitoring processes. For the financial services industry, the application of technology to regulation and compliance has the scope to massively increase efficiency and achieve better outcomes.

For regulators, RegTech provides the means to move towards a proportionate risk-based approach where access to and management of data enables more granular, effective supervision of markets and market participants.[15] This provides the opportunity to minimize the risks of the regulatory capture witnessed in the run-up to the GFC, as well as being a natural response to the increasingly digital nature of finance.[16] Furthermore, applying technology to regulation facilitates the monitoring of financial market participants that are becoming increasingly fragmented by the emergence of new FinTech start-ups.[17]

Enhanced reporting accuracy and decreased compliance costs are not new incentives.[18] However, as the financial services industry becomes increasingly digitized, the gap between the accuracy and costs of manual and automatic compliance and monitoring is widening. Combined with recent advances in data science and analytics, RegTech's growth can be understood as process automation to substantially decrease both compliance costs as well as potential for regulatory fines.[19]

Regulation is benefiting from automation of reporting and compliance processes. This trend is enabling substantial cost savings for industry and superior monitoring by regulators. Indeed, early signs of real-time, proportionate regulatory regimes that identify risks and enable more efficient regulatory compliance are emerging.[20] However, the automation and streamlining of regulatory processes is only an incremental evolution toward a better and more efficient regulatory framework.

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2 See Arner, D. W., J. Barberis, and R. P. Buckley, "The evolution of FinTech: a new post-crisis paradigm?" Georgetown Journal of International Law (forthcoming 2016); Buckley, R. P., and D. W. Arner, 2011, "From crisis to crisis: the global financial system and regulatory failure," University of Hong Kong Faculty of Law Research Paper No. 2012/002

3 See Institute of International Finance, 2016, "RegTech in financial services: technology solutions for compliance and reporting 5-8, March.

4 See Christophe Chazot quoted in Institute of International Finance, 2015, "RegTech: exploring solutions for regulatory challenges," 2, October.

5 See Fernandez de Lis, et al., 2016, "RegTech, the new magic word in FinTech," 1, BBVA Research, March.

6 See Cox, J., 2015, "Misbehaving banks have now paid $204B in fines," CNBC, October 30, http://cnb.cx/1Q3HGSd

7 See Thomson Reuters, 2015, "Thomson Reuters annual cost of compliance survey shows regulatory fatigue, resource challenges and personal liability to increase throughout 2015," Thomson Reuters, May 13, http://tmsnrt.rs/1QhKyYo.

8 See The Economist, 2015, "The FinTech revolution," May 9, http://econ.st/1H2hwbP.

9 Arner et al. supra note 2.

10 See Institute of International Finance, 2015, "RegTech: exploring solutions for regulatory challenges," 2, October, at 1.

11 See Finextra, 2016, "Banks rushing to collaborate with FinTech startups," September 16, http://bit.ly/2cD26Rb; EY, 2015, "FinTech: are banks responding appropriately?" Ernst & Young LLP; Meola, A., 2016, "1 in 5 European banks would buy FinTech startups," Business Insider, July 17, http://read.bi/2cPsbfn.

12 See Roberts, G., 2016, "FinTech spawns RegTech to automate compliance," Bloomberg, June 28, http://bloom.bg/2dNjzMi.

13 Fernandez de Lis et al., supra note 5: at 1.

14 See generally Institute of International Finance, supra note 4: at 5-8.

15 See Gulamhuseinwala, I., S. Roy, and A. Viljoen, 2015, "Innovating with RegTech - turning regulatory compliance into a competitive advantage," 10, Ernst & Young LLP, http://bit.ly/24SGCnl.

16 See Arner, D., and J. Barberis, 2015, "FinTech in China: from the shadow?" Journal of Financial Perspectives 3(3).

17 See GPFI, 2016, "G20 high-level principles for digital financial inclusion," 12.

18 Institute of International Finance, supra note 10: at 1; supra note 7.

19 Deloitte, 2015, "RegTech is the new FinTech: how agile regulatory technology is helping firms better understand and manage their risks," 4, http://bit.ly/1QXnsIY.

20 See Institute of International Finance, supra note 4: at 9.

REGTECH DRIVERS

The GFC and post-crisis financial regulatory reforms transformed the way financial institutions operate, reducing their risk-taking, profitability, and spectrum of their operations.[21] The mass of new post-crisis regulation has dramatically increased the compliance burden on financial institutions, in addition to the direct cost of regulatory penalties.[22]

These changes were the intent of the post-crisis regulatory reform agenda.[23] This new regulatory environment is a major driver behind the emergence of RegTech.[24]

With this dramatically altered regulatory, operating, and compliance environment has come the rapid evolution of FinTech. While FinTech as a term has only gained popularity in the past three years,[25] the interaction between finance and technology has a long history.[26]

Today, FinTech impacts every area of the financial system globally, with the most dramatic impact perhaps in China, where technology firms such as Alibaba, Baidu, and Tencent ("BATs") have transformed finance and raised new challenges for regulators and regulation.[27] Furthermore, since 2016 regulators in countries including the U.S., Australia, Singapore, and the U.K. have been actively engaged in better understanding FinTech market dynamics and developing new regulatory approaches.[28]

In the near future, the application of technology to monitoring and compliance offers massive cost savings to established financial companies and potentially massive opportunities to emerging FinTech start-ups, IT and advisory firms.[29] RegTech enables the prospect of continuous monitoring that would improve efficiency by both liberating excess regulatory capital,[30] and, from a regulator's perspective, making it faster to investigate a firm following a compliance breach.[31] RegTech, however, offers more: the potential of continuous monitoring capacity and close to real-time insights, through deep learning and artificial intelligence filters, which look forward to identify problems in advance rather than take enforcement action after the fact.

In the long run, while FinTech has an inherently financial focus, RegTech has the potential for application in a wide range of contexts, from monitoring corporations for environmental compliance to tracking the global location of airliners on a real-time basis. As our financial system moves from one based on know-your-customer (KYC) principles to a know-your-data (KYD) approach, an entirely new regulatory paradigm to deal with everything from digital identity to data sovereignty, and that will extend far beyond the financial sphere, must likewise evolve.

From a market dynamic perspective, FinTech since 2008 has grown organically as a bottom-up movement led by start-ups and IT firms, whilst RegTech has grown in response to top-down institutional demand. RegTech, therefore, encompasses three distinct, but complementary, groups of participants.

RegTech development to date has primarily been driven by the financial services industry wishing to decrease costs,[32] especially given regulatory fines and settlements have increased 45-fold.[33] The next stage is likely to be driven by regulators, seeking to increase their supervisory capacity. We can, therefore, expect RegTech to focus more on business-to-business ("B2B") solutions in contrast to the FinTech sector which focuses on business-to-consumer ("B2C"), as well as B2B, solutions.[34]

21 See generally Buckley, R. P., 2016, "Reconceptualizing the regulation of global finance," 36 Oxford Journal of Legal Studies 242.
22 See Cox, supra note 6.
23 See Financial Stability Board, 2016, "Implementation and effects of the G20 financial regulatory reforms: report to the G20," August.
24 See Buckley & Arner, supra note 2; Buckley, R. S., E. Avgouleas, and D. W. Arner, 2016, Reconceptualising global finance and its regulation, Cambridge University Press
25 See Google Trends, 2016, "FinTech: interest over time," Google Trends, http://bit.ly/2dGfeGs (accessed September 19, 2016).
26 See Arner et al., supra note 2; Lo, A., 2016, Moore's Law vs. Murphy's Law in the financial system: who's winning?" Bank for International Settlement, Working Paper No. 564, May.
27 See Zhou, W., D. W. Arner, and R. P. Buckley, 2015, "Regulation of digital financial services in China: last mover advantage," 8 Tsinghua China Law Rev. 25; Arner & Barberis, supra note 16.
28 See ASIC, 2016, "FinTech: ASIC's approach and regulatory issues," 10-12, Paper submitted to the 21st Melbourne Money & Finance Conference, July; ASIC, 2016, "Further measures to facilitate innovation in financial services," consultation paper no. 260, June.
29 Shedden, A., and G. Malna, 2016, "Supporting the development and adoption of RegTech: no better time for a call for input," Burges Salmon 2, January, http://bit.ly/2cPvEuA.
30 Citigroup, 2013, "Comment letter on regulatory capital rules: enhanced supplementary leverage ratio standards for certain bank holding companies and their subsidiary insured depository institution," 3, Comment letter from Citigroup, October 21, http://bit.ly/2dpa57b; See Heltman, J., 2016, "Long-term liquidity plan is costly and redundant, banks argue," American Banker, August 12, http://bit.ly/2daTdio.
31 Gutierrez, D., 2014, "Big data for finance – security and regulatory compliance considerations," Inside big data, October 20, http://bit.ly/2dG7F71.
32 See Institute of International Finance, supra note 10: at 1.
33 Kaminski, P., and K. Robu, 2016, "A best-practice model for bank compliance," McKinsey & co., exhibit 1, January, http://bit.ly/2drDAVB.
34 See generally Mead, W., R. Iferenta and R. Hibbert, 2016, "A new landscape: challenger banking annual result," KPMG, May, http://bit.ly/1YjmJUi.

THE EMERGENCE OF REGTECH

Traditional financial institutions, particularly large global banks, have been the major drivers of the post-2008 evolution of RegTech, stemming from their appetite for efficient tools to deal with new and complex regulatory and compliance demands. Financial institutions began applying technology intensively to risk management and compliance in the 1990s, with regulators relying heavily on such systems. However, the GFC fundamentally altered the paradigm. Since the crisis, regulators globally have implemented far-reaching, extensive regulatory reforms that have driven the evolution of IT and compliance in major financial institutions worldwide. Global firms are developing global centralized risk management and compliance functions to address the changed regulatory and compliance environments.[35]

The history of global financial regulation is the story of regulatory initiatives in response to crisis. For example, the extensive financial liberalization and deregulation of the 1970s was followed by the Developing Country Debt Crisis of 1982, which in turn provided the impetus for the first Basel Accord on capital adequacy in the late 1980s.[36]

From the standpoint of financial institutions, the late 1960s to the GFC was a period of continual expansion in scope and scale, culminating in huge global financial conglomerates.[37] This occurred through organic growth and mergers and acquisitions, with the merger of Travelers and Citibank to form Citigroup in 1999 being paradigmatic.[38]

As financial institutions expanded their scope and scale across jurisdictions and sectors, they faced increasing operational and regulatory challenges. This led to a major expansion of risk management and legal and compliance activities, particularly throughout the 1990s and 2000s. From the 1980s, risk management was achieved using financial technology, as finance became increasingly quantitative and IT increasingly powerful. This combination was reflected in the emergence of financial engineering and Value-at-Risk (VaR) systems in major financial institutions.[39] These systems were a major element of the transformation of finance pre-GFC, but also one of the greatest risks and failures underlying the crisis itself.[40] By the early 21st century, the financial services industry had become overconfident in its ability to manage and control risks through the application of quantitative finance and IT.[41]

Regulators too became overconfident in the ability of this quantitative IT framework to manage risks, as is demonstrated in the heavy reliance by the Basel II Capital Accord on quantitative internal risk management systems.[42] Essentially, regulators outsourced major aspects of financial regulation to the internal risk control mechanisms of the largest industry participants.

Reliance on quantitative risk management systems by industry and regulators was the first iteration of RegTech – a sort of RegTech 1.0. This pre-crisis partnership between the financial industry and its regulators, based on quantitative internal risk management systems, provided a false sense of security and confidence that the GFC shattered.

IMPACT OF THE 2008 GFC

To date, traditional financial institutions and their risk management and compliance needs have been the primary driver of, and market for, RegTech solutions. While the financial services industry has long been a major user of automated reporting and compliance tools, increased regulatory costs since 2008 have enhanced the incentive to quickly adopt digitization and automation of processes as the default method of meeting regulatory obligations.

The emergence of RegTech can be largely attributed to the complex, fragmented, and ever-evolving post-GFC global financial regulatory regime. Overreliance on complex, prescriptive, and lengthy regulations led to massive compliance and supervision costs for regulators and the regulated. Carrying out financial supervision, in response to growing regulatory complexity, inevitably required greater granularity, precision, and frequency in data reporting, aggregation, and analysis.[43]

35 See EY, 2014, "Centralized operations - the future of operating models for risk, control and compliance functions," Ernst & Young LLP, February, http://bit.ly/1IQ3ubx.
36 Federal Reserve Bulletin, 2003, "Capital standards for banks: the evolving Basel Accord, September, http://bit.ly/2cPwCaj.
37 See Buckley, R. P., 2016, "The changing nature of banking and why it matters," Buckley, R. S., E. Avgouleas, and D. W. Arner, 2016, Reconceptualising global finance and its regulation, Cambridge University Press 9-27
38 Let's Talk Payments, 2014, "How 37 banks in 1990s became 4 banks in 2009, mega consolidation in US," http://bit.ly/2dnMNIn, citing Federal Reserve; GAO.
39 See Nocera, J., 2009, "Risk management – what led to the financial meltdown," New York Times, January 2, http://nyti.ms/2dADA7b.
40 The VaR model is unreliable in many ways. See Shojai, S., and G. Feiger, 2010, "Economists' hubris - the case of risk management," Journal of Financial Transformation 28, 25-35; Johnson, S., and J. Kwak, "Seduced by a model," New York Times Economix Blog (Oct. 1, 2009), http://nyti.ms/2cOY251; Krause, A., 2003, "Exploring the limitations of value at risk: how good is it in practice?" 4 Journal of Risk Finance, 19.
41 Overreliance on financial technology (like VaR) that allowed hugely complex risks to be modelled may have destroyed Wall Street: Salmon, F., 2012, "The formula that killed Wall Street," 9 Significance 16.
42 See Benink, H., and G. Kaufman, 2008, "Turmoil reveals the inadequacy of Basel II," Financial Times, February 28, http://on.ft.com/2dG9LUG; Staffs of the International Monetary Fund and The World Bank, "Implementation of Basel II – implications for the World Bank and the IMF," International Monetary Fund, July 22, http://bit.ly/2dG8AEt.
43 Institute of International Finance, supra note 4: at 5-8.

Examples can be found in capital and liquidity regulations under Basel III, stress-testing, and risk assessments in the U.K., U.S., E.U., and elsewhere, and the reporting requirements imposed on OTC derivatives transactions resulting from Group of 20 (G20)/Financial Stability Board (FSB) agreed approaches and as implemented – in conflicting fashions – in the context of Dodd-Frank or the E.U.'s EMIR.[44] Compliance costs rose significantly due to the increasing regulatory burden that made innovative technologies a natural and promising solution to compliance requirements.[45] As reported by Let's Talk Payments, "[t]he annual spending by financial institutions on compliance is estimated to be in excess of US $70 billion."[46] In this situation it is no wonder the industry turned to RegTech for cost-effective solutions.

Second, deepening regulatory fragmentation has given rise to an additional layer of compliance burdens for financial institutions. Despite policy-makers pushing for similar post-crisis reforms, the rules for implementing these reforms range from being slightly different to significantly dissimilar between markets. Regulatory overlaps and contradictions led financial institutions to turn to RegTech to optimize compliance management.[47]

Third, the rapidly evolving post-crisis regulatory landscape introduced uncertainty on future regulatory requirements, placing a premium on financial institutions enhancing their adaptability in regulatory compliance.[48] The use of RegTech may have taught financial institutions how to ensure compliance in a changing environment through iterative modeling and testing.

Finally, regulators themselves are becoming motivated to explore the use of RegTech to ensure financial institutions comply with regulations in a responsive manner.[49] RegTech can add value to regulators by helping them understand, in closer to real-time, innovative products and complex transactions, market manipulation, internal fraud, and risks.[50]

Essentially, RegTech embodies technological solutions to improved regulatory processes and related compliance. New technological developments (such as AI and machine learning) additionally allow for new forms of market monitoring or reporting processes.[51] As noted, this was initially driven by post-crisis regulatory reforms, with the application of technology the enabling factor. Examples include anti-money laundering (AML) and KYC compliance requirements and prudential regulatory reporting and stress-testing compliance requirements.

Clearly, we are still at an early stage in this process but its evolution is developing rapidly. As one example, in 2014, Goldman Sachs established a new campus in Bangalore (Bengaluru), India, with capacity for 9,000 staff.[52] Bangalore is already Goldman's second largest office. Other major financial institutions, including JP Morgan, Citibank, Morgan Stanley, Barclays, Deutsche Bank, HSBC, and Standard Chartered, have large proportions of their staff in centralized support operations in India, especially Bangalore, Mumbai, New Delhi, and Chennai. These are no longer primarily traditional back office or call center operations but are increasingly focused on integrated global risk management and regulatory compliance. In the context of customer on-boarding/account opening and KYC operations, these functions may be centralized in India (or elsewhere) for the entire operations of a global financial services firm.[53]

Similarly, in the context of the extensive reporting requirements of prudential regulators worldwide, financial institutions now look to centralized operations to gather the necessary data globally on a real-time basis so that, in the first instance, the institution and its management has a clearer picture of operations and risks, and in the second instance, the information can be repackaged as necessary to meet the requirements of regulators.[54] Ironically, these operations resemble pre-2008 trading floors, with rows of desks with telephones and multiple screens to allow continuous monitoring and communication across the institution.

From a regulatory standpoint, these operations are interesting: generally, they are separately incorporated subsidiaries and are not regulated as banks in their host jurisdiction, as they are not conducting "banking" activities requiring licensing and regulation. Rather, they are often subject to the domestic outsourcing rules of the jurisdictions of the group entities for which they provide support.[55]

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44 Id. For discussion in the context of the U.S., see Financial Stability Oversight Council, 2016, "Study on the effects of size and complexity of financial institutions on capital market efficiency and economic growth," carried out at the direction of the Chairman of the Financial Stability Oversight Council," March, http://bit.ly/2dNtl0W.

45 See Hill, E., 2016, "Is RegTech the answer to the rising cost of compliance?" FX-MM, June 13, http://bit.ly/2dGjENJ; Cornell, A., 2016, "AgTech, ResTech, RegTech, FinTech – actual solutions or techno-babble?" ANZ Blue Notes, February 23, http://bit.ly/2dnOLCs; Eyers, J., 2016, "Welcome to the new world of RegTech," Financial Review, June 20, http://bit.ly/2dAH5dZ.

46 Kate, 2016, "A report on global RegTech: a $100-billion opportunity – market overview, analysis of incumbents and startups," Let's Talk Payments, April 18, http://bit.ly/2dAFMfe.

47 See Hill, supra note 45.

48 See id.

49 Some financial regulators are embracing innovative regulatory techniques. See Eyers, supra note 45.

50 See Augur, H., 2016, "Regtech: the 2016 buzzword is turning heads," Dataconomy, May 3, http://bit.ly/2dOzuGr.

51 See Institute of International Finance, supra note 4: at 11-14.

52 See Times of India, 2014, "Goldman Sachs to invest Rs 1,200 Crore in Bangalore," September 25, http://bit.ly/2dXiG2L.

53 See Bearing Point, 2011, "Survey: shared services industry specifics and trends in the European FS market," 7-10.

54 See EY, supra note 35

55 See Deloitte, 2011, "Shared services handbook: hit the road," http://bit.ly/2cPBwnr.

The result is the emergence of an entirely different way of addressing compliance – one driven by technology and regulatory change and comprising the most sophisticated level of RegTech today, the first element of a new post-crisis RegTech 2.0. The increasing prevalence of RegTech in industry requires regulators to adapt and adopt technology within their own internal processes, which comprises the second element of post-crisis RegTech 2.0.

THE SECOND COMPONENT OF REGTECH 2.0: REGULATORS

Regulators are commonly viewed as under-resourced in terms of human capital and budgets, especially when it comes to acquiring and implementing technology. While this is generally one of the main barriers to RegTech development within the regulatory community, regulators have had notable successes in the context of technology and regulation.[56]

Relative to the private sector, there has been a lag in regulator adoption of RegTech. Nonetheless, large market incidents have prompted regulatory (re)action. Regulators have actively used technology since the 1980s to monitor and enforce market integrity in exchange-traded securities markets, with the U.S. Securities and Exchange Commission (SEC) leading globally.[57] Additionally, regulators and the financial industry have long worked closely in the evolution of robust technological and regulatory solutions to issues regarding cross-border electronic payment systems as well as securities trading and settlement systems. However, with the growing amount of information reported to regulators and new technology such as AI and deep learning, there is great potential for more to be done in terms of automating market supervision, consumer protection, and prudential regulation.[58] Regulators are also being challenged by the pace of FinTech innovation.

RegTech's evolution in the financial industry, particularly in large global financial institutions and infrastructure providers, such as payment systems and securities exchanges and clearing and settlement systems, has been rapid. However, there remains a wide gap between IT-enabled systems in the industry and the lack of IT-enabled solutions among regulators. Regulators are becoming increasingly aware of this due to their need to deal with the masses of reports and data which post-GFC regulatory changes have required.[59] Given these data streams are designed to ensure financial stability and market integrity, regulators need to develop systems to appropriately monitor and analyze these datasets.

Big data: matching reporting with analytical tools

AML/KYC has so far provided a fertile area for RegTech development and the information produced by the financial services industry – particularly suspicious transactions reports – is an area where regulators are beginning to consider technological solutions for monitoring and analysis.

Failure by regulators to develop the IT capabilities to use the data provided in response to reporting requirements will severely impact the achievement of the policy objectives of such requirements.[60] This also provides an important opportunity for collaboration between regulators and academia (particularly quantitative finance and economics academics with highly developed capabilities in analyzing datasets). Such collaboration offers great potential benefit to regulators in supporting financial stability, market integrity, and a greater understanding of market behavior and dynamics.[61]

An area where regulators have successfully used technology to monitor and analyze markets over the past twenty years is public securities markets. Today, regulators rely heavily on trade reporting systems of securities exchanges to detect unusual behavior, which can serve as a trigger for regulatory investigation and enforcement;[62] for instance, trading on inside information before a major corporate event. Securities exchanges maintain data on all trades so it is simple to search for unusual trading activity prior to an announcement of a merger or acquisition. Such activity is then investigated for possible misconduct, which may form the basis of an enforcement action. These systems illustrate the use of RegTech 1.0 in the pre-crisis period.

Since the crisis, such systems have been shown to be limited by their lack of information on activities taking place off the exchange.

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56 See Brummer, C., 2015, "Disruptive technology and securities regulation," 84 Fordham Law Review 977.

57 See e.g., SEC, 1997, "Report to the Congress: the impact of recent technological advances on the securities markets," U.S. Securities and Exchange Commission; See also Technical Committee of the International Organization of Securities Commissions, 2011, "Regulatory issues raised by the impact of technological changes on market integrity and efficiency," October.

58 See Najafabadi, M. M., F. Villanustre, T. M. Khoshgoftaar, N. Seliya, R. Wald, and E. Muharemagic, 2015, "Deep learning applications and challenges in big data analytics," 2 Journal of Big Data 1.

59 See UK Government Chief Scientific Adviser, 2015, "FinTech futures - the UK as a world leader in financial technologies," 48, March, http://bit.ly/1FCBDgS.

60 Kalakota, R., 2013, "RegTech – regulatory/risk data management, AML and KYC analytics," Practical Analytics, January 17, http://bit.ly/2doX0M1; See also KPMG, 2015, "Ten key regulatory challenges facing the banking & capital markets industry in 2016," 2, http://bit.ly/2dNwRIJ; U.K. Government Chief Scientific Adviser, 2015, "FinTech futures - the UK as a world leader in financial technologies," at 52, March, http://bit.ly/1FCBDgS.

61 See U.K. Government Chief Scientific Adviser, supra note 60: at 52.

62 The Board of the International Organization of Securities Commissions, 2012, "Technological challenges to effective market surveillance issues and regulatory tools: consultation report," 14-15, August.

This is a clear concern given that the majority of trading in many major securities markets now occurs off-exchange via ECNs and "dark pools."[63] Regulatory changes in the U.S. and E.U. are set to change this by mandating reporting of all transactions in listed securities, whether or not those transactions take place via a formal exchange or an off-exchange electronic system. Such reporting requirements must likewise be matched with IT systems within regulators to monitor and analyze the information.

Regulators must apply this approach across their regulatory roles. This is the second element of an emerging RegTech 2.0. We see further examples emerging in the context of cybersecurity and macroprudential surveillance.

Cybersecurity

The question of cybersecurity in finance highlights the necessity of further regulatory development.[64] Indeed as the financial services industry continues to evolve into a digitized data-based industry, there is an increasing risk of attack, theft, and fraud. Likewise, the GFC highlighted the public good and public order role of the financial sector, so that the financial sector and financial stability are not only economic issues but also national security issues.

Not surprisingly, this focus area for regulators is increasingly at the center of international attention from organizations such as the FSB and Basel Committee.[65] This is in addition to the natural attention on the issue by financial institutions themselves: cybersecurity is one of the most significant risks faced by the financial industry.[66] Likewise for new FinTech start-ups, cybersecurity should be a key concern as these data intensive companies often have a limited comprehension or perceived need of security as they live in a digital world with an abundance of data. Whilst the scarcity of money drove the development of secure vaults and payment systems, data abundance may not create the right incentive for firms (beyond reputational risks) and can clearly harm consumers.

Macroprudential policy

Prior to the GFC, the focus of prudential and financial stability regulation was on the safety and soundness of individual financial institutions. This was premised on the idea that if each bank was financially safe and sound, then the financial system as a whole would likewise be stable. The GFC fundamentally altered this view and there has since been a new focus on macroprudential policy, with the G20 tasking the IMF, FSB, and BIS to focus on the development of early warning systems to prevent the build-up of risks that lead to financial crises, with the overall intention of preventing crises from happening or at ameliorating their severity. Macroprudential policy focuses on the stability of the entire financial system, by a holistic analysis focusing on interconnections and evolution over time.[67]

As a result of this new focus, an increasing number of jurisdictions have implemented new institutional frameworks to support macroprudential policy, including the Financial Stability Oversight Council (FSOC) in the U.S. and the European Systemic Risk Board (ESRB) in the E.U. These new institutional frameworks have been tasked – along with the IMF, FSB, and BIS – to develop and implement macroprudential policies to support financial stability. Macroprudential policy thus seeks to use the massive amounts of data being reported to regulators in order to identify patterns and reduce the severity of the financial cycle.

Some progress is being made in identifying potential leading indicators for future financial instability.[68] The progress to date involves quantitative analysis of large volumes of data searching for interconnections and implications. The data being reported by financial institutions and financial infrastructure providers is ever increasing and can feed into these analytical processes. Already, major central banks, such as the Federal Reserve, the European Central Bank, and the Bank of England, are beginning to use data "heat maps" to highlight potential issues arising from automated analyses of the masses of data (such as stress tests) being produced.[69]

While these efforts remain at an early stage, they do highlight the likely future direction of RegTech in macroprudential policy. At the same time regulators are continually identifying needs for yet more data.[70] This results in ever increasing reporting requirements for financial institutions, further driving the need for RegTech processes and centralized support services to collect and produce the required data at the required frequency and in the required format. In particular, the Basel Committee (in the so-called "BCBS 239") has set requirements for risk data aggregation and reporting that are driving

63 Public Statement, U.S. SEC Commissioner Luis A. Aguilar, 2015, "Shedding light on dark pools," November 18, http://bit.ly/2dGe5mJ.

64 See Financial Stability Oversight Council, 2016, "FSOC 2016 annual report."

65 See e.g., The Board of the International Organization of Securities Commissions, 2016, "Cyber security in securities markets – an international perspective."

66 See Dahlgren, S., 2015, "The importance of addressing cybersecurity risks in the financial sector," Speech at the OpRisk North America Annual Conference, New York City, March 24.

67 See International Monetary Fund, Financial Stability Board, and Bank for International Settlements, 2016, "Elements of effective macroprudential policy," August.

68 Id. See BIS Committee on the Global Financial System, 2016, "Experiences with the ex-ante appraisal of macro-prudential instruments," CGFS paper no. 56, July; Gadanecz, B., and K. Jayaram, 2015, "Macroprudential policy frameworks, instruments and indicators: a review," BIS Irving Fisher Committee on Central Bank Statistics, Paper, December.

69 See IMF, FSB, and BIS, supra note 67.

70 See Financial Stability Board and International Monetary Fund, 2016, "The financial crisis and information gaps: second phase of the G-20 Data Gaps Initiative (DGI-2) – first progress report, September.

internal processes in financial institutions and regulators, with an increasing focus on near real-time delivery, with near real-time analysis hoped to follow.[71] Significantly, the FSB and IMF have identified the need for harmonization of reporting templates for systemically important financial institutions (SIFI) in order to make data analysis more straightforward.[72]

While these important developments are the first important steps on the way to better regulation through technology, they highlight challenges for other regulators regarding expertise, access to technology, and financial constraints. They also set the stage for the application of more sophisticated big data tools including deep learning and AI.

LOOKING FORWARD

As FinTech gradually moves from digitization of money to embrace the monetization of data, the regulatory framework for finance will need to be rethought so as to cover notions previously unnecessary, such as data sovereignty and algorithm supervision. At this stage, the sustainable development of FinTech will need to be built around a new framework, namely RegTech. This will require a sequenced approach.

Technologically, RegTech development is not a major challenge.[73] The primary limitation may instead come from the regulators' own ability to process the increased amount of data thereby generated.[74] The U.K.'s Financial Conduct Authority (FCA) seems cognizant of this, as it is currently restricting access to its regulatory sandbox to a limited number of applicants with a detailed testing plan.[75] Financial regulators, therefore, need to take a coordinated approach to support RegTech development. Harmonization of financial markets and regulations has a long history, and seems increasingly important given the mobility of new FinTech start-ups.

RegTech 2.0 is largely about streamlining and automating regulatory compliance and reporting; and developed in a different technological context than that which is rapidly evolving today. There is a progressive alignment underway in how FinTech and RegTech are evolving, with each sharing data-centricity. This represents a paradigm shift from a KYC approach towards a KYD paradigm, which, while profound, remains a few years away. Until then, the design and implementation of proportionate, data-driven regulation should enable proactive regulators to handle innovation without compromising their mandate.

As one example, the U.K. government is seeking to promote the design of a regulatory framework able to adapt dynamically to new rules and regulations.[76] The argument for cost reduction within compliance is very strong, and RegTech looks particularly beneficial for firms and regulators alike. Indeed, RegTech should enable firms to better control risks and costs, and regulators to benefit from more efficient monitoring tools and simulation systems to evaluate the consequences of future legislative reforms.

Yet, balance is needed in assessing what is currently feasible when it comes to fully automating regulatory and compliance systems.[77] Furthermore, the RegTech sector will continue to reinvent itself. While post-2008 regulatory requirements are still evolving, going forward we expect the next financial crisis to add extra layers of requirements and to see companies develop new business models, in turn generating unexpected risks.

In conclusion, for the past 50 years the application of technology within regulation has changed dramatically. The pre-2008 evolution we have defined as RegTech 1.0, a paradigm severely damaged by the GFC. Since 2008, the combination of new regulatory obligations and technology has formed the first element of a new RegTech 2.0; the use of technology to facilitate and streamline compliance. The second element of RegTech 2.0, involving regulators using technology to improve their supervision and regulation, is emerging but still at an early stage.

Looking forward, the truly transformative potential of RegTech will be for it to be used to re-conceptualize the future of financial regulation by leveraging new technology. We are beginning to see certain elements of this new RegTech 3.0 emerge, with technological progress changing both market participants and infrastructure, with data as the common denominator. The practical consequences of this shift will mean undergoing a transformation from a KYC mindset to a KYD approach.

71 The Basel Committee, 2013, "Principles for effective risk data aggregation and risk reporting, January.
72 Id.
73 See U.K. Government Chief Scientific Adviser, supra note 60: at 53.
74 Id. at 48.
75 See Moyle, A., and F. Maclean, 2016, "World-first regulatory sandbox open for play in the UK," Latham & Watkins 1, May, http://bit.ly/2dXr7Lv.
76 See U.K. Government Chief Scientific Adviser, supra note 60: at 47.
77 Cyras, V., and R. Riedl, 2009, "Formulating the enterprise architecture compliance problem," http://bit.ly/2db4izR.

U.S. Regulation of FinTech – Recent Developments and Challenges

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Abstract
Regulation of financial technology (or FinTech) providers, products, and services serves many important policy objectives. The rapid development of FinTech products and services, and the dramatic entry of numerous new participants in the market that are not regulated like traditional financial institutions, have presented challenges for regulators around the globe. In the U.S., the financial regulatory apparatus is fragmented, exacerbating those challenges. That, coupled with a difficult financial regulatory environment in the U.S. in the aftermath of the financial crisis and other issues endemic to the FinTech sector, make for strong headwinds for both financial regulators and FinTech providers as they try to strike the right balance between regulation and flexibility to allow innovation to occur. There are a variety of potential paths to address some of those challenges and headwinds, but none are a panacea and a combination of solutions will need to be implemented to strike that balance appropriately.

INTRODUCTION

The regulation of financial services providers by U.S. financial regulators serves a critical function in the provision of financial services in the U.S. The purposes served by such regulation – protection of consumers, monitoring effect on financial stability, etc. – are indisputably of great importance in the post-"Great Recession" world. However, due in part to the highly fragmented financial regulatory system and the general financial regulatory environment in the U.S., such regulation is slow to adapt, burdensome for providers, and may be of questionable effect – particularly in the context of financial technology (FinTech) providers.

This article provides a brief description of the current FinTech phenomenon, the fragmented nature of the U.S. financial regulatory system and the key policy issues and objectives under active discussion by market participants today. We then review certain important potential avenues to address some of the challenges facing the regulation of FinTech in the U.S.[1]

BACKGROUND

FinTech generally

In recent years, the level of interest and activity in the FinTech sector have increased significantly, driven by the rising demand for new products and services by consumers and businesses and the rapid development of innovative technology with the potential to meet that demand. While banks and other regulated financial institutions have long been active participants in FinTech development, new types of unregulated and lightly regulated market participants, including both established technology companies and newer start-ups, have also gained significant traction. This phenomenon has been fueled by a significant increase in private investment in the FinTech sector, with private FinTech investment rising from approximately U.S.$2 bln in 2010 to U.S.$19 bln in 2015. This increase in interest and activity has been accompanied by growing scrutiny by financial regulators around the globe, who have begun to promulgate new regulations and guidance to clarify their expectations regarding the development and delivery of FinTech products and services. This is particularly so in the case of FinTech offerings that involve consumers.

Key FinTech participants

In the U.S., FinTech innovators broadly fall into four categories based on the existing level of supervision and regulation applicable to them:

- Traditional financial institutions like banking organizations, broker-dealers, insurance companies, and other similar institutions, which are subject to U.S. federal and/or state regulation and supervision by their primary financial regulators.[2]
- Technology and other companies that directly provide financial services to consumers or businesses, which may be subject to federal and/or state regulation and supervision by U.S. financial regulators depending on the nature and scope of the financial services that they provide.
- Technology and other companies that provide services to banking organizations and are subject to supervision and regulation by federal banking agencies under the Bank Service Company Act (BSCA). These companies are often not subject to regulation and supervision directly because they may not provide financial services directly to end users, but are subject to bank-like regulation under the BSCA due to the nature of the services they provide to banking organizations. For these companies, federal banking regulators have the authority to examine and regulate their activities, functions, and operations to the same extent as if they were conducted by the banking organization itself.
- "Pure" technology and software companies that provide products and services to companies in the financial sector but are generally not subject to regulation and supervision by financial regulators. Companies in this category provide technology solutions to companies in the financial sector, but do so as a natural extension of the technology and software products and services that they offer to customers in a variety of other industries. Companies in this segment are not generally viewed as a primary target of supervision and regulation by financial regulators due to the nature of their relationship with the financial sector.

U.S. FINANCIAL REGULATORY REGIME

Highly fragmented system

The U.S. financial regulatory system is complex and fragmented, with multiple federal and state regulators and law enforcement authorities exercising overlapping responsibilities and authority. This highly fragmented system is in many ways a product of the U.S.'s constitutional division of authority between the national government and the state governments (referred to as Federalism). At the federal level, it also reflects both historical developments that may or may not continue to reflect current priorities, as well as an intentional allocation of responsibilities to agencies with differing focuses and

1 This article is not intended to be a comprehensive review of the extensive scope of the U.S. financial regulatory regime, the scope of "FinTech" itself, or the myriad issues arising from the FinTech phenomenon.

2 For purposes of simplicity, this article will focus on banking organizations as key traditional FinTech providers.

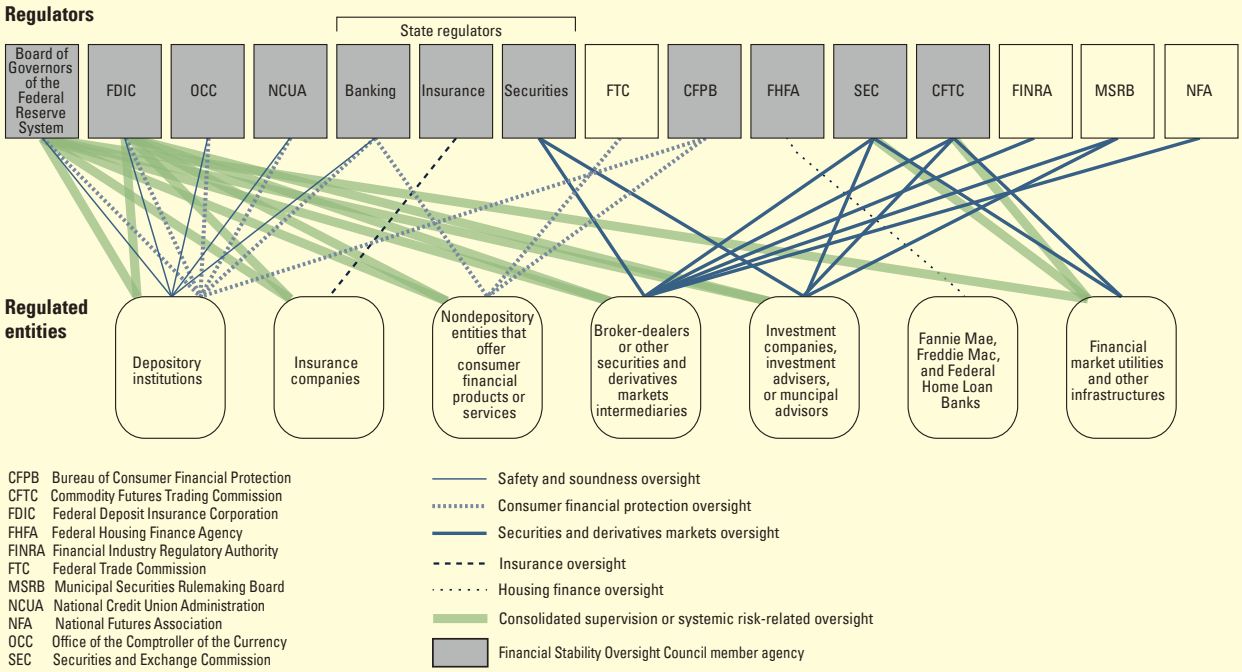

Figure 1 – U.S. GAO's analysis of the fragmented U.S. regulatory regime

missions. This regulatory structure can, in some cases, lead to inefficiencies in regulatory processes, inconsistencies in regulatory oversight of similar types of financial institutions, and opportunities for regulatory arbitrage. The system also makes it difficult for financial regulators to quickly and comprehensively adapt and respond to fast-moving developments.

To illustrate these challenges, the U.S. Government Accountability Office (GAO) recently released a Congressionally-mandated report analyzing the effects of fragmentation and overlap in the U.S. financial regulatory regime. It included the following schematic in that report (Figure 1).

As Figure 1 indicates, U.S. financial institutions face an overlapping and often confusing web of regulatory regimes and supervisors based on their regulatory status and the nature of the products and services they offer. Even where it is clear that a FinTech provider or a service should be regulated, it is not always clear which regulator FinTech companies should look to for guidance as to what regulatory requirements apply to them. This confusion results, in part, from the fact that the services and activities offered by some unregulated FinTech companies may not fit neatly within the statutory mandate of existing regulatory bodies. For many "traditional" regulated institutions, identifying the principal relevant regulator is a somewhat simpler task, as most such institutions are subject to primary supervision and regulation by their primary financial regulator (e.g., the OCC for national banks), although their FinTech-related activities also may be subject to supervision and regulation by one or more other regulators due to the nature of the FinTech product or service in question.

Furthermore, the sheer range of applicable regulatory requirements may be difficult for a new entrant to manage. For example, a FinTech provider that wishes to offer a consumer-facing automated investment platform may be subject to regulation by the U.S. Securities and Exchange Commission (SEC), the Financial Industry Regulatory Authority (FINRA), and the Consumer Financial Protection Bureau (CFPB) on the federal level and by one or more state securities regulators on the state level, each of whom may have different sets of regulatory guidelines and expectations. Of course, banking and other established financial services organizations also experience this overlapping regulatory structure, but the scale of their operations may permit them to spread over a broader base the cost of building and operating a legal and compliance structure to address the range of applicable requirements. In contrast, jurisdictions with a more consolidated financial regulatory system, such as the U.K., are better positioned to offer FinTech providers an integrated set of regulations and regulatory guidance for their activities.

Challenging U.S. financial regulatory environment

In the aftermath of the Great Recession, the complexity of the financial regulatory system has increased, making these challenges even greater. The U.S., like other major jurisdictions, has mounted an extraordinary effort to ensure that another financial crisis will not occur by increasing the scope and depth of financial regulation. The intensity of regulatory scrutiny has been increased further following significant enforcement actions against a number of large banking organizations in a range of compliance areas, including anti-money laundering and sanctions compliance and consumer protection. These trends have resulted in an extremely challenging regulatory environment for financial institutions of all types in the U.S.

The burden of this environment falls particularly hard on FinTech innovators. For startups and other FinTech innovators that do not have a history of operating under an extensive regulatory framework, it may be impossible – financially and operationally – to build a compliance function that adequately addresses regulatory requirements until a product or service has been developed and tested and shows promise. Compliance functions require capital, and without workable products and services it is difficult to attract capital. If a startup cannot even test the market without building a fully fleshed out compliance structure, it may be impossible to ever fully bring innovative ideas to the market to be tested.

More established financial institutions may also find it difficult to bring new products to market in a regulatory environment with little tolerance for error, particularly where it is not clear how existing rules may apply to a new product.

And yet both financial market participants and regulators acknowledge the importance of fostering financial innovation in the U.S. – or at least acknowledge its inevitability – as long as that innovation is "responsible."[3] As a result, major U.S. regulators have begun to grapple with the appropriate regulation of financial technology, whether offered by banking organizations or by non-bank FinTech players.

Key U.S. policy objectives for FinTech

U.S. financial regulators and market participants have articulated a number of key policy objectives for the regulation and supervision of FinTech. These include:

- **Prudential oversight:** prudential regulation, or regulation focused on the safety and soundness of institutions, has traditionally been understood to mean the exercise of supervisory authority by banking regulators over depository banking institutions for the purpose of protecting insured customer deposits and the deposit insurance system. However, for many financial regulators, one of the lessons learned during the recent financial crisis was that prudential oversight might also be used to address threats to stability of the financial system associated with firms that were previously exempt from prudential regulation. In the FinTech space, certain types of FinTech companies, such as the peer-to-peer/marketplace lending businesses developed by Lending Club, SoFi, and Prosper, are increasingly offering credit products that compete directly with the lending platforms traditionally associated with depository institutions. As these types of peer-to-peer/marketplace lenders become increasingly important providers of credit for consumers and businesses alike, regulators have begun to assess the risks posed by their capital structures, due to their inability to rely on the stable funding base provided by deposits and their inability to access the Federal Reserve's discount window in stressed situations.
- **Discouraging regulatory arbitrage and maintaining competitive equality:** in the view of some, it would not be appropriate for FinTech providers that are not banking organizations to gain a competitive advantage through a lighter regulatory burden. By seeking to ensure that comparable financial products and services are regulated similarly, regardless of the nature of the provider, regulators seek to minimize the opportunity for regulatory arbitrage.
- **Anti-money laundering and sanctions:** while payments platforms and money transmission services have proven to be some of the most active sub-sectors within FinTech, regulators have also expressed their desire to ensure that new FinTech providers are not vulnerable to being taken advantage of by users who seek to transfer funds in contravention of bank secrecy, anti-money laundering, and sanctions regulations. To this end, regulators have focused on making sure that FinTech providers comply with existing regulatory frameworks, such as state-level money transmitter licenses, to the extent such existing frameworks are applicable to FinTech companies, and have also begun to design new frameworks suitable for newer FinTech companies, including the new BitLicense Regulations recently adopted in New York.
- **Data privacy and cybersecurity:** while data privacy and cybersecurity considerations are important for all types of financial institutions, regulators have expressed their view that these considerations are even more important to FinTech providers that manage and retain personal information of consumers as part of their operations. Financial regulators have indicated that, going forward, they will continue to evaluate the need for heightened data privacy and cybersecurity protections for FinTech companies, in order to protect customers and to ensure a consistent playing field for all types of market participants, whether they are traditional financial institutions or newer FinTech upstarts.

3 See, e.g., Office of the Comptroller of the Currency, 2016, "Supporting responsible innovation in the federal banking system: an OCC perspective," Washington, D.C., at 2: "Innovation holds much promise. Technology, for example, can promote financial inclusion by expanding services to the underserved. It can provide more control and better tools for families to save, borrow, and manage their financial affairs. It can help companies and institutions scale operations efficiently to compete in the marketplace, and it can make business and consumer transactions faster and safer."

U.S. FINANCIAL REGULATORY RESPONSE TO FINTECH

In order to reconcile the overlapping nature of their authority and create a consistent set of expectations for FinTech providers, key U.S. financial regulators, including the Office of the Comptroller of the Currency (OCC), Treasury Department, and CFPB, have begun to highlight the importance of "responsible innovation." Responsible innovation seeks to balance a forward-thinking attitude towards innovation in the financial sector with a continued focus on financial stability, consumer protection, and other key regulatory priorities. The following are some of the key policy initiatives relating to FinTech developed by U.S. financial regulators to date, and the ways in which each of these regulators has chosen to implement this concept of responsible innovation.

OCC

The OCC, which supervises and regulates federally chartered national banks and savings associations, released a white paper on March 31, 2016 that sets forth its perspective on supporting responsible innovation in the federal banking system. In its white paper, the OCC defines responsible innovation to mean "the use of new or improved financial products, services, and processes to meet the evolving needs of consumers, businesses, and communities in a manner that is consistent with sound risk management and is aligned with the bank's overall business strategy." The OCC white paper identifies eight principles that guide the OCC's approach to responsible innovation, which are collectively intended to facilitate the ongoing development of the OCC's comprehensive framework:

- **Support responsible innovation:** the OCC is considering various reforms to improve its process for understanding and evaluating innovative financial products, services, and processes. As part of this process, the OCC will evaluate its guidance on new product development and third-party risk management and assess whether additional guidance is appropriate to address the needs of banks and their customers in the rapidly changing environment. To expedite decision-making in response to new proposals, the OCC is also evaluating whether it can streamline some of its licensing procedures, where appropriate, or develop new procedures where existing procedures may not work for certain innovative activities. In addition, the OCC is considering the possibility of creating a centralized office on innovation which could serve as a forum to vet ideas before a bank or nonbank makes a formal request or launches an innovative product or service.
- **Foster an internal culture receptive to responsible innovation:** the OCC will evaluate its policies and processes, define roles and responsibilities with respect to evaluating innovation, identify and close knowledge and expertise gaps, and enhance its communication with internal and external stakeholders. In addition, the OCC will develop or augment existing training to reinforce its receptiveness to responsible innovation and develop additional expertise to evaluate the opportunities and risks related to specific types of innovation.
- **Leverage agency experience and expertise:** the OCC will rely heavily on the breadth and depth of knowledge of its existing staff in implementing its responsible innovation framework.
- **Encourage responsible innovation that provides fair access to financial services and fair treatment of consumers:** to encourage responsible innovations that provide fair access to financial services and fair treatment of consumers, the OCC may issue guidance on its expectations related to products and services designed to address the needs of low- to moderate-income individuals and communities and may encourage innovative approaches to financial inclusion.
- **Further safe and sound operations through effective risk management:** the OCC's framework will consider how national banks and federal savings associations identify and address risks resulting from emerging technology, including cybersecurity risk.
- **Encourage banks of all sizes to integrate responsible innovation into their strategic planning:** according to the OCC white paper, a bank's decision to offer innovative products and services should be consistent with the bank's long-term business plan rather than following passing trends, and collaborations with nonbanks to offer innovative products and services should take into consideration whether such partnerships help the bank achieve its strategic objectives.
- **Promote ongoing dialogue through formal outreach:** the OCC plans to bring together banks, nonbanks, and other stakeholders through a variety of forums, workshops, meetings, and "innovator fairs" to discuss responsible innovation.
- **Collaborate with other regulators:** the OCC will work with other regulators, such as the CFPB, to collaboratively support responsible innovation in the financial services industry. As part of this collaborative process, the OCC expects to use best efforts to avoid inconsistent communications with supervised entities.

Following the release of the OCC's white paper, the OCC held a forum on "supporting responsible innovation" in June 2016, in which Comptroller Curry reiterated that the OCC's efforts to encourage responsible innovation were not meant to stifle growth and innovation, but rather meant to start a dialogue with FinTech companies, large and small. Recently, the OCC proposed a rule to address the manner in which uninsured banks chartered by the OCC would be liquidated if they were to fail. While seemingly an arcane topic, the OCC noted that the adoption of clear rules governing such liquidations would facilitate the use of such entities to conduct FinTech-related businesses.[4]

4 See Office of the Comptroller of the Currency, 2016, "Receiverships for uninsured national banks," 81 Federal Register 62835, 62837 (Sep. 13, 2016).

Treasury Department

The Treasury Department has issued guidance identifying the opportunities and challenges posed by peer-to-peer/marketplace lending.[5] In May 2016, the Treasury Department published a white paper on peer-to-peer/marketplace lending that establishes an overview of the market landscape, reviews emerging themes in stakeholder opinions, and provides a number of policy recommendations. The themes identified in the Treasury Department's white paper include the following:

- **Use of data and modeling techniques for underwriting is an innovation and a risk:** the Treasury Department recognized that the use of new types of data-driven algorithms by peer-to-peer/marketplace lenders to identify a borrower's credit risk presents both promise and risk. On the one hand, these new algorithms reduce costs and can expedite the credit assessment process, but on the other hand, these algorithms can create disparate impacts in credit outcomes and violations of fair lending laws. In addition, because there is a lack of transparency to these algorithms, consumers generally do not have an opportunity to check and correct incorrect data being used by peer-to-peer/marketplace lenders to assess their credit profile.
- **Online marketplace lending provides an opportunity to expand access to credit:** the Treasury Department noted that while peer-to-peer/marketplace lending is expanding access to credit by providing loans to borrowers who might not otherwise receive capital from traditional financial institutions, peer-to-peer/marketplace lenders currently serve mostly prime and near-prime borrowers in the consumer loan market. Additionally, the Treasury Department noted that peer-to-peer/marketplace lenders specializing in the student loan space may have difficulty expanding to borrowers beyond those with exceptionally high credit quality, and that the majority of peer-to-peer/marketplace lenders are helping student borrowers refinance existing debt, as opposed to expanding access to credit in the student loan market.
- **Small business borrowers will likely require enhanced safeguards:** the Treasury Department is one of several regulators that have noted the potential need for heightened safeguards for small and medium enterprise (SME) customers, due to the fact that SME borrowers do not currently enjoy all of the same consumer protection laws and regulations as individual borrowers and typically receive protection only through contract law or fair lending laws.

In connection with these themes, the Treasury Department's white paper also outlined a series of policy recommendations, which included the following:

- **Support more robust small business borrower protections and effective oversight:** the Treasury Department expressed its belief that more effective oversight of peer-to-peer/marketplace lenders (that mirrors oversight standards imposed on depository institutions) could enable greater transparency in small business online marketplace lending that could lead to better outcomes for borrowers.
- **Promote a transparent marketplace for borrowers and investors:** the Treasury Department also emphasized its belief that the peer-to-peer/marketplace lending industry should adopt (i) standardized representations, warranties, and enforcement mechanisms, (ii) consistent reporting standards for loan origination data and ongoing portfolio performance, (iii) loan securitization performance transparency, and (iv) consistent market-driven pricing methodology standards. Additionally, the Treasury Department recommended the creation of a publicly available, private sector driven registry for tracking data on transactions, including the issuance of notes and securitizations, and loan-level performance.
- **Expand access to credit through partnerships that ensure safe and affordable credit:** the Treasury Department also believes that for technology to truly expand access to underserved markets, more must be done to serve borrowers who are creditworthy, but may not be scoreable under traditional credit models.

FDIC

The FDIC, which has jurisdiction over all U.S. insured depository institutions and serves as the primary federal regulator for a significant number of smaller and community banks, has also focused its guidance on peer-to-peer/marketplace lending, most notably through guidance issued in early 2015. In its guidance, the FDIC recognized that peer-to-peer/marketplace lending is a small but growing component of the financial services industry that some banks are viewing as an opportunity to increase revenue. Additionally, the FDIC emphasized that it expects banks partnering with peer-to-peer/marketplace lenders to conduct thorough due diligence and ongoing monitoring to ensure that lenders are complying with applicable legal requirements, such as consumer protection and anti-money laundering laws. Finally, the FDIC guidance outlined a set of risks it associated with peer-to-peer/marketplace lending, including (i) compliance risk, or the risk of non-compliance with consumer protection, fair lending, and AML laws, (ii) transactional risk, or the risk arising from large loan volume, document handling, and movement of funds between institutions or third-party originators, (iii) servicing

5 While not discussed in depth in this article, it is important to note that the investing side of peer-to-peer/marketplace lending platforms is also subject to regulation by the SEC. See U.S. Securities and Exchange Commission, 2008, "Cease-and-desist order, Securities Act of 1933," Release No. 8984, November 24: finding that notes issued by Prosper Marketplace, Inc. through its marketplace lending platform were securities within the meaning of the Securities Act of 1933 and that Prosper violated Sections 5(a) and (c) of the Securities Act of 1933 by engaging in the sale of unregistered securities without an effective registration statement or valid exemption from registration.

risk, or the risk of insolvency of an unproven loan servicer, and (iv) liquidity risk, or the risk associated with the limited market for the resale of loans originated by peer-to-peer/marketplace lenders.

CFPB

The CFPB, whose statutory mandate includes jurisdiction over the consumer-facing activities of certain regulated financial institutions and their service providers, has adopted a proactive approach towards FinTech regulation that seeks to encourage a climate of ongoing dialogue with the FinTech companies that currently are, or may become, subject to its supervision and regulation.

In February 2016, the CFPB issued its final policy to facilitate consumer-friendly innovation (CFPB Innovation Policy). The CFPB Innovation Policy establishes a new process for financial services providers to apply for no-action letters[6] regarding the application of consumer regulations to new products that offer the potential for significant consumer-friendly innovation. Through this new process, the CFPB intends to permit providers to clarify regulatory uncertainty during the FinTech product development process.

The CFPB Innovation Policy was created as part of the CFPB's Project Catalyst initiative, which is designed to encourage consumer-friendly developments in markets for consumer financial products and services. The CFPB Innovation Policy is intended to enhance regulatory compliance in specific circumstances where a product promises significant consumer benefit and where there may be uncertainty around how the product fits within an existing regulatory scheme.

State regulation

In addition to federal financial regulators, state financial regulators have also been active in proposing and implementing new guidance relating to FinTech products and services. Historically, state financial regulators have been the principal regulators in certain key areas of the financial sector, with money transmitter laws standing out as one particular example. Nearly every state has a money services businesses statute in place that requires companies seeking to engage in the money transmission business or other money services businesses obtain a license before engaging in that business [Conference on State Bank Supervisors (2016)].[7] A person engaged in the money transmitting business must generally obtain a license from each state in which it conducts business.

Newer FinTech startups focusing on payments, virtual currencies, and related services have sought to understand the extent to which these requirements may be applicable to them. Companies, including now-established FinTech innovators like Paypal, have often asserted – at least at the outset – that money transmitter statutes did not apply to them, but have generally come to accept that obtaining a license is required. Paypal is now licensed in 53 jurisdictions within the U.S. alone (including Puerto Rico, the U.S. Virgin Islands, and Washington, D.C.).

For companies operating in the virtual currency (e.g., Bitcoin) space, the application of state-level money transmitter laws is particularly awkward. Whether such currencies constitute "money," and whether the services these companies provide constitute "transmission" or other regulated services, is not always obvious. Certain states have implemented new regulatory frameworks that are designed to address the challenges and risks posed by virtual currency companies. New York State's BitLicense and North Carolina's Virtual Currency Law provide examples of two different approaches to this new challenge.

New York BitLicense

New York State's BitLicense Regulations (23 C.R.R.-NY I § 200) were intended by New York regulators to address the risks posed by the use of virtual currencies by criminals, particularly in the wake of the federal government's efforts to close down the Silk Road website when authorities realized that the site was facilitating illegal activities including the sales of drugs and weapons. Finalized in June 2015, the BitLicense Regulations were the first attempt by any state (or federal) regulator to formally address the virtual currency sector. They require any person who engages in a virtual currency business activity involving New York or a New York resident to obtain a BitLicense from the New York Department of Financial Services (NYDFS), and establish minimum standards of conduct for all BitLicense holders to ensure compliance with customer protection, cybersecurity, and anti-money laundering regulations.

The BitLicense Regulations define "virtual currency" broadly to mean any type of digital unit that is utilized as a medium of exchange or as a form of digitally stored value, and also defines "virtual currency business activity" broadly to encompass a wide range of activities including (i) receiving or transmitting currency, except where the transaction is undertaken for non-financial purposes and does not involve the transfer of more than a nominal amount, (ii) storing, holding, or maintaining custody or control of virtual currency on behalf of others, (iii) buying and selling virtual currency as a customer business,

6 A "no-action letter" is a letter provided by the staff of an agency that provides guidance as to the way in which the staff of the agency would interpret the application of a law or regulation to a particular set of facts. In general, no-action letters do not bind the relevant agency, but they are generally considered to be good evidence of the way in which the agency itself would likely apply the law in analogous situations. Accordingly, they are an important source of guidance to parties seeking to understand the application of existing law to new situations.

7 Federal law also requires registration with the Secretary of the Treasury as a money transmitter by any person who "provides check cashing, currency exchange, or money transmitting or remittance services, or issues or redeems money orders, travelers' checks, and other similar instruments or any other person who engages as a business in the transmission of funds." 31 U.S.C. § 5330.

(iv) performing exchange services as a customer business, or (v) controlling, administering, or issuing a virtual currency. However, the BitLicense Regulations are intended to apply to persons that act as financial intermediaries, and are not intended to capture software developers or virtual currency miners unless their activities fall within the definition of "virtual currency business activity." Additionally, the BitLicense Regulations exempt two types of entities from the requirement to obtain a BitLicense: (a) entities that are chartered under New York Banking Law and approved by the Superintendent of the NYDFS, and (b) merchants and consumers that utilize virtual currency solely for the purchase or sale of goods or for investment purposes.

The BitLicense Regulations require BitLicense holders to comply with additional New York State anti-money laundering regulations. The BitLicense Regulations also require BitLicense holders to establish and maintain a cybersecurity program that meets certain prescribed standards, and also maintain sufficient capital levels set by the NYDFS.

North Carolina's virtual currency law

In contrast to New York's approach, North Carolina recently adopted a new virtual currency law of its own (N.C. Gen. Stat. § 53-208) that has been viewed by certain virtual currency advocates as friendlier to providers of distributed ledger, blockchain, and virtual currency services. Passed in July 2016, North Carolina's legislation updates the state's existing money transmitter laws to include a defined "virtual currency" term, and clarifies which activities using virtual currency trigger the requirement to obtain a money transmitter license. North Carolina's amended money transmitter law now defines "monetary value" to mean "a medium of exchange, whether or not redeemable in money" and expressly references "virtual currency" in several places, including in the definition of "money transmission," which now includes "engaging in the business" of "maintaining control of virtual currency on behalf of others."

Notably, the updated legislation clarifies that virtual currency miners and blockchain software providers – including smart-contracts platforms – operating in North Carolina will not need a money transmitter license to conduct their activities, and largely exempts business-to-business virtual currency transactions from licensure as money transmitters as well. However, companies that are required by the updated law to apply for a money transmitter license do face some new hurdles, as the minimum net worth requirement has been increased significantly for all applicants – including virtual currency businesses.

ADDRESSING THE CHALLENGES TO FINTECH INNOVATION

Despite the challenges posed by the structure and nature of the U.S. financial system, a number of possibilities have been suggested to ease the path for FinTech innovators. None of them is a panacea, but each may present an important opportunity for the regulation of "responsible innovation." In particular:

National FinTech charter

The creation of a national FinTech charter has been suggested as one solution that could benefit FinTech companies and regulators alike. The existence of such a charter would be intended to provide a platform for FinTech innovation that would apply nationwide, without the need to obtain licenses from each state, and permit a single regulator to clarify regulatory uncertainty regarding products and services that do not fit neatly into the scheme of existing regulations. Encouraged by positive reaction from some segments of the FinTech industry, the OCC has recently taken the lead in assessing the feasibility of a national FinTech charter. In June 2016, the OCC announced that it had begun to evaluate its statutory authority to offer a limited-purpose national charter to FinTech companies. However, Comptroller Curry has suggested that FinTech companies should conduct their own analysis of whether holding a limited-purpose national FinTech charter would be good for their business models, noting that "whether [a national FinTech charter] works for the business model of a FinTech firm is something that sector needs to think through" [Clozel (2016a)].

More recently, as noted above, the OCC released a proposed rule that sets forth a framework for placing uninsured national banks into receivership. The proposed rule would permit the OCC to have receivership powers over non-insured national financial institutions if such institutions were to fail. If adopted, the proposed rule could pave the way for the OCC to regulate these entities as uninsured national financial institutions. The OCC noted the potential applicability of the receivership model to FinTech companies operating under a national FinTech charter, acknowledging in its introduction to the proposed rule that it has requested comment on the utility of the receivership model structure for a special purpose bank operating under a potential national limited-purposed FinTech charter.

While the creation of a national FinTech charter by the OCC could provide greater regulatory clarity for certain FinTech companies that currently face uncertainty in terms of the types and scope of regulation applicable to them and their activities, it is not without its limitations. First, given the OCC's statutory focus on national banks, the types of FinTech companies that would be eligible for such a charter would likely be limited to those that are substantially bank-like in their products and services (i.e., focus on payments, lending and trust-related businesses), and would likely not include companies that operate in other unrelated segments of the FinTech industry, such as robo-advisors or payment processors.

In addition, both the OCC and state regulators have expressed their concern that some FinTech companies may be seeking the benefit

of a national charter specifically to escape the application of state regulations that would otherwise apply, which could weaken the authority of state regulators to enforce state consumer protection or licensing laws. As Comptroller Curry has remarked, "I would be very concerned, for example, if we were to authorize a federal license that offers the benefits of the national bank charter, including preemption, without any of the safeguards or responsibilities that apply to banks and thrifts" [ABA Banking Journal (2016)].

Development of uniform laws

The burden of complying with the laws of many states could be eased if the statutes are consistent from state to state. The National Conference of Commissioners on Uniform State Laws (Uniform Laws Commission), which develops statutory provisions that are intended to be adopted broadly by the states in the U.S., has commenced a project to develop a uniform statute regulating virtual currency businesses in anticipation of the adoption of legislation in additional states. This project is intended to "harmonize" legislation from state to state to the extent possible. The drafting committee "will consider the need for and feasibility of drafting state legislation on the regulation of virtual currencies, and will examine issues such as licensing requirements; reciprocity; consumer protection; cybersecurity; anti-money laundering; and supervision of licensees." The Uniform Laws Commission has developed uniform statutes in a number of areas in which the involvement of multiple states is inevitable, including the Uniform Commercial Code which governs much of the commercial activity within and between the states, and by doing so permitted market participants to operate with a significant degree of certainty and efficiency.

Similarly, the Conference of State Bank Supervisors, which also coordinates among the state regulators of money transmitters, has developed a model regulatory framework for virtual currency activities.

Creation of a regulatory "sandbox"

As an alternative approach to the full regulation model presented by a national FinTech charter, an alternative approach could be for U.S. financial regulators to adopt a regulatory sandbox approach similar to those currently in place in jurisdictions including the U.K., Singapore, and Hong Kong. These initiatives, which are briefly summarized below, allow FinTech companies to work closely with regulators to identify potential issues early on in the product development phase, without the risks of incurring fines or triggering other adverse consequences due to the "safe" nature of the sandbox model.

The U.K.'s regulatory sandbox was launched in May 2016 as a core component of the Financial Conduct Authority's (FCA) Project Innovative initiative. Billed as "a safe space for businesses to test out innovative ideas with real people," the FCA's regulatory sandbox allows it to provide restricted authorization, no action letters, waivers, and individual guidance to U.K. FinTech companies that face regulatory hurdles in the early stages of their development. In turn, FinTech companies that make use of the regulatory sandbox can use it as a virtual laboratory of sorts for new financial products and services without the worry of running afoul of regulations once they are considered to be in the "authorized firm umbrella."

Similarly, on June 6, 2016, the Monetary Authority of Singapore (MAS) announced the creation of its own regulatory sandbox. Through its sandbox, the MAS aims to provide FinTech firms with the ability to experiment by providing customers with actual products and services within a well-defined space and duration, once the FinTech company and customers have reached a satisfactory agreement with MAS. For the duration of the period that a company is in its regulatory sandbox, the MAS will relax specific regulatory requirements so that the FinTech firm can attempt its product pilot and determine whether it will be suitable on a wider scale and under severer regulatory restrictions.

Not to be outdone, on September 6, 2016, the Hong Kong Monetary Authority (HKMA) announced the launch of its own FinTech supervisory sandbox. The HKMA sandbox enables banks to collect data and feedback on new financial products in a regulatory "light" environment. HKMA plans for relaxed regulations to include looser security protocols for electronic banking services and more casual timing of independent assessments prior to the launch of technological services. The HKMA's sandbox differs from those in the U.K. and Singapore because it is not open to all FinTech start-ups, but only banks.

The Uniform Laws Commission draft legislation mentioned above includes an "on-ramp" that, like a sandbox, is intended to permit a new market entrant to experiment and develop their businesses to a certain threshold before being required to obtain a license.

Each of these sandbox models provides a creative solution for regulators seeking to gain a better understanding of the risks and challenges faced by FinTech companies by waiving or reducing the regulatory burden on companies, without stifling innovation while they are in the sandbox. Even though the aforementioned CFPB no-action letter policy has some parallels to this sandbox model, it is distinguishable in many ways, most importantly due to the fact that no-action letters from the CFPB are designed to be issued rarely and are non-binding on the CFPB.

If adopted by one or more financial regulators in the U.S., the regulatory sandbox model could provide a similarly creative solution that would allow regulators to gain a better understanding of the risks and challenges posed by FinTech products and services, while also providing FinTech companies with a safe space to pilot new ideas. However, this model is also not without its own challenges, the most significant of which is the overlapping jurisdictional nature of the

U.S. financial regulatory system, in addition to the often feuding nature of state and federal regulation, which will make it difficult to coordinate a unified review of potential products and services.

Other possible avenues

Even in the absence of a uniform statute or national charter, it may be possible for the cost of innovation and market entry to be reduced by other means. For example, it may be possible for state regulators to adopt a model similar to the "substituted compliance" approach adopted by the CFTC in regulating the inherently international swaps business. Such an approach would require each regulator to evaluate the regulatory approach taken by another regulator or jurisdiction and determine that the other approach is sufficient to serve the purposes of the regulator's own regulatory regime, even if it does so in a different manner – and then permit a FinTech provider to operate in that regulator's own jurisdiction while complying with the other jurisdictions regulatory framework. Even if full substituted compliance is not possible, encouraging regulators to extend reciprocity to other regulators – granting automatic or expedited registration to FinTech providers that are licensed or regulated in another qualifying jurisdiction, for example – could also reduce regulatory burden and facilitate new business development.

CONCLUSION

Great opportunities raise great risks, and the development of FinTech is no exception. In an environment where the tolerance for risk is low and the number of parties required to assess the risk is high, innovation may be difficult to sustain. However, given the significance of these developments and the demand for new products and services, the pressure on regulators and legislatures to find means to ease the path for innovators will continue.

REFERENCES

- 23 C.R.R.-NY I § 200.
- 12 U.S.C. §§1861-1867.
- 18 U.S.C. § 1960.
- 31 U.S.C. § 5330.
- N.C. Gen. Stat. § 53-208.
- ABA Banking Journal, 2016, "OCC examining possibility of limited-purpose FinTech charter," June 14, http://bit.ly/2dJhSQl
- Berry, K., 2016, "CFPB's Cordray: FinTech firms should play by same rules as banks," American Banker, April 7, http://bit.ly/2dRB8XW
- CFTC, 2016, "CFTC approves substituted compliance framework in follow-up to the recent equivalence agreement between the U.S. and the E.U.", U.S. Commodity Futures Trading Commission, Washington, D.C., http://bit.ly/2dJnF8n
- Chen, M., and M. Price, 2016, "Hong Kong to launch banking FinTech "sandbox" as rivals pull ahead," Reuters, September 6, http://reut.rs/2covg7r
- Citi, 2016, "Digital disruption: how FinTech is forcing banking to a tipping point," http://citi.us/1UvuU1o
- Clozel, L., 2016a, "OCC's Curry: limited-purpose charter for FinTech is possible," American Banker, June 14, http://bit.ly/1Q54IK3
- Clozel, L., 2016b, "OCC takes big step toward creation of FinTech charter," American Banker, September 13, http://bit.ly/2dIO2pM
- Clozel, L., 2016c, "OCC weighs new charter for FinTech firms," American Banker, May 9, http://bit.ly/1Odm5Hy
- Clozel, L., 2016d, "State regulators balk at OCC FinTech charter," American Banker, August 19, http://bit.ly/2dDRExz
- Conference on State Bank Supervisors, 2016, "The state of State money services business regulation and supervision," Washington, D.C., http://bit.ly/2dr26tA
- Conference on State Bank Supervisors, 2015, "State regulatory requirements for virtual currency activities: CSBS model regulatory framework," Washington, D.C., http://bit.ly/2drZYPH
- Consumer Financial Protection Bureau, 2016, "Policy on no-action letters," Washington, D.C., http://bit.ly/2dIQexJ
- Curry, T., 2016, Remarks before the OCC Forum on Supporting Responsible Innovation in the Federal Banking System, June 23, http://bit.ly/2d2zyDR
- Department of the Treasury, 2016, "Opportunities and challenges in online marketplace lending," Washington, D.C., http://bit.ly/27bRLDC
- FCA, 2016, "Project innovate and innovation hub: regulatory sandbox," Financial Conduct Authority, London, http://bit.ly/2dIYRZF
- Federal Financial Institutions Examination Council, 2016, "Joint statement on cybersecurity of interbank messaging and wholesale payment networks," Arlington, VA, http://bit.ly/1mp7yII
- Federal Financial Institutions Examination Council, 2015, "Joint statement on destructive malware," Arlington, VA, http://bit.ly/1mp7yII
- Federal Deposit Insurance Corporation, 2015, "Supervisory insights: marketplace lending," Winter, Washington, D.C., http://bit.ly/2d2zPX6
- Finextra, 2016, "North Carolina passes blockchain-friendly virtual currency law," July 7, http://bit.ly/2dIQAEh
- GAO, 2016, "Financial regulation: complex and fragmented structure could be streamlined to improve effectiveness," U.S. Government Accountability Office, Washington, D.C., http://bit.ly/2duG19Y
- Lawsky, B., 2014, Remarks before the Bipartisan Policy Center, December 18, http://bit.ly/1CnYoVs
- Lockhart, D., 2015, "Reflections and projections," Remarks before the Georgia Law Review Symposium on Financial Regulation, March 20, http://bit.ly/2duEqRr
- Monetary Authority of Singapore, 2016, "MAS proposes a "regulatory sandbox" for FinTech experiments," Singapore, http://bit.ly/1ObhOop
- National Conference of Commissioners on Uniform State Laws, 2016, Regulation of Virtual Currency Business Act (Draft), Chicago, http://bit.ly/2dwwE9p
- OCC, 2016, "Receiverships for uninsured national banks," Office of the Comptroller of the Currency, 81 Fed. Reg. 62835, 62837, September 13, Washington, D.C., http://bit.ly/2dJIK3O
- OCC, 2016, "Supporting responsible innovation in the federal banking system: an OCC perspective," Office of the Comptroller of the Currency, Washington, D.C., http://bit.ly/2dsMjHq
- PayPal, 2016, "PayPal state licenses," PayPal Holdings, Inc., http://bit.ly/2d2BbkF
- SEC, 2008, "Cease-and-desist order, Securities Act of 1933 Release No. 8984," U.S. Securities and Exchange Commission, November 24, http://bit.ly/2dJnv12
- Sposito S., 2013, "PayPal veterans share state licensing war stories," American Banker, August 6, http://bit.ly/2cRNCBq
- Williams, J., 2016, "The power of the possible and potential pitfalls," Remarks before the LendIt USA 2016 Conference on FinTech, April 12, http://bit.ly/2de4gao

Strains of Digital Money

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Abstract

This paper provides a basic framework that explains how the major types of known digital money solutions relate to each other, i.e., what the similarities and differences are, and hence the pros and cons of each. The broader purpose is to offer some perspectives on how digital money grids might evolve in the future, so as to make them safer, more convenient and user friendly, more contestable by different providers, and much cheaper than current systems.

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INTRODUCTION

It is easy to feel overwhelmed these days by the sheer volume of innovations around digital money and payments. Some are promoted by existing players, and some are offered by new ones. Some tackle specific points of customer convenience, and some aim for greater safety and robustness. Some feel incremental, and some feel disruptive.

The specific purpose of this paper is to provide a basic framework that explains how the major types of known digital money solutions relate to each other, i.e., what the similarities and differences are, and hence the pros and cons of each. The broader purpose is to offer fresh new perspectives on how digital money grids[2] might be pieced together in the future, so as to make them: (i) safer, technologically and operationally; (ii) more convenient, user friendly, and useful by making them easier to integrate into broader digital solutions (i.e., more programmable); (iii) more contestable by different providers, creating more of a level playing field and stronger incentives to innovate; and (iv) much cheaper than current systems, especially for micro-transactions, which to this day remain unsupported by efficient payment mechanisms and yet constitute the vast majority of transactions in the mass market.

This paper first looks at the user side and examines what it means fundamentally to shift from physical money, which the majority of people are used to and engage with daily, to digital money, which has yet to be discovered by half the world's population. Where are the main customer tensions and anxieties likely to lie? This is the first sense in which the word "strains" is used in the title of this paper. The following two sections then look at the different varieties of digital money that have been deployed, which is the second – and main – sense in which the word is used. The concluding section reviews the major opportunities presented by the emergence of digital money, beyond simply replicating the characteristics of cash but without the hassle of requiring physical support.

Down the path of digital money there is much opportunity for efficiency as well as disruption, for integration and fragmentation, for inclusion and relegation. Those strains again.

THE CONSEQUENCES OF DEMATERIALIZING CASH

The most salient characteristic of cash is, of course, its tangibility.[3] Notes and coins can be thought of as objects, albeit ones subjected to rather unusual legal rules and deep-seated social conventions. Digital money removes the physical support for individual lumps of money, which has profound consequences that go to the root of the concept of money. The more obvious consequence that is often drawn is that digital money requires users to engage in a higher level of abstraction when using it. The sensory experience with cash brings concreteness. The implication is that poor people, in particular, will require substantial accompaniment and education in order for them to become comfortable with even conceiving of dematerialized or virtualized money.

But, that view ignores several millennia of history, as well as everyday informal financial practices that we see everywhere today. The fact is that for most people who do not use digital money, a good proportion of their money already is, and has always been, virtual, in the form of the money that they are variously owed or that they could otherwise obtain from others in their community. Think of all the informal loans, reciprocal favors, income sharing entitlements, and outright gifts that form the social and financial fabric of traditional societies. Virtual money is in fact virtually ageless: that must be the case, because the first and most basic role of money, that of unit of account (the yardstick by which all debts can be measured and netted off), is necessarily an artificial concept, a result of social constructs and legal institutions (see Box 1).

The second major consequence of digitizing money is that using it in any way – whether to check the amount held or to pass it on to someone else – requires access to an infrastructure. Digital money cannot be understood narrowly as a virtual thing, it must be thought of as an entire acceptance system. Notes and coins, in contrast, can be counted and exchanged directly: they are discretized objects that work on an entirely stand-alone basis. It is not that physical cash requires no acceptance, but that it can be accepted visually. All you need to ascertain the value of notes and coins is contained within them; it does not require the help of any external device. The primary purpose of the paper on a note is to carry an increasing range of visual (and tactile) acceptance cues. In dismissing physical cash as an outdated relic, we often forget how much of a technological feat that represents (see Box 2).

The implication is that, unlike with physical money, the discussion of the properties of digital money cannot be separated from the configuration of the rails on which it runs. Digital money may not present a conceptual challenge to people as a unit of account, but it will be

2 The notion of a digital money grid is further developed in a companion piece, which explores various scenarios for getting there. See: Mas, I. and G. Andrade, 2015, "A digital money grid for modern citizenship: Latin American scenarios, 2015-25." Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1725103&download=yes

3 It is estimated that only 8% of the world's money exists as physical cash, the rest is in the form of bank deposits (source: Grabianowski, G., 2016, "Forms of currency: electronic," in How Money Works blog, accessed on September 14, http://bit.ly/1V2ztQY. But money in the bank is actually money in a computer, so it counts as a "strain" of digital money.

Monetary economists explain the rise of modern financial arrangements as a logical sequence: first barter, then currency, then credit systems, finally double-entry book-keeping – a natural evolution towards higher levels of abstraction and complexity in trading arrangements. A long lineage of anthropologists have disputed this, finding no evidence that human societies ever worked on barter. In the beginning there was debt, as people variously shared, gifted and loaned each other stuff. The fabled "coincidence of wants" problem that makes barter so impractical (the fact that at the market you and I can only transact if I want your chicken and you want my goats) was solved by separating transactions in time (now I take something from you, later you will take something from me), developing simple debt tracking devices (such as the tally stick), developing various moral codes to guide the sizing and fulfillment of these dues, and periodically netting out the various debts across people in the community.

As David Graeber puts it in his book "Debt: the first 500 years"; "abstract systems of accounting emerged long before the use of any particular token of exchange." The primary need was to create common notions of value, not necessarily to harmonize how value got stored or passed around. So in the beginning money only fulfilled a unit of value or accounting function; means of payment and storage of value came later, much later. The startling conclusion is that "there's nothing new about virtual money. Actually, this was the original form of money."

People everywhere seem to have no problem managing the "artistry" of gifting – an even more intangible and convoluted practice than exchanging digital money. You can see generosity and balanced reciprocity leading to mutual insurance. But you can equally see dependence and charity preserving hierarchy. In Graeber's eloquent words, gifts "are usually fraught with many layers of love, envy, pride, spite, community solidarity, or any of a dozen other things." There is nothing simple about that, but somehow people work out a proper response to gifts (whether they are an honor, a provocation, or a form of patronage) intuitively.

Hence, there is no reason to believe that dealing with abstract notions of digital money should, in itself, be a barrier for ordinary people who are used to informal debt and reciprocity arrangements. The real challenge will be the formalization of finance: making them accustomed to reducing financial arrangements to a bunch of numbers and financial relationships to impersonal arithmetic.

Removing the social context from transactions may obliterate much of the intuition and survival strategies people have developed around money matters for centuries. As Johnson et al (2012)[4] vividly explain, the social dimension of informal finance allows for much more open-ended negotiability of resources in case of exceptional need. And it is not all casual: reading the typologies of informal financial mechanisms documented by Rutherford (1996)[5], Wright (1999)[6] and others, one wonders at how inventive and recurring certain structures are. Those can only be the result of a natural evolutionary process based on variation (fed by the inherent flexibility of social arrangements) and selection (the disciplinary and insurance benefits they bring).

With formal finance, all that is replaced by binding credit limits, inflexible terms made up by someone, and an imposed moral requiring you to repay your debts on time (the "criminalization of debt [non-repayment]," to use Graeber's graphic if hyperbolic language). The core problem of digital finance for poor people is then not how intangible it is, but rather how explicit everything becomes. Being more discreet may be an advantage, but must it all become so discrete too? To end with Graeber: "When matters are too clear cut, that introduces its own sorts of problems."

Box 1 – Virtual money is virtually ageless[7]

rejected if it does not provide adequate mechanisms to access it as a store of value and as a means of payment.

It is not fruitful, then, to discuss digital money in the abstract, we can only talk meaningfully in the context of specific instances of digital money systems – how the rails are made and laid out. In comparing different digital money architectures, it is convenient to split the discussion into two parts: the rules and mechanisms around the creation (and destruction) or issuance of digital money, and the rules and mechanisms for acceptance (i.e., validation and exchange, of money outstanding.

4 Johnson, S., G. Brown, and C. Fouillet, 2012, "The search for inclusion in Kenya's financial landscape: the rift revealed summary report" FSD Kenya, March 1.
5 Rutherford, S., 1996, A critical typology of financial services for the poor, ActionAid
6 Wright, G. A. N., 1999, "A critical review of savings services in Africa and elsewhere," MicroSave
7 This box is drawn from Mas, I., 2013, "Virtual money is virtually ageless," in MicroSave Financial Inclusion in Action blog, August.

Hard cash certainly has its drawbacks. Poor people mired in a cash economy find it difficult, in times of need, to support or seek support from distant relatives and friends. The size of the market they can sell their products and wares into or source their inputs from is limited by how far they can easily and securely transport cash. They are captive to local financial organizations and moneylenders, because more distant financial institutions do not find it cost effective to go collect their saved-up cash and have no visibility of their prior cash-based financial histories on which they might otherwise grant credit.

All of these are good reasons to expect that people everywhere will embrace digital money, if only it is served up to them in a convenient, understandable, reliable, and secure way. Money is just information – how much I have, how much I owe – and the short history of the internet shows us that information wants to become free of physical impedances.

So will cash go the way of the compact disk, in a gradual wind-down towards oblivion? Must we, or even can we, go for an accelerated eradication of cash? Many hope so, but I do not think so. The CD is simply digital information bottled up for convenient transport. Once devices became ubiquitously connected, there was no longer any reason for musical information to be delivered through a physical distribution network rather than online. But cash is more than just bottled-up information on financial value: it is value that is readily and universally recognized and accepted on mere visual inspection. The physicality of banknotes makes it easy for people to make snap judgments on how much value it embodies and whether it is a real banknote or not. Cash is a visual acceptance instrument, in contrast to electronic money which requires electronic acceptance (an ATM, a point-of-sale terminal, a mobile phone) in order to be recognized and exchanged. Electronic acceptance introduces risks that when you want to pay with electronic money there may not be a device available, that it may not work properly, that it may be tampered with, or that the information on that payment will be passed on to third parties (including the taxman). It takes a long time to overcome these fears, which is why the shift to electronic money is so slow and gradual, even in the most developed countries.

So, here you have the basic trade-off: electronic money is superior to physical cash in transport and storage (lower transaction costs), but cash has advantages over digital money in acceptance (immediacy, universality and privacy). Digital music, in contrast, requires electronic acceptance (i.e., translation of stored digital signals into sounds) whether it is delivered as a compact disk or online. The compact disk involves much transport pain and no acceptance gain. That is why it will end up going away, as have done the specialist stores that sell them.

Box 2 – Will hard cash go the way of the compact disk?[8]

A TAXONOMY OF DIGITAL MONEY ISSUANCE MECHANISMS

For money to retain its value, a key requirement is that it be a finite resource. The limitation on the supply side can come from a scarce underlying resource that the money is a claim on, outright promises made by the issuer within certain rules imposed by a legal code and governance structure, and (nowadays) the software code that implements the money management protocol. It, therefore, matters who the issuer is and under what parameters it determines the money supply. These are key determinants of the trust that economic agents will place on various strains of money.

The main mechanisms that money issuers have used to inject trust in their product are discussed below.

Fully backed (or reserved) money

Traditionally, money has represented a claim on a scarce physical resource, typically a naturally occurring, pure commodity such as gold or silver. Such metallic standards dominated international financial systems before World War II. The growth in the quantity of these assets is linked to the rate of discovery of the asset, which itself is a function of the sheer availability of the commodity in the ground and the amount of labor and cost incurred in finding, extracting, transporting, and refining it.[9] The assets can embody significant labor and skill to turn what may be an inherently unlimited asset such as limestone into a scarce commodity – for instance, in the form of heavy stone wheels used in the Island of Yap.[10]

8 This box is drawn from Mas, I., 2013, "Will hard cash go the way of the compact disc?" All about finance blog, World Bank, November.

9 Of course, in a commodity-linked standard, the money supply would also be affected by the demand for the commodity for uses other than as a monetary reserve, such as the gold used for jewelry or that hoarded as a private store of value.

10 These were thick, round stones of a diameter of 1-12 feet, with a hole in the middle to facilitate transportation with a pole. The limestone used to make them had to come from another island some 400 miles away from Yap. See Friedman, M., 1994, "The island of stone money," in Friedman. M. (ed.), Money mischief: episodes in monetary history, Harcourt Brace & Co.

		HOW IS THE MONEY SUPPLY DETERMINED?				
		Who is the issuer?	**Discretionarily, under broad policy and governance rules**	**Under explicit prudential ratios and standards**	**100% reserved**	**Pre-set under mathematical rule**
HOW IS THE MONEY DENOMINATED?	**In national currency**	Central bank			E-money accounts (Ecuador)	
		Licensed bank		Commercial bank deposits		
		Licensed non-bank			E-money accounts	
		Any, unlicensed	Store gift cards, cellular airtime			
	Private numeraire	Any, unlicensed	Frequent flyer miles & other loyalty point schemes			Crypto-currencies

Table 1 – Main issuance models for digital money

The backing for a national currency can also be in the form of other major currencies held as reserves by the central bank. Under a currency board system, the law requires that local currency in circulation must be 100% backed with international reserves.[11] Domestic non-bank money issuers (including payment system providers such as PayPal, prepaid card providers such as VISA-branded cards, and mobile money operators such as M-PESA) are also legally required to reserve the totality of the value of their money outstanding with safe and liquid assets, usually as deposits in prudentially regulated banks or in short-term government obligations. Of course, when a particular form of money is backed by other types of money held in reserve (as is the case with currency boards and non-bank issuers), the value of the issuer's obligations may be fully reserved, but the reserves they hold themselves may not be fully reserved by their issuer. This gives rise to a mixed trust system.

Prudentially managed money

Unlike non-bank prepaid card and payment service providers, licensed commercial banks are authorized to issue money that is not fully backed by safe, liquid assets. They create new money every time they give out a loan and create a deposit in the borrower's name with the corresponding amount.[12] These loans carry the specific risk of the borrower and are not immediately callable or even sellable if there is a need to fund an unexpected demand for depositor withdrawals. To mitigate these credit and liquidity risks, banks are typically subjected to strict prudential standards relating to the amount of capital and reserves they must hold, and the quality of the borrowers they can loan to or assets they can invest in, as well as certain governance and accounting rules. This turns the lack of backing for bank money into a calculated risk. Given the predominance of bank money within today's monetary system and the interdependence of banks to supply liquidity to each other in moments of need, this presents the risk of extended bank failures leading to potentially severe systemic risks. Commercial banks' activities tend to be heavily regulated to mitigate these risks.

Fiat (promise-based) money

For most national currencies today, the currency's value does not stem from its convertibility into other assets or the value of reserves held against it by the central bank, but from an inherent trust in the central bank not exploiting its money creation powers. Thus, the issuer retains substantial discretionary powers to fix the money supply arbitrarily. Though central banks generally must abide by some broad governance rules and policy mandates that curb its powers, these rules are generally not as specific as the kind of prudential rules that apply to commercial banks.

In the same way as reserve currencies (under a metallic standard or currency board) have shown a tendency to become fiat currencies, Milton Friedman explained how the stone money in the island of Yap could equally well become disengaged from the actual number of big stones available. He noted how Yap islanders started trusting that a defined number of big stones existed in the distant island where they came from, thereby saving the cost of having to transport them. At that point, if the large stones got wiped out, they could continue acting as if the stones existed, and nothing in people's behavior in Yap need change.

11 A long-standing currency board is that managed by the Hong Kong Monetary Authority. A notoriously failed currency board was that maintained by the Argentine Central Bank until 2002.

12 For a lucid account of how the process of money creation works, one that is a bit at odds with conventional wisdoms expressed in some standard textbooks, see McLeay, M., A. Radia, and R. Thomas, 2014, "Money creation in the modern economy," Bank of England Quarterly Bulletin Q1, 14-27

In the past, money has also been issued by private entities operating on an unlicensed and unregulated basis. This is now generally banned; private issuance tends to be allowed only for restricted-purpose money, such as store-value cards, and other forms of value that are not directly convertible to cash, such as loyalty points.

A fixed, pre-determined, rule (no discretion)

Monetarist economists have long argued that the growth rate of money supply should be fixed and pre-announced. They believe that unexpected variations in money supply (i.e., decisions imposed discretionarily by the central bank) are ineffective as a policy lever in the long term, and can produce disequilibria in the short term.

Present-day crypto-currencies are governed by an arbitrarily set, fixed money supply path that is coded into the currency's operating system. It is a fixed numerical rule that is enforced through technology rather than legally. In the case of bitcoin (BTC), the total supply is scheduled to grow at a diminishing rate until 2140, when the amount of BTCs stabilizes at 21 million and no new ones will be issued subsequently. In the case of Ripple (XRP), the supply was set at a fixed, invariant amount of 100 billion from the outset. However, in both these currencies, a substantial share of the currency outstanding is held by the early promoters of each system, and thus can be released at any time into public circulation at their discretion. Hence, the crypto-currency holding public is implicitly placing some trust in the actions of the currency promoters.[13]

The distinguishing characteristic of the issuance models

We can discern three critical dimensions that distinguish the various issuance models described above, as depicted in Table 1.[14] One critical distinction is the numeraire that is used. What is the currency in which the units of value are denominated: is the digital money linked to the national currency, or does it have its own, private denomination? Another key distinction is who the issuer is. This ranges from the national monetary authority (or central bank) issuing national currency at the top of the money food chain, through various categories of licensed financial institutions issuing money denominated in the national currency, to unlicensed entities issuing their own proprietary currencies. The third dimension, captured in the columns in Table 1, is the degree of discretion that the issuer has in determining or affecting the money supply. The scope for discretion may be limited by broad policy or governance rules, a more specific set of prudential standards and ratios (on capital, liquidity and reserve requirements), a mechanistic full reserving requirement, or a fixed mathematical rule.

Most electronic money in circulation today is issued by licensed financial institutions, under a strict prudential regime if they are banks or under an even stricter full reservation regime if they are non-banks (such as e-money issuers, payment service providers, and mobile money operators). These types of money are denominated in the national currency, so they are in principle a close equivalent to, or substitute for, central bank-issued money. But still, these forms of money are not legally and economically identical to national currency, for two reasons:

Issuer risk: a dollar note issued by the central bank is only subject to country risk; the risk that the government may undermine the value of its own currency through inflationary policies, or outright repudiation or confiscation.[15] But money held in deposit at a commercial bank is, in addition, subject to the bank's idiosyncratic default risk, which may or may not be linked to country risk. Thus, bank money requires trust not only in the central bank as the keeper of the value of the national currency (to which the value of the deposit is pegged) and the national bank supervisor, but also in the management and board of the individual commercial bank. This distinction can be mitigated by the extension of deposit insurance on bank deposits, though that is generally capped.

Legal obligations to accept payment (legal tender): central bank-issued notes and coins generally are designated as legal tender, i.e., they are a form of payment that must be accepted in settlement of pre-existing debts. This is done to ensure that notes and coins are accepted universally within the country's territory. This designation is normally not extended to bank-issued money (deposits) because the state does not see a role in ensuring the tradability of the balances held at individual private banks, which may be subject to some idiosyncratic risks. With the growth of bank money, the notion of legal tender has become much less significant. Nowadays, governments typically place a cap on the transactions that must be accepted with notes and coins of different denominations (to avoid causing problems of procuring change), and many governments in fact cap the

13 In the case of Bitcoin, it is not known how many bitcoins have been kept by its anonymous founder(s) and the early group of miners. But well over half of all bitcoins are known to have never been traded. In the case of Ripple, 80% of all XRPs were gifted by their creator to Ripple Labs, which oversees the Ripple protocol and ecosystem. Ripple Labs has been releasing some of these, such that today 32% of all XRP are held by others. In the case of central banks, money that is printed but not in circulation is not counted within the money supply figures.

14 In this table and throughout the paper we refer to money in a broad, but not necessarily legal, sense. For instance, governments may choose whether to treat bitcoin legally as a commodity rather than as money. This legal distinction can have important consequences, one of which is that if it is treated as a commodity then fluctuations in its price may expose its holders to capital gains taxation.

15 If you think the scenario of a central bank repudiating its own currency is farfetched, you ought to know that there is a long history of just that. Repudiation of the currency amounts to a confiscation of the value of the currency outstanding. Usually it is done covertly, in the form of a currency reform. See: Mas, I., 1995, "Things governments do to money: a recent history of currency reform schemes and scams," Kyklos, October.

Mondex: is a smart card electronic cash system, implemented as a stored-value card and launched in December 1993. Initial public trials of the payment system were carried out from July 1995, and the system was subsequently sold to MasterCard International in 1996.

Mintchip: was a smartcard chip system launched in 2012 by the Royal Canadian Mint. The card stored electronic value, and the system allowed transfers of value across cards.

Octopus/Oyster card: the Octopus card was launched in 1997 as an electronic purse for public transportation in Hong Kong. The Oyster card was launched in London in 2003, also as a form of ticketing for mass transit. Subsequently the use of both cards was extended to other retail settings, beyond transit.

BTC: is a private currency as well as a peer-to-peer payment network that lets users transact directly without needing an intermediary. Transactions are verified by network nodes and recorded in a public distributed ledger called the blockchain. The system works without a central repository or single administrator.

Ripple: is a real-time gross settlement system (RTGS), currency exchange, and remittance network launched in 2012. It is built upon a distributed open source Internet protocol, consensus ledger and native currency called XRP (ripples). Ripple is the second-largest crypto-currency by market capitalization after BTC.

Box 3 – Digital money solutions mentioned in this article[20]

total size of payments that can be made just with cash (to avoid tax evasion and money laundering).[16]

While most forms of digital money are denominated in the national currency and aspire to become as close a substitute as possible for central bank-issued currency, the new breed of crypto-currencies, such as BTC and XRP, represent an alternative currency in their own right.[17] Their value is not pegged to the national currency, and thus must be converted from and into national currency at a floating exchange rate (determined at electronic exchanges). The value in exchange of these currencies is, of course, heavily affected by the credibility of how their supply is managed. Because this trust is not backed by any statutory limitations, they have taken the approach of eliminating all discretionary decision-making and pre-setting the money supply growth path for posterity. This tying-of-the-hands on the supply side in principle makes these currencies more inherently subject to price volatility because there is no way to accommodate demand-side shocks other than through the dynamic adjustment of its price at the exchanges.

The Central Bank of Ecuador has taken an unprecedented step in asserting the monetary authority's role in electronic money issuance by launching its own electronic money system. Others may follow Ecuador's lead. The governor of the central bank of Bangladesh has recently proposed replacing all cash with central bank-issued electronic money.[18] At the other extreme, Argentina is said to be one of the leading countries in terms of regular BTC use by ordinary people for real commercial transactions, perhaps due to its turbulent recent monetary history that has undermined the credibility of national authorities in handling money issuance responsibly.[19]

It should also be noted that these forms of money are often complements to each other, rather than substitutes. For instance, central bank notes and coins may fulfill the need for small-denomination transactions, whereas commercial bank deposits fulfill the need for larger-denomination transactions. E-money accounts may compete with bank accounts at the retail level, but their very existence relies on there being bank deposits that back the amount of e-money in circulation. Airtime balances (privately issued money denominated in national currency) can only be bought with an acceptable form of convertible money.

16 For instance, European Regulation EC 974/98 limits the number of coins that can be offered for payment to fifty. In Canada, a payment in coins is a legal tender for no more than $40 if the denomination is $2 or greater but does not exceed $10, no more than $25 if the denomination is $1, and so on. In Spain, payments in excess of €2,500 cannot be made with cash and must be made electronically; in France, the cash payment limit is €1,000. Source: Yoteasesoro (2014), posted online on March 15, http://bit.ly/2cppUxF.

17 Throughout this paper we refer to crypto-currencies as a form of money, but many governments do not legally accept them as a form of money because they ban private monies. Instead, some governments choose to interpret crypto-currencies as virtual commodities. This is not only a legal technicality, as it affects their tax treatment: holders of commodities – but not money – are required to pay income tax on any capital gains they obtain upon their sale.

18 The Ecuadorean mobile money system developed and managed by the Banco Central del Ecuador is described in its homepage http://www.dineroelectronico.ec/. See the statements made by Dr Atiul Rhaman of the Bank of Bangladesh in Islam, S., 2015, "BB governor for e-currency to fit in digital Bangladesh," Financial Express, February, 15, http://bit.ly/2cwLdch.

19 For a vivid description of the bitcoin scene in Buenos Aires, see Popper, N., 2015, "Can Bitcoin conquer Argentina?" The New York Times Magazine, 3 March.

20 Some of the text in this box is taken from the respective Wikipedia entries.

A TAXONOMY OF DIGITAL MONEY ACCEPTANCE MECHANISMS

Once money has been issued, it must be handled as a uniquely held property claim: holders of legal monetary value must be able to establish command over accumulated balances, including the possibility of transferring balances to others or to exchange it into other forms of money. For the system to work well, there are three requirements: (i) no parties other than the issuer should be able to create new money (i.e., no counterfeit); (ii) no two parties should be able to establish claim to the same amount of money (i.e., unambiguous, rivalrous ownership); and (iii) no party should be able to use or pay out with the same money twice (i.e., no double-spend).

One's claim over money can be established in several ways:

As a bearer instrument (anonymous)
With physical forms of money, such as central bank-issued notes and coins, but also store coupons, the value is embedded within the monetary token itself. Money can, therefore, be handled entirely in bearer form, without requiring any identifying information or conducting any form of identity checks on the parties involved. Holders of notes and coins can pay out simply by handing out their physical money tokens, and all recipients need to do is to (visually, and maybe tactilely) check the integrity of the money tokens received.

For electronic money to be handled in this way, it is necessary for it to be embedded within and passed around through a physical device. This usually takes the form of stored-value card systems, where the value is stored within the card itself rather than in a remote server. Typically, smartcards with a chip are used as these have full digital read/write capabilities and hence the value on the card can be adjusted over time as it is used.

A high profile early example of such a system was Mondex, which was developed and trialed in the early 1990s. A more recent example is MintChip, launched by the Royal Canadian Mint in 2012. Both of these systems failed to take root, likely for two main reasons. First, these systems are costly to roll out because they require spreading new dedicated and expensive cards and new payment acceptance devices across the entire user base. Second, if cards are lost or stolen the value embedded within them is irrevocably foregone, so users tend to adopt them only for very specific, low-value purposes.[21]

More successful versions of stored value smartcard systems have tended to be restricted within specific usage domains. Smartcard systems have been successfully rolled out in mass-transit systems, starting with the Octopus card in Hong Kong and followed by the Oyster card in London. More recently, they are spreading as store value cards, such as the Starbucks card, offering convenient payment at the point of sale and a hook for loyalty programs. These restricted-use systems are easier to push into the market than general money schemes such as Mondex and MintChip because all acceptance points are controlled by the same company and hence can be converted overnight (e.g., equipping turn-styles at the subway to accept card payments). Moreover, because the value is only expected to trade at defined locations (such as at subway stations or at Starbucks stores), it is easier to ensure that all transaction points are online, establishing the possibility of backing up card values in central servers to recover stored value in case of loss or theft of the card.[22]

As a centralized account system (usually identity-based)
In most forms of digital money, the value is not stored primarily within devices held by users but rather in an account maintained by the provider. In other words, the information on who owns how much money is centralized.[23] User-held physical tokens such as cards may still be used, but their role is circumscribed to identifying the user and storing the account number details, but they do not in any way hold or represent monetary value by themselves.

More formally, customer identity information operates at three levels:[24]

- Each digital account – whether held at a bank, payment service provider, or mobile money operator – must be given a unique identifier, usually an account number. If only this identification level is used, the result is anonymous accounts, such as the Swiss numbered accounts of old where the only information one needed to present to gain access to an account was the secret account number.
- Additionally, digital account owners are typically assigned a set of unique authentication credentials (such as a card, the user's mobile phone number, a PIN, or a set of secret personal

21 This problem can be solved by maintaining a register of the value in all cards within servers in the network or cloud. This then requires that all transactions be conducted online, so that the server(s) can be updated in real time. Some intelligent systems, such as Net1's UEPS of South Africa, stores recent transaction histories in all cards (the payers' and the recipients'), so that balances can be reconstructed if some cards are lost even if they had done some recent transactions offline. Their system depends on cards synching their transaction history often enough, but not all the time.

22 For a detailed case study comparing the experiences of Mondex and the Octopus card, see Mas, I., and S. Rotman, 2008, "Going cashless at the point of sale: hits and misses in developed countries," CGAP Focus Note, No. 51, December. Available at: https://www.cgap.org/sites/default/files/CGAP-Focus-Note-Going-Cashless-at-the-Point-of%20Sale-Hits-and-Misses-in-Developed-Countries-Sep-2008.pdf

23 Of course, there is a fine line between this and the instances referred to earlier where money balances are held on the card and backed up into central servers. Technically, the distinction is which entity is presumed to have the right balance when there is a discrepancy between the account balance stored in the card and the balance held on the centralized server.

24 For a fuller treatment of the meaning of identity and common identification mechanisms, see Mas, I., and D. Porteous, 2015, "Minding the identity gaps," Innovations 10:1-2, 27-52.

questions) that they must use to establish their ownership over the account number, and hence to operate the account. By separating the account number from the user identification credentials, account numbers can now be shared publicly, for instance in order to solicit direct payment from others. Moreover, security is usually enhanced by requiring two distinct authentication factors, unlike the Swiss numbered accounts that operate on the single authentication factor represented by knowledge of the secret account number.

- In addition, the account issuer may link the account number and its associated authentication credentials to a verified legal identity. This is often a regulatory requirement imposed on licensed financial institutions, known as know your customer (KYC), though there may be exemptions for low-value accounts.

Thus, in contraposition to bearer systems, account-based systems are based on two distinct sets of capabilities: those relating to identity (being able to establish you are the rightful owner of the funds in your account, and to designate the intended recipient in a money transfer) and those relating to the accounting or ledger system (keeping track of balances held and owed, and authorizing transactions when there are sufficient funds per the account rules).

As a public, decentralized account system (pseudonymous)

Crypto-currencies have brought a disruptive new approach to the ledger system that supports the management of user accounts. Instead of having different institutions uniquely control their own ledgers, crypto-currencies work on the basis of a globally distributed ledger that is not controlled or managed by any single party. The ledger is decentralized in the dual sense that there is no central authority, and there are many instances of the ledger since any user (or node) in the network can gain access to a copy of the ledger. Ripple and Stellar are the two leading systems operating on this basis.[25]

A publicly available, decentralized global ledger has several advantages. First, it removes the power of individual organizations from imposing their access and pricing conditions; the market ought in principle to become more contestable and fair. Second, it automatically ensures interoperability across all players in the system since all are operating from the same global accounting system. The result ought to be stronger network effects and lower cost of providing transactional services.

But there are two major challenges associated with operating a public, decentralized ledger, that Ripple has had to design around:

- In a centralized account-based system, the account issuer is responsible for ensuring that all transactions are properly authorized and recorded in the system. Because there is no central authority in the Ripple system, this needs to be replaced by a system that creates consensus across all nodes on the system about which transactions are valid and hence should be used to irrevocably update all account balances. Ripple has created a complex algorithm under which all nodes vote on the validity of recent transactions they have become aware of. Transactions are deemed final once 80% of nodes vote them as being valid, and it may take several rounds of voting before this threshold is reached. This voting process is typically run and completed every five seconds or so.
- In a centralized account-based system, account balances are visible only to the account owner and the account issuer, and the issuer is duty-bound to maintain confidentiality. But on the Ripple system, anyone can query the global ledger, so the accounts cannot be directly linked to legal identities, as this would raise serious privacy concerns. Instead, users are identified by a pseudonym – technically, a private key that only they know and which they can use to sign transactions they wish to undertake from their account but without necessarily revealing their legal identity.

As a public chain of transactions (pseudonymous)

The BTC protocol, and particularly the blockchain technology it implements, has introduced a different mechanism for managing the validity of digital money claims, one that is neither embodied within a device nor account-based: through a historical record of its provenance. The closest analogy is the role that historical records proving the age, ownership transfers, and state of conservation of old art masterpieces play in attributing paintings to famous artists. The more complete the provenance, the stronger the attribution.[26] BTCs can be thought of as purely software-based tokens that represent control over a certain amount of money. These virtual tokens encode two crucial pieces of information, relating to the identity of the current owner of the money and its provenance. The identity part is done

25 Ripple Labs, the promoters of Ripple, are now positioning their platform as one that can power banks' business rather than bypassing them. Several banks, including Germany's Fidor and U.S.-based CBW and Cross River Bank, have embraced the Ripple platform. Source: Ferency, D., C. French, H. Tran, and S. Gibbs, 2015, "The internet of finance: unleashing the potential of blockchain technology," CMM Research Note, Institute for International Finance, April 16.

26 There is an interesting parallel between the stone money of Yap Island and bitcoin. When a transaction occurred, the big stones were not physically moved to the premises of the new owner nor were they marked in any way. Instead, the fact that they had changed hands was announced publicly and it became a matter of collective memory. The stones could all continue being housed together, and it was clear who was entitled to what stones. See: Ettinger, G., 2013, "The island of stone bitcoins," Lets Talk Bitcoin blog, September 15, http://bit.ly/2d28aHi.

through public key encryption, under which the token is "locked" with a public encryption key to which only the valid owner of the money has the corresponding private key. The provenance part is done by attaching a pointer to the previous virtual token where the value emanated from. The holder of a valid token (i.e., one to which they have the corresponding private key and that has a provenance that checks out fully in history all the way back to the moment of the money's creation) can effect a transaction by creating a new token, which contains the public key of the money's recipient and a pointer to the previous token. The previous token becomes spent, and hence no longer valid, because there is now a newer token that points to it. The new token is valid because it points to a previously valid token and no newer token points to it.

All these tokens – in effect, transaction histories – are collected in what is known as the blockchain. The blockchain must be freely searchable by anyone wishing to check the validity of any money they receive and hold. It is thus a public ledger, unlike the traditional account-based systems mentioned earlier, which are private ledgers controlled uniquely by individual financial institutions. Given this decentralized, public nature of the blockchain, there also needs to be a process for extending the blockchain as new transactions occur, one that drives a consensus among all parties as to which of the newly reported transactions are valid and should, therefore, enter the blockchain. The BTC protocol implements this through a process called mining, under which every ten minutes a specific entity (a miner) earns the right to append to the blockchain a new block of transactions they deem to be valid. Miners earn that right by being the first to solve a complex mathematical problem, so that miners who are willing to expend most computing resources are most likely to succeed.[27]

The BTC protocol is not account-based in the sense that the underlying value of each amount of BTC that you hold must be established independently, since each will have a different provenance. In account-based systems, on the other hand, once you prove ownership over the account, you gain control over the entire balance in it. However, most users are likely to experience BTC as an account because there is BTC wallet software that implements the BTC protocol in the background, thereby sheltering the user from directly having to manage disparate public/private keys and checking multiple BTC provenances.

As with Ripple, the BTC protocol is not based on anonymity because all BTCs need to be linked to a public key that their owner can use to claim the money. However, it is not identity-based in the sense that this public key cannot be directly linked back to a legal identity. The public key thus becomes a form of pseudonym for its owner. Anyone can see and trace all the transactions performed under the pseudonym, but the pseudonym itself is held anonymously. Thus, the system performs as if it were anonymous, only as long as users are able to hold their ownership of keys secret. As soon as public keys are linked to specific identities, their entire transaction history with that key becomes exposed.

		HOW IS OWNERSHIP ESTABLISHED?		
		Anonymous, with hardware token or device	Pseudonymous, software-based (using public key infrastructure)	Linked to identity, with mixed factor authentication
HOW IS VALIDITY ESTABLISHED?	Decentralized, directly from token	Stored-value smartcards		
	Checking public consensus ledger of past transactions		Ripple protocol	
	Checking public consensus ledger of current holdings		BTC protocol using public blockchain	
	Account issuers checking their private ledgers		Private blockchains on BTC protocol	Bank & e-money accounts

Table 2 – Main models for managing ownership rights over digital money

Based on the above discussion, there are two main differences between the various digital money systems, as shown in Table 2. The columns capture how the ownership over one's digital money is established: whether that comes with the possession of a physical device (analogously to how coins and notes work), access to encryption keys that work like a virtual or software token, or the use of multiple (generally two) factors of authentication that allow an account to be linked to an underlying identity. The rows capture how the validity of the money itself is established: whether it is done in an entirely decentralized fashion through direct manipulation of the tokens, in a distributed fashion by checking a public ledger that represents a consensus of past transactions or of current monetary holdings, or in a centralized fashion by requesting the account issuer to confirm the monetary value against their private ledger.

In the same way that various issuance models can complement each other, these various acceptance mechanisms can also work together and support each other. An example is the BTC protocol,

27 This is where it gets very technical, but the overall logic is that basing the mining rights on what is called a proof-of-work protocol (that combines the demonstration of raw computing power with some element of luck) ensures the stability of the blockchain itself. For more on how the bitcoin protocol works, see Box 4 and Mas, I., 2014, "Why you should care about bitcoin, even if you don't believe in it," mimeo, April. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1769124

The mining process implemented by BTC is designed to ensure that only valid transactions are captured in the blockchain, in the right sequence. The mining process runs every ten minutes or so, and results in a new block being appended to the blockchain that records the transactions that have been deemed valid during the last ten-minute interval. The blockchain has thus been growing since its inception many ten-minute intervals ago, such that at any point in time it represents the full record of all transactions that have ever been done using the BTC protocol. The blockchain is propagated to all nodes in the network, so that each node can reach the same conclusions as to whether certain BTCs that a user is proposing to use to pay someone else are valid or not.

Advocates of cryptocurrency systems such as Ripple and Bitcoin argue that they offer the possibility of much lower transaction costs than those we are accustomed to with our existing interbank infrastructure. First, these platforms can operate on generic internet infrastructure rather than on purpose-designed, proprietary systems. Second, by eliminating any central control over the ledgers, no player can exercise pricing control over the ensuing payment services. Third, the protocol enforces a standard so that all nodes in the network are interoperable; this lays the basis for reaping global network effects, in contraposition to traditional payment systems that are a patchwork of variously interconnected payment islands. On the other hand, critics argue that the system is not as cheap as it appears. First, the distributed, peer-to-peer nature of the ledger means that the same ledger information must be replicated, communicated and stored many times. It, therefore, ought to use up far more network resources in total than a centralized system that maintains at most a few instances of the ledger. Second, the mining process is extremely costly in terms of the computing power miners must expend, as well as in terms of the corresponding electric power that is used up in the process. Third, while per-transaction fees earned by miners is currently very low, this will change as the reward offered to miners is set to decrease over time and to disappear altogether eventually. In the meantime, the miners' reward acts as an inflation tax on existing holders of BTC, which is a form of hidden transaction tax.[28]

In addition, the operation of crypto-currency systems such as Ripple and Bitcoin raise a number of regulatory issues for central banks, beyond purely fiscal and monetary aspects: (i) there are systemic issues relating to the stability, integrity, and reliability of the crypto-currency protocol itself, i.e., the set of rules embedded in software which govern how the system works; (ii) there are operational, technological, and prudential issues relating to the firms offering digital currency services on top of the payment platform, such as hosted wallet providers, currency exchanges, and merchant payment processors; and (iii) there are conduct issues, particularly those relating to KYC and anti-money laundering (AML), given the pseudonymous nature of these services.

Box 4 – Benefits, costs, and risks of crypto-currencies

which can operate on a public, distributed blockchain as described above, but also on a private blockchain basis. Because the protocol is freely available on an open source basis, it can be implemented by private players on a closed network, centrally controlled basis. For instance, private blockchains could be used to cwonduct transactions among users served by the same wallet provider or in the same closed user group, leaving the public blockchain to record transactions between users of different providers or closed user groups. This might achieve a better tradeoff between efficiency (which generally favors centralization of information and authorizations) and universality (which generally favors decentralization).[29] On the other hand, the proliferation of private blockchains would introduce layers of opacity on the BTC system, hence potentially undermining its core objective of transparency.[30]

Most digital money in circulation today is managed in centralized fashion by licensed institutions that operate private account ledgers, and are linked to verified identities via authentication credentials that have been issued to each user. This is as far as it gets from physical cash, which is inherently anonymous and operates on an entirely decentralized fashion. We look at the implications of that below.

28 For an analysis of the sustainability of Bitcoin's low transaction fees, see: Ali, R., J. Barrdear, and R. Clews, "The economics of digital currencies," Bank of England Quarterly Bulletin 54:3, 276-286.

29 Moreover, the creation of private blockchains on top of the public blockchain might help address the scalability issues of the latter, which demands replication of the blockchain data at every node and broadcasting of transactions network-wide. Under a mixed model, only certain transactions (presumably larger ones, or those involving unconnected parties) would place a network burden, and the rest would be handled in centralized blockchains that need not be propagated to all nodes. See: Beikverdi, A., 2015, "How trustless off-blockchain transactions could solve the block size problem," op-ed, Cointelegraph.com, May 31, http://bit.ly/2cyZ041.

30 Private players offering off-blockchain transactions could in theory operate with less than full backing in terms of the volume of actual bitcoins they hold relative to the bitcoin exposure they absorb on behalf of their transacting customers. Off-blockchain operators could, therefore, have the effect of expanding BTC issuance on a fractional reserve basis. See: Carey, D., 2014, "Are off-block chain transactions bad for bitcoin?" Coindesk.com, May 14, http://bit.ly/1iMERPR.

Attributes of cash	Adaptation in digital money systems
Anonymity: no need for personal identification of sender	Most forms of digital money require the holder to present some form of credentials to gain access to the device, wallet application, account, or software tokens that holds the value. Moreover, because these credentials are likely to be persistent over multiple uses, all ledger-based systems, whether public or private, are in principle traceable: transactions can be linked to each other, if not back to the user's legal identity. Only stored-value systems implemented entirely in user devices can provide full anonymity.
Payment convenience: no need to specify identity or address of recipient	Digital money transfers must always entail addressing of money to the proper recipient. However, this can be hidden from users in proximity payment situations such as at a store if the payment instruments of sender and recipient can communicate directly. This can be done, for instance, by inserting cards into POS devices, bumping of mobile devices, or employing short radio communication interfaces such as NFC, Bluetooth, or infrared.
Universal technical acceptance: no need for specific acceptance technology	All forms of digital money require the use of electronic devices to request and confirm transactions. This introduces several potential problems. First, it creates the possibility of encountering situations where one cannot transact despite having enough digital money, if the device of either payer or recipient is malfunctioning or is not otherwise available. Second, it may create compatibility issues between senders and receivers, if they are not on the same digital money system. Their devices must be able to communicate and negotiate the transaction appropriately, and their providers need to agree to interoperate. Third, it creates large adoptions costs, as new systems and the evolution of existing ones require the upgrading of devices across the user base.
Universal legal acceptance: legal tender:	Digital money is usually not assigned legal tender status because it is generally issued by private entities and hence carry at least notional issuer default and fraud risk. This could change if central banks follow the lead of the central bank of Ecuador in issuing and managing its own form electronic money.
Instantaneous settlement: no counterparty risk	Payments using server-based digital money will usually imply at least some micro delays associated with network communications for issuing and confirming transactions, which creates at least the theoretical risk of an instantaneous counterparty risk while the transaction is being completed. These delays can be significant where network communications are poor.
Fixed denominations: available in standard amounts	Paying from a digital money account or wallet requires gaining access to the full digital money balance. It is hard to replicate the fixed-denomination feature of bank notes digitally, as this would require holding a number of sub-accounts, each with their unique numbers and credentials. The fixed-denomination feature of cash can be very useful in specific use cases where people want to cap how much money they carry with them. On the other hand, the ability to define the precise transaction amount makes the notion of giving change completely unnecessary in digital money transaction.

Table 3 – Cash versus digital money

BETTER THAN CASH?

So is digital money better than hard cash? The drawbacks of physical cash are clear: (i) transactions leave no record so they do not build up a financial history and balances cannot be regenerated in case of loss; (ii) cash transactions entail high transaction costs associated with the conveyance of cash, especially in remote payment situations, and present the problem of procuring change which may be scarce in some environments; and (iii) because of its more conspicuous nature, cash may be particularly subject to loss through theft, as well as the passing of counterfeit money.

But hard cash has some remarkable features that have stood the test of time. What do we lose when we transition to digital money systems? Table 3 describes some key attributes of cash and how those are dealt with (or not) in digital money systems, by way of summary of what has been stated previously.

But the emergence of digital money creates opportunities that go beyond simply replicating the characteristics of cash but without the drawbacks of handling a physical product. There are four major trends that digital money is likely to unleash. Each of these presents some exciting opportunities, though they may come with some hard-to-assess risks:

Decentralized and peer-to-peer money services

We are already seeing digital money spawning a new ecosystem of online price comparison sites, neutral peer-to-peer marketplaces, crowdfunding sites, online service aggregators, and specialized online financial service providers with innovative savings, credit, and international remittance models.[31] The new breed of crypto-currencies brings the concept of peer-to-peer services to the core function of money transfers – people being able to pass money to each other without involving any service provider. Many of these new models aim to disintermediate traditional players, who have long enjoyed a substantial degree of control over the market. All this serves to create more service options and choices for users. As a greater number and more diverse types of players vie for customers' attention, there are greater incentives to innovate and reduce prices.

However, managing risks, especially system-wide risks, may be harder in this more complex ecosystem. It may be harder to regulate and effectively supervise consumer protection risks, as the range of players involved and the complexity of their offerings increase. There may be much greater scope for regulatory arbitrage, as business models

31 For a categorization, analysis and leading case study of each of these new digital financial service models, see Mas, I., 2014, "Using broadband to enhance financial inclusion," IDB discussion paper no.: IDB-DP-427

morph and adapt to changing regulatory environments. It may be harder to quantify overindebtedness risks as product definitions and provider categories become blurred. And a rise in crypto-currencies may enable massive flight-to-safety flows out of financial institutions in case of a banking crisis, thereby aggravating systemic liquidity risks.

Programmable money

A particular source of innovation will likely be the embedding of money and transactions in software. Payments could be triggered automatically form any application, including social networking sites (such as Facebook or Twitter) and personal productivity tools (such as Google Calendar). Digital money could be earmarked for specific purposes only and special kinds of money could be tracked, creating a digital version of colored coins. Crypto-currency payments could be linked to the underlying asset purchased, thereby creating an automatic register of asset ownership right in the blockchain.

Bitcoin itself has an in-built scripting capability that allows some conditions to be placed on BTC payments, though it is quite limited in its programming power. Other crypto-currencies, such as Ethereum, have been designed with a much more flexible native application environment. In addition, there are services such as Codius that provide hosting environments for applications that implement smart contracts automatically on crypto-currencies.[32]

All these applications represent a major shift from finance as a service to finance as an application, much in the same way that Skype and other voice-over-IP applications turned the traditional voice service supplied by telecoms company into a downloadable application. Financial services will increasingly be conceived as apps directly downloadable by users onto their digital wallets, rather than as service upgrades offered by financial services providers.

Enabling true micropayments

Digital money, and especially crypto-currency protocols that run on standard internet infrastructure in peer-to-peer fashion (hence without necessitating dedicated servers and intermediary institutions), have the potential for massively reducing unit transaction costs, down to vanishingly small levels. It may become possible to charge for very small transactions, below the $1 threshold, which today cannot be efficiently charged for electronically.

This can uncover a new nano-economy, including dynamic usage-based pricing on roads and public transport, and supply of products and services on a much more granular piece-work basis. Most importantly, widespread access to micropayments would likely unleash a creative explosion in digital services, as it would open up new paths for content and app developers to monetize their services. This would permit highly fine-tuned charging models for code, pay-per-view models for consumption of small-format online content such as press articles, and small rewards for answers to questions posted on online discussion.

However, there are questions as to how scalable the Bitcoin protocol is, and hence how capable it is of handling the explosion of transactions that would come with micropayments. One solution might be to handle micropayments through private blockchains, as private services offered by micropayment wallet providers working on specific transaction types, communities, or ecosystems. These transactions would be handled and authorized by centralized ledgers controlled by each provider, and would not need to be broadcast, mined, or stored individually within the public blockchain.[33] This amounts to using BTCs as a unit of account, but without using the BTC system (blockchain) as a payments system.

Digital currencies as legal tender

So far, central banks have not been inclined to issue currency in digital format to complement the physical currency formats (notes and coins) we are all familiar with.[34] Central banks have typically delegated the digitization of money at the retail level to licensed institutions, such as commercial banks and e-money issuers. Only central bank-issued currency constitutes legal tender, which means that in practice there is no notion of legal tender for larger transactions. Larger transactions must be settled in forms of money that embody some element of idiosyncratic counterparty risk since they are necessarily liabilities of some entity other than the central bank.

In future, central banks may choose to issue digital currency directly. A digital currency could be used as a settlement system for large-value payment systems, if its use was restricted to larger eligible economic actors. Alternatively, it may function as a retail

32 Smart contracts are programs that formally encode certain conditions and outcomes which have been agreed in advance between certain parties. The code is then faithfully executed by a disinterested, neutral system, such as Codius, based on whether the agreed conditions were met or not. See: Thomas, S., and E. Schwartz, 2014, "Smart oracles: a simple, powerful approach to smart contracts," Codius white paper, July 17, http://bit.ly/1rH2aEo.

33 The natural players for implementing off-blockchain micropayments are hosted BTC wallet providers, since they can validate the BTC holdings of their customers and hence directly clear payments between them. An example is Coinbase, which is said to enable transactions as small as 0.00000001 BTC (equivalent to roughly 5 millionths of a U.S. dollar). See: Gilson, D., 2015, "Coinbase implements zero-fee microtransactions off the block chain," Coinbase, June 18, http://bit.ly/2cLpbTV.

34 There are two narrow exceptions to the statement that central banks do not issue digital currencies. First, it could be argued that commercial banks' excess reserve deposits at the central bank are a form of digital currency, since they are liquid liabilities of the central bank and maintained by servers managed by the central bank. However, this is a highly restricted form of currency since only deposit-taking banks have access to it. Second, as we saw earlier, the central bank of Ecuador has taken the extra step of becoming the national issuer of e-money, which it has designated as legal tender.

payment system if it is made available to everyone, regardless of transaction size, thereby enabling individuals to use it to settle debts between each other directly.

Against these potential benefits, a digital currency may be rejected by people if they fear that the government might use its control over the digital currency systems and protocols as a tool for mass surveillance. There are already reports in Ecuador that such fears are limiting the take up of the central bank's new e-money.

The architecture for such a national digital currency could replicate today's centralized systems with servers controlled by the central bank keeping track of money outstanding and a hierarchy private entities reselling the currency to their customers (akin to the Ecuadorean system). Alternatively, it could be based on a decentralized ledger under a cryptographic payment protocol controlled by the central bank.[35]

CONCLUSION

The rise of information and communication technologies (ICT) over the last twenty years has spawned a tremendous boom of financial service innovations – including all kinds of structured products, derivatives, and risk syndications. This has opened up substantial funding and risk management opportunities for many, but along with that has come a level of complexity and opacity that has been at least partially responsible for the global financial crisis. As the power of ICT continues to unfold, we can expect the innovations to spill from financial services into the nature of money itself. The opportunities as well as the risks may be even more profound.

35 Imagine a bitcoin-like system, except that the BTCs are denominated in U.S. dollars and proclaimed to be legal tender. IBM is reportedly developing such a solution. See: Chavez-Dreyfuss, G., "IBM looking at adopting bitcoin technology for major currencies," Reuters, March 12, http://reut.rs/1QVWfq8.

Banking 2025: The Bank of the Future

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Abstract

Developments in information technology are fundamentally changing many traditional business models. Progress in the IT area is bringing about one change in particular: it is reducing search costs and allowing buyers and sellers of products and services to find each other directly on web-based platforms, without the need for a mediator, broker, or intermediary. All business models of trade are affected by this development, and this means that financial trade is also affected. However, bank customers will only turn to the new business model of web-based financial intermediation if the economic advantage of a behavioral change, in which the individual approaches the unfamiliar, is so compelling that the associated transaction costs of learning the new, as well as the initial uncertainty of action, are justified. Once the number of new users reaches a critical mass, the process of reorganization is no longer linear and continuous, but advances in bursts and exponentially. This means that, at a certain point in time, the process of system change gains so much momentum that it can hardly be controlled. In view of the inefficiency of the existing banking system, as well as the economic superiority of web-based alternatives, it seems that it is only a matter of time before a system change takes place in the banking business.

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THE CURRENT "BANK" BUSINESS MODEL

Social privileges and their utilization

In economic textbooks, the bank is usually depicted in its role as an intermediary that collects deposits from individual savers on the liability side of its balance sheet and distributes them on the asset side as credit to the private sector. This intermediary function, i.e., as a simple mediator of capital, would mean that a commercial bank could only lend out the same volume of credit that savers had previously deposited. This, however, is a misconception. Every commercial bank receives two social privileges along with its banking license that enable it to expand its business, regardless of the volume of savings deposits. The first is the option of favorable refinancing via central bank credits, which means that commercial banks always have central bank money at their disposal.[2] The second is the privilege of creating its own deposit money through lending and fractional holding of minimum reserves on deposits. Each time a commercial bank lends out money, it creates new deposit money because the borrower usually has an account with it and the amount of the loan will be credited to this account. If one simply looks at the way balance sheets work, the bank grants a loan on the assets side and credits itself with the same amount on the liabilities side as a customer deposit.[3] Since fractional reserve banking only requires a bank to hold a small fraction of the amount as a deposit with the central bank, banks can grant almost unlimited loans from a given volume of savers' deposits, thus creating money.[4]

The central bank has a limited control on money supply as commercial banks can procure the necessary central bank money on favorable terms at any time by availing themselves of central bank loans. The central bank can only influence money market rates, which indirectly affect demand for credit in the real economy via capital market interest rates and thus guide the creation of money [McLeay et al. (2014)]. However, this transmission mechanism of monetary policy is highly vague and uncertain because, as the current situation in Europe demonstrates, the demand for credit in the real economy is influenced by a variety of factors.[5] The costs of financing are only one determinant of business investment decisions, and often they are not even the deciding determinant. The central bank is, of course, free to intervene directly in the market by purchasing or selling securities (so-called open market policy) to create or remove money, enabling it to control the money supply. Nevertheless, the central bank can only justify such measures of quantitative control of the money supply in extreme market situations. Aside from this, the monetary policy of the central bank regarding deposit money creation can best be described as accommodative rather than controlling and supervisory.

For commercial banks, the ability to create their own money is a lucrative source of profit because the interest margin between lending and deposit rates is earned with every loan that is granted. No other type of private business has the privilege of automatically receiving financing (a bank deposit) on favorable terms for a (credit) claim at the point in time when the claim is created. The question is whether banks use this privilege in the interests of society, in other words for financing the real economy. Table 1 provides an overview of the formation and usage of deposit money created by German banks.

If one looks at the aggregated assets and liabilities of German banks, it becomes apparent that the (unsecured) credits granted to the real economy only account for an average of 40% of the overall balance sheet volume, while loans to banks make up 26%.[6] However, when banks lend to banks, money is created that does not flow into the real economy and create real value there. Instead, it remains in the monetary or nominal financial sector. Banks primarily use this money to acquire securities, investments and derivatives, and this is documented by the fact that they account for approximately 30% of the balance sheet total. This means that only a fraction of banks' usage of the social privilege of creating deposit money is for the purpose of financing the real economy.

Macroeconomic risks of the business model

The pictures of savers queueing in front of the Northern Rock Bank in the U.K. in 2007 made it clear that there exists an inherent danger in our monetary system: the only basis for the value of money and, therefore, for our existing monetary system is the faith of citizens in being able to exchange their money for goods and services at stable prices at any time, i.e., their confidence in its purchasing power. If this confidence is lost, then the result is a run on the banks to physically secure money. However, cash only accounts for approximately 10% of the euro money supply, and the bitter realization that not everyone can exchange their account balances for cash leads to a desperate struggle to be the first at the bank counter. Sight deposits on accounts are ultimately bank bonds that include the right to exchange them for cash.[7] The only thing that gives deposit money

2 Central bank money includes cash and sight deposits with the central bank.

3 This means that the process of deposit money creation takes place differently in reality than the way it is explained in many textbooks. The creation of money is primarily dependent on the demand for credit and not on the volume of savings deposits. The process begins with the bank granting the loan, which generates new deposits and new deposit money, not with the savings deposit [McLeay et al. (2014)].

4 The minimum reserve ratio of the ECB is 0.05%. The minimum reserves bear interest at the interest rate of the main refinancing facility for commercial banks at the European Central Bank. See EC Regulation No 1745 (2003).

5 Despite extremely low capital market interest rates, the private credit demand from non-banks in the Eurozone has been in decline since the 2008 financial crisis.

6 If one removes mortgage lending from that, on the grounds that mortgages are mainly used to transfer ownership of existing assets rather than create new productive capacity, the figure for lending to the real economy in Germany falls to a level of around 20%.

7 The English use the very tangible expression "I owe you" (IOU) for bonds. By making a deposit at a bank, savers have implicitly acquired IOUs from banks, even if individual bank customers are hardly aware of this.

Assets	€ bln	in %	Liabilities	€ bln	in %
Cash and cash equivalents	82.5	1.0%	Liabilities to banks	1743.6	22%
Lending to banks	2637.8	33.4%	Liabilities to non-bank	3375	43%
• thereof unsecured loans	2029	25.7%	Bank bonds	1157	15%
• thereof securities issued by banks	597.8	7.6%	Capital and reserves	466.6	6%
Lending to non-banks	3928.8	49.8%	Others	1149.7	15%
• thereof unsecured loans	3153.9	40.0%	thereof derivatives trading portfolio	800	10%
• thereof securities issued by non-banks	765.7	9.7%			
Shareholdings	132.7	1.7%			
Other	1110.1	14.1%			
• thereof derivatives trading portfolio	838.6	10.6%			
balance sheet total	**7891.9**	**100.0%**		**7891.9**	**100.0%**

Deutsche Bundesbank (2015)

Table 1 – Aggregated assets and liabilities of banks in Germany (November 2014)

value and acceptance as a means of payment is the confidence in being able to exchange it for cash at any time, although only cash is defined as legal tender and must be accepted.

In a monetary system in which money has no intrinsic value, but its value is derived solely through the attribution of purchasing power, the money supply must necessarily rise in proportion to the volume of goods.[8] Given the current business model of banks, this is difficult or almost impossible to achieve because, as explained above, the central bank only has limited influence over the creation of money by commercial banks.

Since the introduction of the euro, the growth of the money supply has been much greater than the growth of the volume of goods. The reference value of 4.5% for the growth of the money supply specified by the European Central Bank (ECB) was almost continuously exceeded in the period between 1998 and May 2009.[9] A comparison of M3 growth rates with those of the GDP on a quarterly basis shows serious deviations, i.e., highly excessive growth of the money supply, prior to the financial crisis. As Figure 1 documents, commercial banks created significantly more money than the real economy produced in new goods over a period of several years, and the ECB did not intervene to correct this.

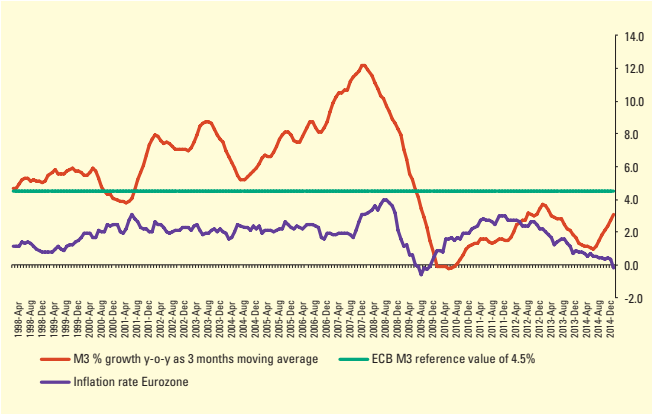

Figure 1 – M3 growth, the ECB reference value, and inflation rate

With the introduction of the euro, the ECB had explicitly defined monetary analysis and M3 growth as the second pillar of its strategy. However, in 2003, the ECB clarified that M3 growth has more a medium- to long-term significance in relation to the development of prices. Under no circumstances could a failure to adhere to the annual reference value for M3 growth be viewed as justification for the central bank to automatically implement short-term monetary policy measures. To emphasize this point, the ECB announced that it would no longer take any special notice of the annual deviation of monetary growth from its reference value in the annual evaluation of the success of its monetary policy [European Central Bank (2003)].

8 In Europe, money finally lost its intrinsic value with the collapse of the Bretton Woods system in 1973. In the Bretton Woods system of fixed exchange rates, participating currencies were still backed by gold, albeit implicitly, because the dollar was backed by gold, and this allowed a metal value to be calculated for each currency. During times when the gold standard existed, money had a direct connection to the price of gold via exchange ratios set by governments [Veit (1969); Jarchow and Rühmann (1984)].

9 The reference value is calculated as a three-month moving average of annual growth rates. The ECB guideline of 4.5% is based on the assumption of 2% annual inflation, 2% to 2.5% annual growth of production potential, and a decreasing velocity of money 0.5% to 1% per year [European Central Bank (1998)].

Debt growth percentage since 2000	France			Spain			Italy			Germany		
	2005	2010	2013	2005	2010	2013	2005	2010	2013	2005	2010	2013
Total economy	35%	92%	115%	105%	231%	232%	81%	83%	95%	16%	32%	30%
Corporates	23%	54%	74%	96%	204%	148%	61%	86%	82%	7%	19%	26%
Financial corporations	41%	148%	155%	490%	1137%	978%	390%	166%	172%	25%	39%	17%
Public sector	42%	94%	134%	14%	75%	207%	43%	32%	56%	27%	20%	81%
Households	46%	112%	132%	124%	210%	171%	72%	149%	148%	4%	1%	4%

Table 2 – Debt of selected countries in the Eurozone by sector

The development of inflation during the same period validated the ECB's position. The rate of inflation in the Eurozone was continuously close to the target of 2% up until the financial crisis. Hence, technically speaking, the ECB's monetary policy was successful because it sustainably ensured the monetary stability of the euro with a low inflation rate.

But is the focus of monetary policy on consumer price inflation as the exclusive measure to preserve monetary stability not an overly one-dimensional interpretation of the value of money? The excessive development of the money supply in recent years is also reflected in a sharp increase in debt in all sectors of the economy. As debt levels rise, the insolvency risk of debtors also increases. The imminent insolvency of governments or banks is a serious threat to the stability of the financial and the monetary system [Buttiglione et al. (2014)]. Table 2 shows how debt has developed in the different economic sectors of selected European countries in the period since 2000 (base year) [OECD (2015)].

The level of debt in the economies of France, Spain, and Italy has risen considerably during the last ten years. The financial sector and private households in particular have experienced an extraordinarily high credit growth. The figures for Spain are particularly dramatic. In that country, the indebtedness of the entire economy has more than tripled since the turn of the millennium. In direct comparison with the other euro countries, credit growth within the German economy was relatively moderate.

In the banking and financial sectors, this credit policy has particularly harmful effects:

- In most countries, the banking sector has reached a size that is several times as large as the national economic output. This means that the nominal monetary sector has largely decoupled itself from the real economy and is trading internally with securities and derivatives, and this is increasingly becoming a risk to the stability of the monetary system. With equity ratios of between 3% and 5%, banks are leveraged more than 20 to 30 times. Since a significant portion of the inflated credit volume is accounted for by interbank loans, not only does the sheer size of commercial banks lead to the "too-big-to-fail" problem but their mutual interdependence also poses a systemic risk [Cœuré (2014)].
- The expansive credit growth is driving stock and bond prices on the securities markets as well as real estate prices to increasing heights, and this is causing an uncontrolled rise in prices of assets. With the growing divergence between the nominal and real economy, asset prices lose their signaling and steering functions, which are extremely important for the efficient allocation of capital. Money flows into investments that have no connection with the real economy and, therefore, have no long-term value.
- Liberal lending to governments through the purchase of government bonds enables these governments to increase their budget deficits and debts far beyond their ability to sustain debt. Under current banking legislation, the purchase of government bonds, i.e., public financing, is privileged compared to the financing of businesses. In contrast to the purchase of corporate bonds, banks are not required to hold an additional amount of equity capital as a risk buffer when purchasing government bonds. Incidentally, this regulation has not been changed in the "new" Basel III guidelines [Deutsche Bundesbank (2014)]. The high monthly growth rates of government bonds and public sector loans on the balance sheets of European credit institutions shown in Figure 2 are evidence of a growing interdependence between nation states and national commercial banks.
- Governments are almost forced to rescue their creditors, the banks. If they were to lose their financiers, then sovereign default would be the consequence. The costs incurred by governments in rescuing banks are, of course, once again financed by banks, and the renewed increase of government loans on bank balance sheets from 2007 onwards is evidence of this.

Interest payments and loan redemptions represent claims on the future economic performance of the real sector [Gali (2010)]. Companies must generate a return on investments in order to service

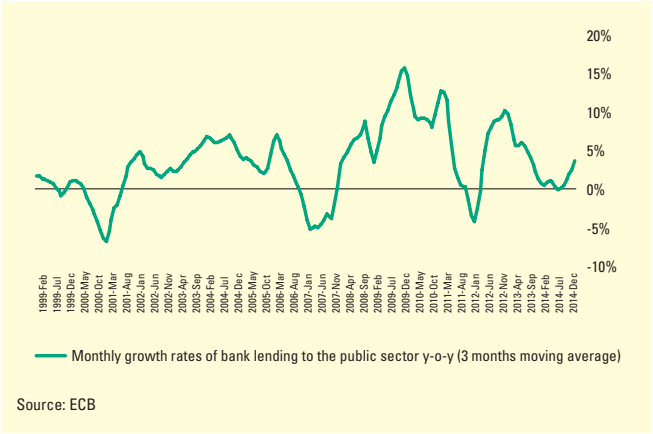

Figure 2 – Monthly growth rates of bank lending to public sector (1999 to 2014)

debt costs. In the case of private households, the interest and repayments have to be generated by labor income. Governments, in turn, pay interest and principal from the taxation of company profits and private income. However, since money has been created over the years without sufficient coverage from the real economy, these demands on real economic performance cannot be fulfilled. Nominal assets and liabilities have been created in the economy without any corresponding real economic values.

From a macroeconomic point of view, the financial crisis and the bankruptcy of debtors are the inevitable consequences of excess monetary assets and liabilities being devalued, resulting in the adjustment of corresponding claims on the aggregate production potential within the currency area.[10] A monetary policy that focuses solely on the inflation rate as an indicator of monetary stability and ignores the development of the money supply as well as its impact on the stability of the financial system is clearly misguided.[11]

Monetary policy and regulation of the "bank" business model

ECB monetary policy after the crisis

Since the financial crisis, the ECB has acted as a "lender of last resort," preventing the collapse of insolvent debtors in the banking sector as well as governments and private households. It extended its credit facilities so that banks are able to take on long-term debt from the central bank at low interest rates. To reduce the burden on debtors and to stimulate the private demand for credit, they consequently reduced the interest on central bank lending to nearly zero. With the promise of unconditional purchases of government bonds from euro countries that are at risk of becoming insolvent, the ECB is shielding debtors from paying high-risk premiums on their liabilities. However, the private demand for bank credit - and consequently the money creation machine of banks – does not seem to want to start up again, despite stimulation via low interest. Now the central bank steps in and fills the gap by creating money via its own open market instruments. At the beginning of 2015, citing an acute threat of deflation, the ECB announced a multi-year program for monthly purchases of securities on the market worth a total of €60 bln, which will ultimately lead to a direct expansion of the money supply in the trillions [European Central Bank (2015)].

This monetary policy saves the monetary and financial systems in the short term, but the problems of unsustainable debt in many sectors of the economy continue to exist. Ultimately, the ECB's policy of quantitative easing is only perpetuating the banks' pyramid scheme of deposit money creation, thereby keeping many insolvent debtors, including banks, governments (public sector at all levels), as well as private households, financially afloat in the short- to medium-term. An interest rate of almost zero or even negative interest rates may be advantageous for debtors in the short-term, but have a negative impact on the overall economy in the long run. Interest rates define the time value of money, which builds the basis of all valuation models for investment and financing decisions. If there is no more a difference between the present and the future value of cashflows then financial markets are sending the wrong signals to investors. This inevitably leads to a misallocation of capital. Bond and stock prices are being driven upwards to higher and higher levels by infusions of central bank money, signaling an economic strength and creditworthiness of borrowers that do not exist in reality.

Regulation of the banking and financial sector

Generally speaking, there are two ways to make the current "bank" business model resilient and useful for society. One option would be to take action at the point where money is created and either completely remove commercial banks' ability to create their own deposit money or significantly reduce it by regulating lending and channeling the money that is created into the real economy. This regulatory intervention would reduce the current business model of banks towards the function of a simple intermediary between savers and investors. The second option would be to target risks arising from the use of (surplus) bank credit money, which would leave the existing "bank" business model unchanged and exclusively regulate

10 It would be ideal if the excess money in the economy could be easily written off by a symmetric devaluation of nominal assets and liabilities in an aggregated balance sheet restricted to the monetary area, without having real economic consequences. Unfortunately, this balance sheet mechanism does not exist. Debtors and creditors are neither identical economic operators nor are debts and assets distributed evenly among all individuals and institutions. For this reason, any financial and debt crisis has serious consequences for the real economy.

11 De Grauwe and Gros (2009) express similar criticism and propose a new two-pillar strategy for the ECB that explicitly defines financial stability in addition to price stability as an objective of monetary policy.

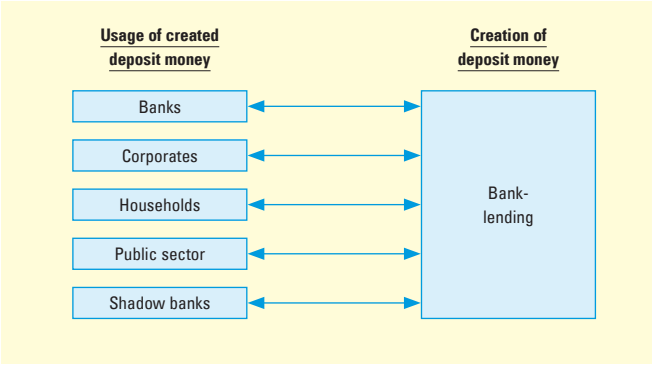

Figure 3 – Use and creation of deposit money

its consequences. Figure 3 outlines these two alternative approaches to government regulation of the banking sector.

Ever since the Basel I equity capital guidelines came into effect in the 1990s, the focus of financial market regulation has been to monitor and regulate the use of money, not its creation, i.e., the source or origin of money. The problem with this approach is that there are endless uses for (newly-created) money; the creativity and innovation of the financial sector in this respect knows no limits. Ideally, money that has been newly created by bank lending is used to finance real economy investments in the corporate sector. However, the disbursement of a loan can also be used by the debtor to purchase securities, derivatives, or investment certificates. Every use of money has its own risks and every debtor has their own risk-bearing capacity, each of which needs to be monitored and evaluated by financial supervision agencies. Debtors are those in a credit relationship with the banking sector, i.e., the banks themselves as borrowers, private households, businesses, governments, and shadow banks.[12]

The many uses of money and types of debtor give rise to a vast number of individual risks that can neither be controlled nor evaluated, and as if that were not enough they also influence each other. In seeking to identify and regulate every single risk, lawmakers and governmental financial supervisory agencies are letting themselves get pulled into a competition with financial institutions that revolves around the invention of an endless stream of new variations. With limited public resources, their chances of winning are slim. And even if banking supervisory agencies were halfway able to regulate the numerous risks in the banking sector, new risks caused by the uncontrolled financing of shadow banks and their mutual interdependence with commercial banks are emerging.

The same applies to the interface between the government and the banking sector; financial supervision has its limitations here as well. If euro countries can take on debt that exceeds their economic ability to service that debt, then the threat of sovereign default of individual euro countries will continue to be a risk factor in the banking system that the European financial supervision authorities cannot control. In order to bring the risks resulting from the nexus between government and the banking system in the Eurozone under control, central European financial market supervision would need to be complemented by a central European fiscal policy with the authority to monitor and regulate government budgets. This shows how tightly monetary policy, fiscal policy, and the stability of the monetary and financial systems are interconnected.

The financial crisis in Europe permanently shook the confidence of policymakers and citizens in the stability of the euro and the banking and financial system [Gali (2014)]. Given the high cost of the bank bailout for government budgets and the real economic cost in Europe, this loss of confidence is hardly surprising.[13] As always, when confidence in a business partner is lost, the reaction is to try to cover all risks contractually. This is the only explanation for the exceptionally high number of new laws that were passed to regulate the European banking and financial markets during the last five years. Table 3 provides an overview of institutional reforms to European financial supervision as well as legal initiatives to regulate the banking sector, financial markets, and shadow banking.

Banking and financial market legislation was relatively complex even before the financial crisis, but with this wave of new laws it has reached a degree of complexity and proliferation that can hardly be increased.[14]

Costs and benefits of the "bank" business model in 2015

In view of the effort that society puts into the regulation and supervision of the banking and financial sector, the question immediately arises as to whether the costs and benefits are proportionate. The economic benefit of the banking sector is to finance the real economy via lending and loan securitization as well as taking deposits from savers.[15] But the current monetary system allows banks to expand their lending with nearly no constraints as the central bank lacks control over the process of money creation. The growth rate of bank

12 The term "shadow bank" refers to financial investors such as private equity funds, hedge funds, or securitization platforms that perform highly-leveraged banking functions without having access to the refinancing facilities of the central bank.

13 In the "state aid scoreboard 2014," the E.U. Commission provides a detailed list of all 450 governmental support measures authorized by the E.U. to stabilize the financial sector for the period between October 2008 and October 2014. The total volume of governmental support measures from 2008 to 2013 adds up to more than €700 bln euros or 5.5% of European GDP.

14 Haldane (2012) describes the extreme complexity of banking legislation as well as the public and private resources necessary for banking supervision, using a variety of examples, comparisons, and figures.

Institutional reform of financial supervision

2011 European Financial Supervisory System:
Three European supervisory authorities for banking, insurance, and securities markets (micro-prudential supervision) plus the ECB's European Systemic Risk Board (macro-prudential supervision)

2014 European banking union with three supporting pillars:
(1) Uniform supervisory mechanism with ECB (2) uniform settlement mechanism with resolution fund (3) deposit guarantee schemes

Regulation of the banking sector (Basel III – CRD IV – 2013)

Debt sustainability:
Risk adjusted equity 8%, leverage ratio 3%, liquidity requirements, macro-prudential risk provisioning

Global systemically important banks:
1% to 3.5% more equity for additional loss absorbency in steps from 2016 to 2018, FSB list of GSIBs

Bonus cap:
Variable remuneration not to exceed fixed remuneration

Implementation Act:
Corporate governance regulations including requirements for the supervisory board

2014 E.U. bank structure reform:
Proposal to separate investment banking activities from commercial banking under certain circumstances (based on Liikanen Report 2012); 2013 Germany and France introduce national "separated banking" laws

Financial market regulation

2012 E.U. regulation on short selling of credit default swaps:
Restrictive handling of short selling

2014 PRIIPs (Packaged retail and insurance-based investment products):
Investor protection through better information on the risks of structured products – 07/2016

2014 MiFID II – Review of the Markets in Financial Instruments Directive:
Investor protection: Independent investment advice, product governance, product intervention by supervisory agencies, obligation to keep records, reference rates (Libor, fixings, etc.)
Trading transparency for almost all types of securities: prices, volumes, mandatory reporting of trading in commodity derivatives, uniform tick sizes for ETFs
Authorization requirement for high-frequency trading and order-to-trade ratio limits
Obligation to trade with central counterparty for derivatives – and no more OTC

Regulation of credit rating agencies and shadow banks

2010 E.U. regulatory standards for rating agencies:
Obligation to provide information on costs; transparency of rating models of credit risks

2014 E.U. action plan to reduce dependency on ratings by rating agencies

2011 Alternative Investment Fund Managers Directive (AIFM):
Uniform E.U. rules and requirements for managing alternative investment funds (hedge, private equity as well as open and closed real estate funds)

2013 E.U. standards for money market funds:
Transparency in repo and lending transactions.

2016 E.U. regulation on financial benchmarks:
Supervision of benchmark administrators and critical benchmarks; measures to reduce conflicts of interests

Table 3 – Institutional reforms and regulation in European banking and financial markets

deposit money does not have to be backed by real economic growth nor the claims of creditors covered by the economic strength of the real economy. This inevitably leads to a nominal devaluation of assets and liabilities with damaging consequences for the real economy and thus for the prosperity of society: the insolvency of companies increases unemployment, debt-ridden governments must cut public spending (social transfers, education spending, etc.), and private households must restrict their consumption. This bank business model is embedded in a monetary system in which the central bank does not centrally control the development of the money supply in accordance with the production potential of the real economy. Instead, it continues to allow commercial banks to create their own deposit money to further their pursuit of profit, and this will lead to financial, economic, and political crises with predictable regularity.

Instead of changing the business model, its foundations are being cemented by the extremely complex regulation of the banking and financial sector. The approach of regulating the use of money in the various sectors of the economy instead of changing the creation of money only treats the symptoms, not the causes. In the end, the citizen pays the private and public costs of this extremely expensive financial legislation as a bank customer and taxpayer by covering the cost of numerous national and European supervisory institutions, as well as the banks' internal implementation of the laws. This regulation simultaneously deters potential competitors from acquiring a banking license and shields the banking industry from competition from other economic sectors.

To sum up, the cost-benefit balance of the bank business model in 2015 is clearly negative. The limited social benefits in terms of lending to the real economy are outweighed by extremely high social costs and risks. The current banking system is a high risk factor as well as a burden for society.

15 Organization and settlement of payments are also on the asset side of the banking sector's balance sheets. A comprehensive network of ATMs and branch offices ensures the supply of cash. Banks' internal payment transaction networks with clearing houses ensure the smooth processing of cashless payment transactions. However, banks no longer have a monopoly in this area; the increasing penetration of non-bank payment processors is an indicator that there are efficiency gains to be capitalized on here. In addition, a banking license is not needed for processing payment transactions.

THE "BANK 2025" BUSINESS MODEL

The monetary and financial systems are constructs created by humans to increase the prosperity of society as a whole. There is no law of nature that extrinsically determines the structure of the monetary system and the financial system. Organizational forms change with changing circumstances, and forms of organization that turn out to be negative factors for society do not last. For this reason, the question is not whether a new monetary and financial system will emerge in the coming years: in view of the state of the current monetary system, that seems to be certain. The more interesting question is how the new monetary system will be organized and what the change process might look like.

Process of change

Crises often lead to fundamental changes in the structure of organizations and processes. However, the European financial and euro crisis has apparently not had this effect. On the contrary, the reforms introduced after the financial crisis only serve to stabilize the current monetary system and can thus be labeled as system-compliant repairs. All of the reforms are objectively justifiable and are characterized by a self-contained, systemic logic. What is striking is the extremely high level of complexity, which makes expert knowledge necessary for the legislative process, supervision, and control, as well as on the part of the bank. In the spirit of "technocracy," the current reforms in the financial sector are dominated by a kind of objective necessity and organizational determinism, and they are taking place without a societal evaluation of financial institutions and instruments. This technocratic method of managing the situation, which is completely removed from the context of its social effects, is hardly surprising: all of the proposals for legislation come from the Financial Stability Board, the Bank for International Settlements, the International Monetary Fund, and national central banks. That is to say, from institutions that are shielded by their status from direct democratic control by society or national parliaments. No impulses, proposals, or momentum for a system change are to be expected from these financial institutions. On the contrary, institutional economics teaches that institutions have an inherent urge to increase their power and influence. With the financial crisis, numerous new regulatory institutions were established for the financial sector and the responsibilities of the existing institutions expanded. A system change in money and finance would mean dismantling the rampant financial bureaucracy, and from the perspective of these institutions, this represents a risk.

In a society in which the majority of relations between individuals follow economic rationality, a system change will only occur if it is worthwhile for the economic operators. This means that the economic advantage of a behavioral change, in which the individual approaches the unfamiliar, must be so compelling that the associated transaction costs of learning the new as well as the initial uncertainty of action are justified. At a certain point, the increasing number of users causes the network effect, and this gives the process of reorganization and system change its own momentum.

Such a development has been evident in the financial market for a number of years. In addition to conventional banking, which is protected by regulation, a parallel market consisting of an increasing number of web-based financial intermediation platforms is establishing itself. Initially, so-called "crowdfunding" was considered as a niche market for purely technology-focused business start-ups, but the platforms have now developed into a real alternative to bank loans. The high annual growth rates of this parallel market in Europe document the fact that more and more users are recognizing the economic advantages of web-based financial intermediation and are also willing to bear a higher risk [Wardrop et al. (2015)].

Peer-to-peer lending is attractive to both investors and borrowers because the existing bank margin between deposit and credit interest rates can be shared. The platform only receives a commission. These charges are much lower than a bank's interest margin because they only need to cover the cost of operating an Internet platform for financial intermediation. Nevertheless, when investors purchase credit claims they also take the credit risk of an individual debtor. Investors can diversify the individual credit risk exposure ("unique risk") by participating in various financing projects with small amounts or by joining together in groups of investors over the Internet. The platform only fulfills the role of intermediation and does not take on risk through its own contractual positions. In a pure peer-to-peer model there is also no systemic risk if a platform becomes insolvent because the risks are now spread across the users in a decentralized manner. Whereas banks accumulate risks, platforms decentralize the risks. The increased transparency and the central management and documentation within the transaction platform simplify the monitoring and supervision of financial market transactions considerably. The unbeatable homogeneity makes money into a product that is ideally suited for web-based mediation. Transparency, competition, and the mobility of capital are significantly increased by the use of information technology on transaction platforms compared to the oligopolistic banking market. Web-based platforms for credit intermediation do not require a banking license because they are not classified by the European supervisory institutions as credit institutions, but rather as payment providers [European Banking Authority (2015)]. This enables non-bank companies to also enter the market for financial intermediation without having to fulfill the demanding requirements of banking regulation. Increased transparency, increased competition, and, not least, the elimination of the bank margins all reduce the cost of capital and at the same time facilitate access to capital.

Despite all of the economic benefits, one might be skeptical as to whether the innovation of web-based intermediation can actually

prevail against the banking business in the financial market. Nonetheless, the current zero-interest monetary policy of the ECB, as well as extensive banking regulations, are forcing bank clients to change their behavior. Very low interest rates combined with low economic growth are to be expected in Europe over the next several years. A debt-based economy, such as the Eurozone simply cannot afford a rise in interest rates without risking the insolvency of many borrowers. Since many households, as well as governments, are already having to restrict their consumption due to the burden of interest and repayments, a rate increase will not be a stimulus for domestic demand and economic growth.

For the banking sector, this scenario means low profits because the essential advantage of money creation cannot fully come into play [Economist (2015)]. If the interest rate is zero, the interest margin that can be earned remains low because most customers will not accept a negative rate of interest on their bank deposits. At the same time, the costs of bank regulation will increase during the coming years. With these meagre profit prospects, it is becoming increasingly difficult for banks to raise additional capital on the market to cover the risks from their lending businesses. Some banks will have to reduce activities that require high amounts of equity, including lending. By contrast, simple financial intermediation in the sense of passing money through as an intermediary will become increasingly attractive because the bank does not take any risk that requires it to hold additional equity capital. The business of securitization of loans, which shrank after the financial crisis, could be revitalized. Nevertheless, regulations will require the quality standards of securitization techniques to be higher, meaning that previous profit margins can no longer be earned [European Commission (2015)]. These circumstances make entering the business of web-based financial intermediation via platforms, such as peer-to-peer lending, more attractive. Banks have all the prerequisites for this new business model: large customer bases, expertise in the assessment of credit risk, technical knowledge and experience in the area of online banking, and methods of processing payment transactions.

But, how can a separate web-based platform for financial intermediation with its own legal personality be integrated with the traditional "bank" business model? The platform will quickly prove to be much less expensive and can offer investors, as well as borrowers, better terms and faster processing. The traditional "bank" business model, burdened by the high fixed costs of regulation, buildings, staff, and so on, will not be able to compete with web-based intermediation in the long term. Banks are, therefore, facing a dilemma: zero-interest monetary policy means that money creation becomes less attractive, a social privilege which web-based platforms do not have in any case. In addition, the costs of the excessive amount of regulation are burdening their business model. All banks are affected by this. Their competitors, the non-bank companies that offer web-based financial intermediation and operate outside of the regulatory walls of the banking sector, are not affected. The crowdfunding market in Europe has three-digit annual growth rates [Wardrop et al (2015)]. For banks not to enter this rapidly growing market segment would mean that they are leaving their very own business of financial intermediation, in which they have the core competency, to non-bank competitors. Embracing the new business model, however, carries the risk of radical restructuring or even completely phasing out the old business model, including all of the consequences that this would have for employees and the organization of business processes.

Unless forced by economic necessity, banks may not be willing to give up their existing business models and break new ground. But a long-term zero-interest scenario is forcing savers to accept a higher risk and pursue new forms of investment that offer a positive yield. Bank customers will increasingly ask their financial advisors about opportunities for peer-to-peer lending, and if an offer is not forthcoming, then they will look for investment opportunities outside of the banking sector. The same applies to the credit customers of the banks. Empirical studies show that it has become more difficult for small and medium-sized enterprises in particular to obtain a bank loan in the wake of the financial crisis, and if they are able to, then only at high interest rates [Öztürk and Mrkaic (2014); European Central Bank (2014)]. Instead of asking banks for a loan, many companies are already turning directly to P2P platforms because they offer two benefits from a business perspective. First of all, they provide quick and uncomplicated online processing of loans even outside of banking hours. Secondly, the terms of online lending are attractive compared to bank loans, often including the option of early loan redemption without a prepayment penalty.

Savers and borrowers who are turning away from banks and to crowdfunding will allow P2P platforms to achieve the critical mass of users that is required for the network effect. The more participants a platform has, the greater the benefit for individuals. Consequently, when a minimum number of users is reached, the number of transactions on platforms begins to grow exponentially because each user passes on their experience with the new application to individuals in their social environment, which in turn accelerates growth. For many of the younger users, investing and raising capital via a web-based platform will be the norm, much like shopping online and using a variety of mobile applications in their daily lives is also the norm.

The new organization of the monetary and banking system

Information technology is reducing the search cost, so that supply and demand can meet directly and independently of their physical distance on the Internet platform. Business models whose value creation is based entirely or partially on the intermediation of supply and demand will increasingly be driven out of the market by web-based intermediation platforms.

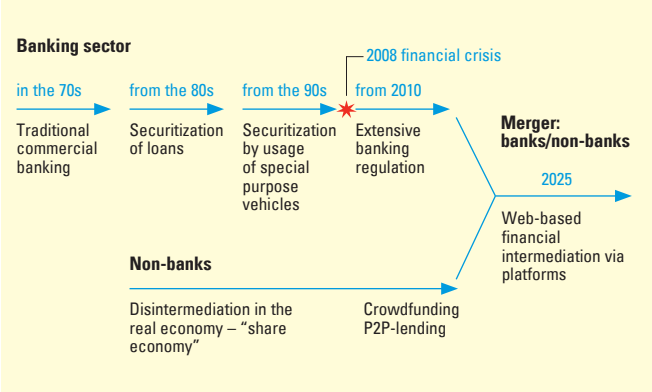

Figure 4 – Development of the reorganization of the banking business

In the banking sector, this process of disintermediation already began with the securitization of loans in the late 1970s. One could also refer to the securitization of loans as an initial form of crowdfunding because, with the acquisition of a tradable credit claim, a large number of bondholders are directly connected with the issuer of the bond. In the 1990s, banks increasingly established off-balance-sheet transaction platforms ("special purpose vehicles") as an own legal entity because they were much more flexible in terms of securitization. However, unlike in the real economy, the financial crisis and its resulting increase in regulation put an end to this trend towards disintermediation in the banking sector. Figure 4 outlines the development of the reorganization of the banking business during the past decade and shows a possible prospect for further development.

The logical continuation of this trend is web-based financial intermediation via platforms, which gradually replaces the conventional bank as an intermediary. Commercial banks that recognize this trend early on and take the risk to enter the platform business could continue to exist but in a completely different organizational structure. These banks might set up their own platforms to offer their expertise in credit risk assessment, provide consultation to clients about investment opportunities on their own, as well as other providers' platforms, and continue to process payments. Such banks could gradually become the "front end" for the underlying digital platforms without having any risk positions on their own books, instead operating exclusively in the business of financial intermediation. Customers could continue to use branch offices to seek personal advice and to process payments, but would have to pay a fee for these services in the future. In the finance platform business, banks compete with a variety of non-bank companies that also have a large customer base and many years of experience in digital processing of transactions, but which lack specific expertise in finance and their own payment transaction network. It remains to be seen who will ultimately prevail in this competition as an efficient mediator.

However, banks are not the only ones facing a process of radical restructuring. This also applies to the monetary system of the central banks. Web-based platforms are simple capital intermediaries that cannot create their own money. If the banks were to convert wholly to such a business model, the central bank would be missing a key element of its previous transmission mechanism of money supply. The central bank would then face the problem of managing the money supply directly in relation to economic growth without the previously existing creation of money via bank lending. In this scenario, deposit money, which hitherto represented the customer's claim against the commercial bank, would need to be a direct claim against the central bank for cash in the future. This could be implemented as a two-stage system, much the same as it has been up to now:[16] customers have accounts with commercial banks and these, in turn, have the same amount of credit as a mirror image with the central bank. The current fractional reserve requirements of commercial banks would de facto be replaced by reserve holdings of one hundred percent. The introduction of "full reserve money" would eliminate the risk of bank runs because each claim to deposit money would be covered by corresponding deposits with the central bank and be exchangeable for cash at any time. In addition, the central bank would now have complete control over the development of the money supply.

The question remains as to what method the central bank would use in the future to put the necessary additional money into circulation when economic growth is expected, without directly intervening in the real economy and running the risk of favoring individual economic groups with a windfall. Different suggestions exist among economists for this. One idea is to implement the "Chicago Plan" written by Irving Fisher in 1930, which provides for money to be transferred to the government on a regular basis via an account with the central bank. This direct form of government financing by the central bank would allow all citizens to benefit from the creation of money [Benes and Kumhof (2012)]. Another model suggests that all citizens should be equal beneficiaries of the annual windfall from the central bank. The central bank would then transfer an equal amount to all accounts through the commercial banks [Mayer (2014)].[17] At this point, one could suggest a third model that would use the financial intermediation platforms directly as an entry point. For the purpose of creating money, the central bank could act as an investor on all registered platforms, helping to finance real economy investments by "sprinkling" money into the system. On the one hand, this would promote the volume of transactions on all platforms, including those of non-bank providers; on the other hand, it would ensure that the newly-created money is used for the real economy.

16 Technical progress would make it possible for every citizen to have an account directly with the central bank.

17 This model could be easily linked with the growing movement calling for a universal basic income (http://basicincome.org/basic-income/).

PROSPECTS

Web-based financial intermediation is going to prevail as an economically superior form of organization compared to the traditional banking business model. There is no doubt about this. The only question is the time period in which this system change takes place in the financial market. Whether this change occurs with or without the participation of banks depends on whether the banking industry recognizes the signs of the times and is in a position to gradually restructure its present business model of money creation towards web-based financial intermediation. However, if the European banking sector entrenches itself behind the thick walls of regulation, then non-bank companies that are already active in the platform business in other areas of the real economy will gradually conquer the financial market. The increasing market share of non-bank companies in the settlement of payments is a taste of things to come.

The problem is that the entire monetary system, including the central bank, banking supervision agencies, as well as exchanges, would be affected by a change in the bank business model. It is uncertain whether policymakers and governmental financial and banking supervision agencies can quickly switch from their current detail-obsessed, extremely complex regulation and control of all possible banking and market risks to the monitoring of financial platforms. Unlike banking legislation, consumer and data protection laws have the highest priority in web-based financial intermediation.

The worst thing that could happen would be for Europe to try to impose existing banking and financial legislation on the platforms. In doing so, Europe would miss its chance to provide a counterweight, at least in the financial market, to the U.S. dominance in IT driven platform business and in social media with its own European platform companies (banks or non-banks). Neither technological progress nor the economic benefits can be stopped. The only question is whether Europe has the courage to play a pioneering role or whether it prefers to follow global developments after they have happened.

REFERENCES

- Benes, J. and M. Kumhof, 2012, The Chicago Plan Revisited, IMF Working Paper, WP12/202
- Buttiglione, L., P. R. Lane, L. Reichlin, and V. Reinhart, 2014, "Deleveraging? What deleveraging?" Geneva Reports on the World Economy, No. 16
- Checherita, C., and P. Rother, 2010, "The impact of high and growing government debt on economic growth: an empirical investigation for the euro area," ECB Working Paper No. 1237
- Cœuré, B., 2014, "On the optimal size of the financial sector" speech in: http://www.ecb.europa.eu/press/key/date/2014/html/sp140902.en.html, accessed on 31.03.2015
- De Grauwe, P., and D. Gros, 2009, "A new two-pillar strategy for the ECB," CESifo Working Paper No. 2818
- Deutsche Bundesbank, 2014, "Ertragslage und finanzierungsverhältnisse deutscher unternehmen im Jahr 2013," monthly report, December, 37-48
- Deutsche Bundesbank, 2014, Finanzstabilitätsbericht 2014
- Deutsche Bundesbank, 2015, Statistische beihefte bankenstatistik, January
- Economist, 2015, "Global banks, A world of pain," volume 414, No., 8928, March 7th
- European Banking Authority, 2015, "Opinion of the European Banking Authority on lending-based crowdfunding," EBA/Op/2015/03, London
- European Commission, 2003, Regulation (EC) No 1745/2003, European Central Bank, September 12, 2003 on the application of minimum reserves (ECB/2003/9) Brussels.
- European Commission (2015), "GRÜNBUCH, Schaffung einer Kapitalmarktunion," CM(2015) 63 final, Brussels
- European Central Bank, 1998, "The quantitative reference value for monetary growth," press release, December 1, Frankfurt
- European Central Bank, 2003, Monthly bulletin, June
- European Central Bank, 2014, "Survey on the access to finance of small and medium-sized enterprises in the Euro-Area (SAFE), October 2013 to March 2014," April
- European Central Bank, 2015, "ECB announces expanded asset purchase program," press release, January 22
- Gambacorta L., J. Yang, and K. Tsatsaronis, 2014, "Financial structure and growth," BIS Quarterly Review, March, S. 21-35
- Gali, J., 2010, "The monetary pillar and the great financial crisis. ECB (Hrsg.), the great financial crisis, lessons for financial stability and monetary policy," An ECB colloquium held in honor of Lucas Papademos, May, S. 74 – 95
- Haldane, A. G., 2012, "The dog and the Frisbee," speech given at the Federal Reserve Bank of Kansas City's 36th economic policy symposium, "The changing policy landscape," Jackson Hole, Wyoming
- Jarchow, H.-J. and P. Rühmann, 1984, Monetary foreign trade, II. Internationale Währungspolitik, Göttingen
- Kumar, M. S., and J. Woo, 2010, "Public debt and growth," IMF Working Paper 10/174
- Mayer, T., 2014, Die neue Ordnung des Geldes: Warum wir eine Geldreform brauchen, Munich
- McLeay, M., A. Radia, and R. Thomas, 2014, "Money creation in the modern economy," Bank of England Quarterly Bulletin 2014, Q1, 14–27
- Öztürk, B., and M. Mrkaic, 2014, "Access to finance by SMEs in the Euro Area – what helps or hampers, IMF Working Paper, WP/14/78"
- Reinhart, C. M., V. R. Reinhart, and K. S. Rogoff, 2012, "Public debt overhangs: advanced-economy episodes since 1800," Journal of Economic Perspectives 26:3, S. 69-86
- Veit, O., 1969, Grundriss der währungspolitik, 3rd edition, Frankfurt a. M.
- Wardrop, R., B. Zhang, R. Rau, and M. Gray, 2015, "Moving mainstream, the European alternative finance benchmarking report," University of Cambridge and EY, London
- Wolf, M., 2014, The shifts and the shocks: what we've learned - and have still to learn – from the financial crisis, London

Banks Versus FinTech: At Last, it's Official

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Abstract
In recent years, we have witnessed a substantial amount of discussion, but little empirical evidence, about the threat that financial technology ("FinTech") firms pose to the established banking sector. We seek to contribute such evidence by analyzing explicit mentions of competition from FinTech in U.S. banks' annual reports. Surprisingly, there were no such mentions prior to 2016. We identify 14 banks that acknowledge being threatened by FinTech companies. These banks represent only 3% of the banking sector by count but nearly a third of its assets. While this FinTech-mentioning group is skewed toward large banks, its characteristics and valuation differ little from those of other banks of comparable size. On the other hand, there is some evidence that banks that have expressed concern about FinTech competition are more likely to be involved in the FinTech space themselves. Overall, banks that have formally voiced their concern about FinTech competition seem, if anything, to be better equipped to weather it.

1 We are grateful to Frank Dierick, David Le Bris, Yuliya Snihur, and Maxim Zagonov for comments. All errors are ours.

INTRODUCTION

Interest in financial technology, or "FinTech," has been growing almost exponentially since the last financial crisis. It has been accompanied by predictions of severe disruption of traditional banking. Headlines such as "Banks are right to be afraid of the FinTech boom" [Hart (2015)] have become commonplace. Concern has also come directly from bank executives. In a widely quoted comment, JP Morgan's CEO James Dimon said in early 2014 "[w]hen I go to Silicon Valley… they all want to eat our lunch. Every single one of them is going to try" (Krouse, 2014). The Economist (2015) states that 54% of the senior bankers it surveyed believe that "banks are not meeting the challenge" posed by FinTech. More recently, PWC (2016, p.19) reports that 95% of the banks that it surveyed "believe that part of their business is at risk of being lost to standalone FinTech companies." Given such sentiment, one would expect FinTech disruption risk to feature prominently in risk disclosures among U.S. banking institutions, and to have done so for some time.

In this study, we examine explicit references to potential competition from FinTech in annual SEC filings of U.S. bank holding companies (for brevity, we use this term interchangeably with "banks"). Surprisingly, only 14 banks, or 3% of the total, acknowledge FinTech as a competitive risk – a far cry from the majority of bankers that express concern in anonymous surveys. No less remarkably, not a single one of these 14 banks formally considered FinTech to be a competitive risk prior to 2016.

Are the 14 banks particularly vulnerable to the FinTech threat, as taking the disclosure at face value would suggest, or are they simply more aware of it? Does it make a difference whether a bank discusses the FinTech threat explicitly or implicitly? While definitive answers to these questions are elusive, some preliminary insights can be gleaned from the data.

BACKGROUND

All public U.S. corporations are required to file annual reports by the Securities and Exchange Act of 1934. Since the 1990s, these reports have had to be filed electronically through the so-called Form 10-K.[2] Competition the company faces is typically discussed either in Item 1 ("Business description") or in Item 1A ("Risk factors"). In Mirakhur's (2011) random sample of 122 filings, 83% included a discussion of competitive risks. Campbell et al. (2014) found risk disclosure to be informative of actual firm risk levels. Johnson (2010) states that the SEC had been pushing for greater specificity in risk factor disclosure. IRRC Institute's (2016) study of risk disclosures reports that "competition, global market factors and regulatory matters are the most common risks cited by all companies but are often discussed generically. This suggests an opportunity for companies to reconsider existing generic discussions" (p. 3). Cohen et al. (2016) show that firms are very slow to change the wording of their quarterly and annual SEC filings – but when they do so, the changes are highly informative (especially in "Management discussion and analysis" (MD&A) and "Risk factors" sections).

Technology has always played an important part in the financial services industry, be it the arrival of the internet, the telephone, or the telegraph [Garbade and Silber (1978)]. In recent years, technology-driven innovation in finance has accelerated to a point where the terms "financial technology" or "FinTech" are commonly understood to be shorthand for technological innovations in finance and/or for the business sector comprised of firms that enable such innovations.[3] Accordingly, the term "FinTech" has become accepted within the banking industry as well, with numerous senior industry figures employing it in speeches and interviews.[4] In light of this, and with numerous reports and surveys pointing to FinTech having the potential to disrupt traditional banking, one could expect banks' risk disclosure to address FinTech competition by its name.

THE CHARACTERISTICS OF FINTECH-WARY BANKS

We start our investigation by identifying all depository institutions (i.e., corporations whose standard industrial codes (SICs) start with "60") whose 10-K filings from 2013 onward mention the term "financial technology" or "FinTech." We retain those filings where the above terms occur i) in Item 1A ("Risk factors") or ii) under the

2 According to the SEC, "The annual report on Form 10-K provides a comprehensive overview of the company's business and financial condition and includes audited financial statements. Although similarly named, the annual report on Form 10-K is distinct from the "annual report to shareholders," which a company must send to its shareholders when it holds an annual meeting to elect directors." (https://www.sec.gov/answers/form10k.htm)

3 It is a little-known fact that the earliest mention of the term "FinTech" in a peer-reviewed journal far predates its mention in the popular and business press. Bettinger's (1972) report in Interfaces starts as follows: "Over the last four years Manufacturers Hanover Trust Company's Operations Research Department has developed approximately 100 models that are currently used throughout the bank. A group of 40 models has been set aside and designated as FinTech. **FinTech is an acronym which stands for financial technology, combining bank expertise with modern management science techniques and the computer**" (our emphasis). While this decades-old definition has unmistakable parallels with common understanding of today's FinTech sector, modern academic journals have yet to embrace FinTech as a distinct field of study. It also is interesting to note that Manufacturers Hanover was one the constituent parts of today's JP Morgan. For more detail about FinTech, see Gardiner (2016). For a broad historical perspective on FinTech, see Goetzmann (2016).

4 Note also that American Banker magazine's "FinTech 100" survey was first published in November 2004.

Ticker	Company	State	CIK	MV ($m)	Assets ($m)	Rank	Employees	MV/Assets	MV/Emp
BK	Bank of New York Mellon Corp.	NY	1390777	45,367	385,303	5	50,300	0.118	0.902
BBT	BB&T CORP	NC	92230	28,028	186,814	9	33,400	0.150	0.839
BNCL	Beneficial Bancorp Inc.	PA	1615418	923	4,752	114	830	0.194	1.111
STL	Sterling Bancorp	NY	1070154	1,070	7,337	81	836	0.146	1.279
CSBB	CSB Bancorp INC/OH	OH	880417	58	621	351	186	0.094	0.313
UNB	Union Bankshares Inc.	VT	706863	106	624	350	186	0.170	0.569
FIBK	First Interstate Bancsystem	MT	860413	1,274	8,610	68	1,705	0.148	0.747
UBSI	United Bankshares Inc./WV	WV	729986	2,595	12,329	56	1,703	0.210	1.524
HBK	Hamilton Bancorp Inc./MD	MD	1551739	47	303	404	58	0.154	0.803
CFBK	Central Federal Corp.	OH	1070680	19	316	402	62	0.061	0.311
HBNC	Horizon Bancorp/IN	IN	706129	241	2,077	186	448	0.116	0.538
BMTC	Bryn Mawr Bank Corp.	PA	802681	431	2,247	176	444	0.192	0.971
HBAN	Huntington Bancshares	OH	49196	8,537	66,298	21	11,873	0.129	0.719
KEY	Keycorp	OH	91576	11,946	93,821	18	13,853	0.127	0.862
IBKC	IberiaBank Corp.	LA	933141	2,169	15,759	48	2,825	0.138	0.768
MBFI	MB Financial Inc./MD	IL	1139812	2,457	14,602	53	2,839	0.168	0.865
JPM	JPMorganChase & Co.	NY	19617	232,471	2,573,126	1	241,359	0.090	0.963
BAC	Bank of America Corp.	NC	70858	188,141	2,104,534	2	223,715	0.089	0.841
PNC	PNC Financial Services Group Inc.	PA	713676	47,713	345,072	6	53,587	0.138	0.890
USB	U.S. Bancorp	MN	36104	80,275	402,529	4	66,750	0.199	1.203
SIVB	SVB Financial Group	CA	719739	5,911	39,345	23	1,914	0.150	3.088
COLB	Columbia Banking System Inc.	WA	887343	1,586	8,579	69	1,844	0.185	0.860
UMBF	UMB Financial Corp.	MO	101382	2,590	17,501	43	3,592	0.148	0.721
FULT	Fulton Financial Corp.	PA	700564	2,212	17,125	44	3,560	0.129	0.621
UMPQ	Umpqua Holdings Corp.	OR	1077771	3,745	22,613	34	4,569	0.166	0.820
SNV	Synovus Financial Corp.	GA	18349	3,688	27,051	29	4,511	0.136	0.817
ZION	Zions Bancorporation	UT	109380	5,788	57,209	22	10,462	0.101	0.553
CMA	Comerica Inc.	TX	28412	8,385	69,190	20	9,115	0.121	0.920

This table gives the identities and characteristics of our sample and control banks. Sample banks are unshaded. Each sample bank is followed by its matching control bank (shaded). Sample banks are U.S. headquartered public companies whose SIC begins with "60" and which explicitly refer to competition from the FinTech sector in a 10-K filing. Control banks do not explicitly refer to competition from the FinTech sector, but are otherwise similar to sample banks. Specifically, for each bank in our sample, we identify its control bank as another U.S. headquartered bank with the same 4-digit SIC for which a 10-K form with completed Item 1 and Item 1A is available for the most recent fiscal year, and with the closest number of employees to that of the sample bank. All data are from Compustat as of the end of the 2014 fiscal year.

Table 1 – Descriptive statistics of sample and control banks

heading "Competition" or iii) in the same or the following sentence as a word including the string "compet" (such as "competes," "competition," or "competitive") but not "competen" (such as "competent" or "competence").

Our final sample comprises 14 banks, representing 3% of the population of U.S. listed bank companies. All of these banks explicitly mention competition from FinTech in their 2016 filings, and not in the previous years. These banks are listed in the left column of Table 1. Further, for each of these banks, we scan their 2016 and the previous year's 10-K filings for indirect mentions of competition with financial technology companies. To do so, we follow the same criteria as described in the paragraph above, but replace the search terms "FinTech"/"financial technology" with "online"/"internet"/"e-commerce"/"technology."[5]

5 The relevant text is presented in Appendix 1 of www.fintxt.com/s/FinTech.pdf

Although our sample is small, we nonetheless will seek to understand whether officially FinTech-wary banks are different from their peers. To this end, we construct a peer group of comparable banks to use as a benchmark. Specifically, we first identify, using the Compustat database, the eligible population of U.S.-headquartered depository institutions with SEC filings in 2015 and 2016: this results in a total of 418 banks. Then, for each bank in our sample, we identify its control bank as the bank with the same 4-digit SIC and with the closest number of employees[6] to that of the sample bank. We then scan their most recent and previous years' 10-K filings for mentions of technology and competition in the same manner as we did for sample banks, and record the relevant text.[7]

Table 1 presents our 14-bank sample together with the 14 matching banks. For each bank, it shows its identifying information: its stock ticker, name, state of incorporation, and its SEC-assigned central index key (CIK). It also shows bank characteristics as of the end of the 2014 fiscal year, obtained from Compustat: market value, assets, and the full-time equivalent number of employees. Additionally, it presents the bank's rank by assets within the group of 418 banks meeting our eligibility criteria,[8] and the ratios of the bank's market value to its assets and to its employee count.

The distribution of FinTech mentions by bank size is heavily skewed toward larger banks. Three of our 14 banks are among the six largest by assets: JPMorgan (1st), PNC (5th), and Bank of New York Mellon (6th). The other eleven are substantially smaller, with none exceeding U.S.$100 billion in assets or U.S.$10 billion in market capitalization. However, these banks are still large relative to the 418-member U.S. banking sector as defined in our study: only two (CSB and Hamilton) are in the bottom quartile by assets, two (Beneficial and Horizon) are in the second quartile, and the remainder of the sample (which includes Huntington, Zions, SVB, Umpqua, UMB, IberiaBank, and First Interstate) are all in the top one-sixth.

Looking at bank size another way, the distribution of FinTech-mentioners is quite intriguing. 30% of the top ten banks by assets have admitted to being exposed to FinTech risk, as did 7% of the next 100 banks – and only 1% of the remaining 308 banks. On the surface of it, one could argue that bigger banks have less to worry about as they have greater resources with which to resist competition from FinTech – whether through competing with FinTech firms for talent, signing partnership agreements with them, or even buying them outright. By contrast, smaller banks are often considered to be particularly vulnerable [Antonakes (2015), Arora (2015)]. Perhaps the greater likelihood of large banks acknowledging competition from FinTech simply reflects their greater familiarity with that sector rather than their greater fear of it – with possible clues to be found in the banks' own words and in their actions.

WHAT DO BANKS ACTUALLY SAY ABOUT FINTECH?

Beyond the mere fact of banks mentioning FinTech by name, it is informative to examine these mentions in context. Six of the 14 banks in our sample simply mention FinTech as part of a list of competitor types ranging from five (CSB Bancorp, Umpqua Bank) to 18 (JPMorgan) in number. The other eight banks make an effort to explain how they are threatened by FinTech. These points are generally widely known, such as PNC's "banks generally are facing the risk of increased competition from products and services offered by non-bank financial technology companies, particularly related to payment services." Two excerpts, however, evoke lesser-known aspects of the bank-FinTech dynamic. Thus, Horizon Bank raises the possibility of competing with FinTech companies for talent, while IberiaBank suggests that trying to keep up with FinTech firms could result in an increased likelihood of cyber-attacks.

The prize for the depth of disclosure with respect to FinTech competition would have to go the pioneer. Huntington Bancorp, the first-ever U.S. depository institution to mention FinTech in its annual report, also goes the furthest in discussing its competitive strategy in this regard: "we are monitoring activity in marketplace lending along with businesses engaged in money transfer, investment advice, and money management tools. Our strategy involves assessing the marketplace, determining our near term plan, while developing a longer term approach to effectively service our existing customers and attract new customers. This includes evaluating which products we develop in-house, as well as evaluating partnership options where applicable."

Interestingly, Hamilton Bancorp, by far the smallest and the most recent filer, comes the closest to Huntington in deviating from boilerplate language in discussing FinTech and provides perhaps the most revealing disclosure of all: "They offer user friendly front-end, quick turnaround times for loans and other benefits. While Hamilton is evaluating FinTech companies with the possibility of developing relationships for efficiency in processing and/or as a source of loans and other business, we cannot limit the possibility that our customers or future prospects will work directly with a FinTech company instead." It will be interesting to see whether Hamilton's text foreshadows much more widespread and informative discussion of FinTech in the next filing season.

6 We use the number of employees because it is a reasonable proxy for bank size and the data are consistently available on Compustat.

7 The relevant text is presented in Appendix 1 of www.fintxt.com/s/FinTech.pdf

8 Note that Citigroup, for example, has Standard Industry Code of 6199 (which otherwise mainly includes closed-end funds and ETFs) and as such is not in our eligible population. For the record, Citigroup does not mention FinTech in its 10-K statements.

We also note that whereas five of the banks mention FinTech competition in the "Risk factor" (Item 1A) section of the annual report, seven do so under "Business description" (Item 1), one under MD&A (Item 7), and one in its the letter to shareholders.

Lastly, comparison with previous year's filings shows that overwhelmingly the FinTech-related text has been an addition to rather than replacement of earlier text. In other words, these banks have tended to talk about technology competition risk already, but in 2016 they added specificity with their FinTech mentions.

WHAT DO CONTROL BANKS SAY ABOUT THE COMPETITIVE IMPACT OF TECHNOLOGY?

Since control banks, while presumably operating in a similar competitive environment to that of sample banks, did not mention FinTech, this raises the question: did they eschew the topic altogether, or did they simply phrase things differently? After all, as Shakespeare's Juliet noted, "that which we call a rose by any other name would smell as sweet."

Examining the relevant text shows that the three top-ten banks in our control group prepared disclosures that were indeed informative about the threat from FinTech in spite of not mentioning the term directly. Thus, BB&T, the 9th largest bank by assets, is unmistakably speaking of FinTech in spite of omitting the term itself: "technology companies have begun to focus on the financial sector and offer software and products primarily over the Internet, with an increasing focus on mobile device delivery. These companies generally are not subject to the comparable regulatory burdens as financial institutions and may accordingly realize certain cost savings and offer products and services at more favorable rates and with greater convenience to the customer. For example, a number of companies offer bill pay and funds transfer services that allow customers to avoid using a bank. Technology companies are generally positioned and structured to quickly adapt to technological advances and directly focus resources on implementing those advances." The same can be said of Bank of America (the second largest by assets), which writes that "technological advances and the growth of e-commerce have made it easier for non-depository institutions to offer products and services that traditionally were banking products, and for financial institutions to compete with technology companies in providing electronic and internet-based financial solutions including electronic securities trading, marketplace lending, and payment processing." Similarly, U.S. Bancorp, the third largest by assets, mentions competition from "technology companies" and elsewhere warns of "innovative ways that customers can make payments or manage their accounts, such as through the use of digital wallets or digital currencies."

In a more limited way, Union Bankshares mentions "competition by out-of-market competitors through the internet" and Fulton notes that some of its competitors "conduct business primarily over the internet," although they do not offer more detail. Along similar lines, Bryn Mawr speaks of "on-line banking enterprises" and Columbia of "Internet-based banking institutions." Internet banks, however, are not synonymous with financial technology companies, and it is not clear that the phrasing of these disclosures would help their readers grasp the breadth of the potential threat that these banks face from FinTech.

Sterling, United Bankshares, Central Federal, Keycorp, Synovus, and Comerica offer boilerplate language such as "The financial services industry is undergoing rapid technological change" and "some of our competitors have substantially greater resources to invest in technological improvements" but, unlike the two categories of banks above, do not specifically warn their investors about the possible impact of new entrants in the financial technology space – the phrasing they use could be referring to competition from better funded and/or more tech-savvy traditional banks.

Lastly, our textual filters have not identified any technology competition-relevant text for MB Financial, even though this bank, according to its 10-K filing, offers both internet and mobile banking to its customers. We note that with the exception of BB&T, which significantly expanded its discussion since the previous filing, there has been virtually no change in the relevant passages of the other control banks.

The takeaway from the above textual comparison of sample and control banks is nuanced. Among top-ten banks, it is hard to argue that those citing FinTech by name offer much more informative warnings about the threat they are facing from technology firms than do their non-FinTech-citing counterparts. Smaller banks, on the other hand, clearly do a better job of informing their investors about this threat when they specifically mention FinTech. This suggests that the choice to mention FinTech explicitly is more than just a question of semantics.

BANKS' FINTECH-RELATED ACTIONS

Actions speak louder than words, so a natural way to assess banks' FinTech-awareness is to examine their past actions in the FinTech space. However, doing so thoroughly is a non-trivial undertaking. For example, former S&P President, Deven Sharma, categorizes possible FinTech-facing actions by a financial services incumbent as follows[9]: 1) create accelerator program for FinTech startups; 2)

9 See https://vimeo.com/getsmarter/review/172078632/239ed4ba11.

set up venture funds for FinTech companies; 3) partner with FinTech companies; 4) buy out FinTech startups; 5) launch own FinTech subsidiary; 6) create an industry consortium.

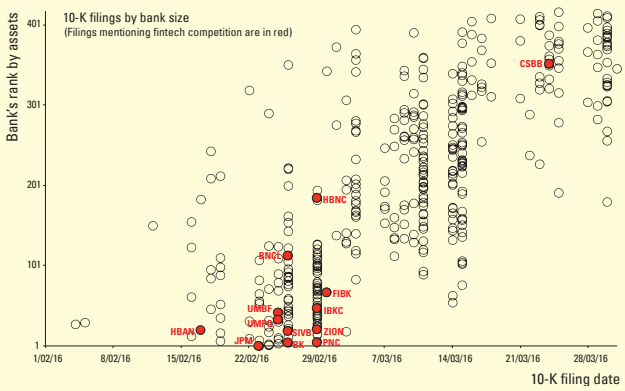
On these measures, our FinTech mentioners appear to be rather more proactive than non-mentioners. JP Morgan has launched a residency program for FinTech firms and is a partner in Financial Solutions lab that runs a FinTech competition, has invested in FinTech firms such as Motif, and formed a partnership with OnDeck. BNY Mellon has created several innovation centers, including in Silicon Valley. PNC (along with JP Morgan and several other leading financial institutions) invested in Digital Asset Holdings, a blockchain technology company subsequently named by Fortune as one the "five hottest FinTech companies."[10] SVB, which stands for "Silicon Valley Bank," after its geographical location, is historically innovation-focused, has equity investments in such FinTech companies as Lending Club and Nvoicepay, and hosts a FinTech conference. Umpqua is establishing a FinTech subsidiary, also in Silicon Valley.

By contrast, among control banks, the most notable FinTech activities are Bank of America's annual Innovation Summit in Silicon Valley and US Bancorp's and BB&T's participation in INV FinTech accelerator.

THE BANK THAT DIDN'T BARK

Of the top six U.S. banks by assets, we have so far examined five: three (JP Morgan, PNC, and BNY Mellon) are in our sample, and two (Bank of America and US Bancorp) are among the control banks. This leaves out Wells Fargo, the third largest – and a particularly curious case, given its well-known and far-reaching activity in the FinTech field through its FinTech Group, its accelerator, its participation in ClearXchange network, and numerous other initiatives. How does Wells Fargo, then, talk about FinTech competition in its annual report?

Surprisingly, the Business Description section contains only a passing reference to "online lending companies," while "Risk factors" offers boilerplate: "Continued technological advances and the growth of e-commerce have made it possible for non-depository institutions to offer products and services that traditionally were banking products, and for financial institutions and other companies to provide electronic and internet-based financial solutions, including electronic payment solutions." It is worth noting that the deeply FinTech-involved JP Morgan, in spite of its mention of FinTech, is similarly taciturn on the subject. It may be that particularly extensive ongoing involvement with the FinTech sector makes some banks feel less threatened by it or at least feel less need to officially express their concern.[11]



This figure shows the sequence of 10-K filings for the 384 filings that took place in February and March 2016. The filing date is on the horizontal axis, with the Monday of each week indicated. The bank's rank by assets (out of the eligible total of 418) is on the vertical axis. Banks whose filings explicitly refer to FinTech competition are indicated in red, with their stock ticker shown next to the data point.

Figure 1 – The timing of banks' 10-K filings with and without mentions of FinTech competition

THE TIMING OF FINTECH MENTIONS

Having discussed the nature of banks' disclosure on the subject of FinTech competition, it is worth addressing the suddenness with which banks began to acknowledge it by name in their annual reports. The fact that the number of officially FinTech-concerned banks went from zero to 14 in a single year is rather suggestive of copycat behavior in banks' decisions to mention FinTech. As a simple calculation, taking 3% as the probability of FinTech mentions (based on 14 mentioners out of 418 banks in the most recent 12-month period), if FinTech mentions were random then the chance that none of the 418 banks would have mentioned FinTech the year before is 0.97^{418}, or about three in a million.

10 See http://fortune.com/2016/06/27/five-hottest-FinTechs/.

11 Readers are free to form their own opinion on whether such insouciance is justified. We do note that CB Insights' striking "Unbundling of a bank" graphic (https://www.cbinsights.com/blog/disrupting-banking-FinTech-startups-2016/) is based on a screenshot of Wells Fargo's online service. Wells Fargo's well-known aggressive focus on sales means it has both more to gain from successfully taking on or co-opting FinTech firms, and more to lose if it fails to do so. The sudden collapse of its partnership with Amazon in an attempt to take on FinTech student loan lenders (http://www.wsj.com/articles/wells-fargo-amazon-end-student-loan-partnership-1472681989) is an indication that even for a bank of its resources and know-how, there are obstacles in implementing FinTech-like solutions.

The above insight makes it interesting to examine the sequence of FinTech mentions in more detail. To aid in this, Figure 1 focuses on 10-K filings in February and March 2016, the period when 92% of the eligible 10-Ks were filed, including those by all but one of the FinTech-mentioning banks (as pointed out earlier, Hamilton's filing took place in June of this year). Specifically, the chart plots the filing bank's rank by assets (so that largest banks are at the bottom) against the day of the filing. Banks that mentioned FinTech are marked in red.

Several things stand out immediately. First, regardless of FinTech mentions, larger banks file earlier in the season. Second, as discussed previously, banks that mention FinTech tend to be larger. Third, with the exception of the tiny CSB, all the filings took place in the span of less than two weeks, from 17 February through 1 March 2016, having stopped (or at least paused) even more suddenly than they started.

The first-ever mention of a competitive threat from FinTech on 17 February 2016 was by one of the first ten filers of the season: Huntington, a 150-year-old institution headquartered in Columbus, Ohio, and ranking only 21st by assets. Why would Huntington be the first bank in the nation to officially raise the issue of competition from FinTech? A possible clue lies in its acquisition of FirstMerit, another Ohio bank with smaller assets but an even longer history, which Huntington announced three weeks earlier and which was largely motivated by geographic synergies. It is conceivable that the FinTech threat would have come up as an issue during merger discussions and/or due diligence work and as a result attracted senior management's attention – perhaps sufficiently so to make Huntington the first bank to acknowledge competition from FinTech in a 10-K filing. On the other hand, the depth of Huntington's FinTech-related disclosure suggests that it may have been seriously contemplating the FinTech landscape for some time.

Whatever was Huntington's motivation, it was shared by none of the following 16 filers. This changed on February 23rd, when one of the seven banks filing that day did mention financial technology companies as competitors – and that bank was none other than JPMorgan, the nation's largest bank and one whose CEO's concern about FinTech competition had made a considerable impression on the media and, arguably, on the industry back in 2014. It is not entirely clear why JPMorgan did not concede the threat of FinTech competition in its February 2015 10-K filing, given that its CEO did so publicly, albeit in different words, almost a year earlier. It does seem possible, however, that JPMorgan's passing mention of FinTech competition in its February 2016 filing had something to do with Huntington's earlier declaration, and with JPMorgan not wishing to fall a full year behind the disclosure pioneer. It is, of course, also possible that the timing was merely coincidental. But the subsequent sequence of ten FinTech mentions over the following one-week stretch (out of 86 total filers) seems likely to have been triggered, at least in part, by JPMorgan's precedent.

From March 2nd until the 31st, however, only one of the 258 filers mentioned FinTech. Why? One possibility is that, once the dust settled, it became clear that although several of the nation's largest banks indeed followed Huntington's and JP Morgan's lead, many did not. Yet this does not satisfactorily explain the extreme reticence of post-March 1st filers to mention FinTech. Another possible reason is that, March filers being substantially smaller, they did not feel that the actions of large banks were of relevance to them. While CSB is an exception, it is tempting to conjecture that it may have taken its clue from Huntington, a dominant bank in CSB's region. But then why didn't other regional banks mentioning FinTech, such as Zions or IberiaBank, inspire local followers?

An alternative interpretation is that FinTech-mentioning banks are simply those that have existing or future FinTech activity on their mind. Viewed in this light, the clue to tiny Hamilton Bancorp's mention of FinTech is in the filing itself: it talks about possible collaborations with FinTech firms (and speaks about the sector in unmistakably positive terms). If so, and in the spirit of Cohen et al. (2016), these FinTech mentions will begin to make sense in the near future.

We stress that the above are no more than speculations about the mechanisms underlying the patterns we observe. New data and analyses may shed light on how accurate these speculations have been. In the meanwhile, we now attempt some preliminary analyses with the quantitative data we have at this time.

A QUANTITATIVE STUDY

Generally, an empirical researcher would be ill-advised to undertake a cross-sectional analysis with only 14 observations. As data availability leaves us no choice, we undertake this exercise nonetheless, in order to try and glean some early insights into the bank-FinTech dynamic. To do so, in Table 2 we present a number of characteristics for 1) 14 sample banks, 2) 14 control banks, and 3) all 418 banks, and we report on differences between the first group and the other two.

The first few rows of Table 2 focus on the full-time equivalent number of employees, with the medians of 3,209 and 3,200, respectively, for sample and control banks being very close. This is not surprising, since sample and control banks were matched on the employee count. Accordingly, parametric and non-parametric tests for differences between sample and control banks' employee counts produce insignificant p-values. By contrast, and as noted earlier, the

		Banks			Differences			
		Sample	Control	All	Sample - Control		Sample - All	
Employees	**median**	3209	3200	354	9	**0.385**	2855	**0.000**
	average	27408	25916	3580	1492	**0.474**	23828	**0.000**
	N	14	14	411				
	% of total	26.1	24.7	100.0				
Assets (U.S.$ mln)	**median**	20057	15863	1595	4194	**0.761**	18462	**0.000**
	average	252756	210507	26589	42249	**0.265**	226167	**0.000**
	N	14	14	418				
	% of total	31.8	26.5	100.0				
MV (U.S.$ mln)	**median**	3168	2526	226	642	**0.808**	2942	**0.000**
	average	25488	23638	3217	1850	**0.672**	22271	**0.000**
	N	14	14	406				
	% of total	27.3	25.3	100.0				
MV/Employees	**median**	786	861	728	-75.6	**0.865**	58.1	**0.047**
	average	924	892	621	32.4	**0.391**	302.9	**0.135**
	N	14	14	401				
MV/Assets	**median**	0.138	0.148	0.132	-0.010	**0.268**	0.006	**0.473**
	average	0.135	0.149	0.125	-0.014	**0.298**	0.009	**0.877**
	N	14	14	406				
Monthly stock return	**average 2013**	3.13%	2.92%	2.93%	0.21%	**0.508**	0.19%	**0.638**
	average 2014	0.57%	0.65%	0.68%	-0.08%	**0.787**	-0.11%	**0.849**
	average 2015	0.43%	0.55%	1.09%	-0.12%	**0.681**	-0.66%	**0.321**
	average 2013-15	1.38%	1.35%	1.53%	0.03%	**0.972**	-0.16%	**0.529**

This table shows the key characteristics of sample and control banks, as well as of the population of U.S. banks. Eligible banks are U.S. headquartered public companies whose SIC begins with "60" and which filed a 10-K report between July 2015 and June 2016 inclusive. Mcap (market capitalization), Employees (the full-time equivalent number of employees), and Assets (total assets) are from Compustat as of the end of the 2014 fiscal year. Monthly returns are from CRSP. Comparisons of means (respectively, medians) for descriptive variables are followed in bold by t-test (respectively, signed-rank test) p-values. Comparisons of average monthly returns are followed by Fama-Macbeth p-values.

Table 2 – Key characteristics of sample banks, control banks, and the U.S. bank population

population of banks from which our sample and control banks are drawn tends to have banks whose employee count is an order of magnitude smaller.

Similar patterns hold for banks' assets and market values: no significant difference between sample and control banks, but sample banks are much larger than the bank population on average (or median).

A crude but potentially effective way to assess how investors value banks that mention FinTech competition is to examine the ratio of market value to fundamental variables such as employee count and assets. As the next rows of Table 2 show, differences between sample and control banks continue to be insignificant, although this may be due to the small sample size. While market value per employee is significantly higher for sample banks as compared to the bank population, this may be due to economies of scale in the banking sector, since sample banks tend to be larger – and in fact this ratio is even higher for our size-matched control group.

Lastly, we compare monthly stock returns for all three groups of banks for the last three calendar years individually and taken together. All differences are insignificant, although once again the small sample size would naturally make any differences difficult to detect.

While the table is rich in numerical content, its main takeaways are straightforward. Although FinTech-mentioning banks are significantly different from the bank population, notably in being larger, their

stock market-derived attributes (such as valuation ratios and stock performance) are quite similar to those of their peers of comparable size. In other words, whether mentioning FinTech competition is a reflection of an innovative streak in a bank's DNA or of its genuine vulnerability in the face of such competition, these have yet to manifest themselves in a prominent way in the banks' valuations.

CONCLUSION

Having emerged in the wake of the 2008-2009 financial crisis, the FinTech sector has been increasingly attracting attention, investment, and customers ever since. Remarkably, it is only this year that U.S. banks first began to acknowledge formally competition that they are facing from FinTech. In this paper, we examine the composition of the pioneering group of officially FinTech-wary banks, as well as the timing and the nature of their disclosure and the stock market's perception of them. We propose some plausible clues explaining the composition and the timing, although much about both remains puzzling. The sample banks' disclosure is limited, although generally superior to that of comparable banks that do not mention FinTech; and (consistently with small sample size) there is no evidence that FinTech mentions are correlated with stock market valuation or performance. Overall, our investigation into the inaugural year of FinTech mentions in banks' annual reports points less to systematic patterns than to industry members taking cues from one another as to whether they should be admitting to being vulnerable to competition from FinTech firms (or, conversely, to implicitly boast about being part of the FinTech "in" crowd). This behavior may be a reflection of larger uncertainty about future competitive interaction between traditional banking and FinTech.

Our study also carries an important message for the SEC.[12] While privately the majority of bankers acknowledge the seriousness of the FinTech threat, only a small proportion do so in their annual reports, despite being compelled by SEC regulations to disclose important risks, and to do so in plain English. Is most banks' failure to mention FinTech risk a sign that the SEC's disclosure requirement lacks bite? One possible reason why a bank might not mention FinTech explicitly could be a belief that a general mention of potentially disruptive technologies would be sufficient. However, given that the terms "financial technology" and "FinTech" have become ensconced in the business lexicon (and "FinTech" has even entered the Oxford English Dictionary), avoidance of their use may appear to be at odds with the SEC's "plain English" directive.[13] An alternative explanation could be banks' belief that, on the contrary, FinTech competition risk is too generic to merit a mention, in that it is potentially applicable to all firms in the industry. The same, however, also applies (for example) to interest rate risk, which is explicitly addressed in most banks' 10-K filings. Perhaps a more plausible explanation is the notion that many bank managers feel that by being among the first to acknowledge officially the threat from FinTech, they signal to investors that they are particularly defenseless on that front. Still another possibility is that many banks may hold the view that standalone FinTech firms are not viable in the long run and will become absorbed by incumbent financial institutions. Such banks could view themselves as being vulnerable to FinTech-incited disruption without necessarily regarding FinTech firms as competitors.

Our examination of the initial, small cohort of banks to recognize formally the threat posed by FinTech can necessarily give only preliminary clues as to what sets these banks apart, and what the future will hold for them. Is it that they are especially vulnerable in the face of this threat after all, and will this be reflected in subsequent poor performance? Or are they unusually prescient, and as such will exhibit greater adaptability and resilience, accompanied by strong financial results? And, indeed, will the performance of the FinTech sector justify the concerns of our cohort of officially apprehensive banks? Will disclosures about FinTech competition continue to spread through banks' annual reports? If so, to which banks? Will most banks copy or adapt others' formulations, or will disclosures become increasingly informative? The coming years promise to shed much light on these and many other aspects of the evolving relationship between traditional banking and the FinTech sector.

REFERENCES

- Antonakes, Steven L., 2015, FinTech threatens small banks more than crisis ever did, American Banker, November 24, 2015, http://www.americanbanker.com/bankthink/FinTech-threatens-small-banks-more-than-crisis-ever-did-1077964-1.html
- Arora, Rahit, 2015. FinTech: An existential threat to community banks, Forbes, August 15, 2015, http://www.forbes.com/sites/rohitarora/2015/08/25/FinTech-an-existential-threat-to-community-banks/
- Bettinger, Abraham Leon, 1972. FinTech – A Series of 40 Time Shared Models Used at Manufacturers Hanover Trust Company, Interfaces 2(4), 62-63.
- Campbell, John L., Hsinchun Chen, Dan S. Dhaliwal, Hsin-min Lu and Logan B. Steele, 2014. The information content of mandatory risk factor disclosures in corporate filings, Review of Accounting Studies 19, 396-455.
- Cohen, Lauren, Dong Lou, and Quoc H. Nguyen, 2016. Lazy prices, Working Paper, Harvard Business School.
- The Economist, 2015. The Disruption of Banking, http://www.economistinsights.com/sites/default/files/EIU-The%20disruption%20of%20banking_PDF.pdf

12 The SEC has increasingly been taking an interest in FinTech, most recently exemplified by its intention to hold a forum "to discuss FinTech innovation the financial services industry" (https://www.sec.gov/news/pressrelease/2016-195.html)

13 E.g., "[a] plain English document uses words economically and at a level the audience can understand" and "[w]here acronyms, such as REIT, are widely understood to the investing public, they can safely be used without creating confusion" [U.S. Securities and Exchange Commission (1998)].

- Garbade, Kenneth D. and William L. Silber, 1978, Technology, Communication and the performance of financial markets, 1840-1975, Journal of Finance 33, 819-832.
- Gardiner, Gareth, 2016. FinTech or internet: Which came first?, http://blog.kantox.com/FinTech-or-internet-which-came-first
- Goetzmann, William N., 2016. Loans without officers? Investment without investment banks? Welcome to FinTech, http://historynewsnetwork.org/article/163339
- Hart, Patricia, 2015. Banks are right to be afraid of the FinTech boom, Time Magazine, July 8, 2015, http://time.com/3949469/financial-technology-boom/
- IRRC Institute, 2016, The Corporate Risk Factor Disclosure Landscape, http://irrcinstitute.org/wp-content/uploads/2016/01/FINAL-EY-Risk-Disclosure-Study.pdf
- Johnson, Sarah, 2010. SEC pushes companies for more risk information. CFO Magazine, August 2, 2010, http://ww2.cfo.com/risk-compliance/2010/08/sec-pushes-companies-for-more-risk-information
- JP Morgan, 2015. 2014 Annual Report, http://files.shareholder.com/downloads/ONE/3844439630x0x820066/f831cad9-f0d8-4efc-9b68-f18ea184a1e8/JPMC-2014-AnnualReport.pdf
- Krouse, Sarah, 2014. Dimon sees threat from Silicon Valley, http://blogs.wsj.com/moneybeat/2014/02/25/dimon-sees-threat-from-silicon-valley/
- Mirakhur, Yatin, 2011. Risk disclosure in SEC corporate filings, Wharton Research Scholars Journal, Paper 85.
- PWC, 2016. Blurred lines: How FinTech is shaping financial services, available from www.pwc.com/FinTechreport
- U.S. Securities and Exchange Commission, 1998, A Plain English Handbook: How to Create Clear SEC Disclosure Documents, https://www.sec.gov/pdf/handbook.pdf

The Un-Level Playing Field for P2P Lending

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Abstract

This paper considers how regulation affects competition between traditional banks and new peer- to-peer (P2P or marketplace) lenders employing a platform-based business model to directly connect borrowers and investors. Such platform-based lending has the potential to dramatically reduce the need for banks to use their own equity capital to support credit risks and substantially increase the supply of credit to smaller and less credit worthy borrowers that are unable to directly access security markets. The impact of P2P lending has to date been quite modest, however, and may struggle to achieve the scale necessary to cover platform costs. For example, while P2P lenders have been active in the U.S. and the U.K. for more than a decade, they still hold less than 1% of the total stock of unsecured consumer lending and most platforms are losing money. P2P lending in other countries is still very much in its infancy. Only in the U.K. – not elsewhere – has P2P lending become an important source of loans for smaller companies. One reason for this modest market impact is that prudential regulation – in particular government sponsored and backed 100% insurance on all bank deposits under deposit insurance limits, even when held for investment rather than transaction purposes – gives banks a substantial advantage in the market for savings deposits, forcing P2P lenders to rely instead on unstable sources of wholesale funding and limiting their ability to compete with banks in the provision of consumer and small business loans.

INTRODUCTION

A wide range of "peer-to-peer" (P2P) financial platforms have emerged in the recent years, providing personal loans (Zopa, Prosper, Lending Club), small business lending (First Circle, Kabbage), invoice discounting (The Receivables Exchange, Market Invoice), and foreign exchange transactions (Currency Cloud, Currency Fair, Transferwise). The volume of these activities has grown rapidly from a relatively low base. For example, P2P lending in the U.K. has doubled every year over the past four years, with the stock of loans exceeding £1 bln in 2014 and £2 bln in 2015 [Peer-to-Peer Finance Assocation (2016)].

A number of commentators have suggested that the development of these new P2P platforms will overturn the existing organizational and institutional structure of banking, much as there has been disruptive transformation in other industries, such as in recorded music distribution, in telephony, or in air and travel reservations [King (2010)]. The perception that P2P lending can "reinvent" the bank has prompted ambitious projections of P2P lending growth over the next five to ten years (with a suggestion that the stock of lending taken from banks by P2P platforms could be as high as U.S.$1 tln globally [Moldow (2015)]). P2P or marketplace lending is also seen as a way of providing credit to a range of personal and small business borrowers inadequately served by conventional banks and, by removing the intermediary role of banks, providing much better returns than are available from bank deposits, especially in today's low growth low interest rate economic environment.

The purpose of this paper is to review the development of P2P lending (we do not investigate other forms of P2P finance such as alternative foreign exchange) and address the question of the appropriate comparative regulatory treatment of banks and P2P platforms when they compete for medium term finance to fund loan products with a corresponding medium term maturity. It raises the question of whether, as a result of the differential treatment of banks and P2P lenders by law and regulation in the U.K., the U.S., and other countries, these new lenders are competing on an "un-level" playing field, struggling to capture market share from banks. In particular, it is argued here that banks have an unfair advantage over P2P lenders because they are able to take term deposits with the benefit of a deposit insurance guarantee.

Banks provide essential financial services, the payments services that support all economic exchange and also – through maturity transformation – the opportunity for customers to realize value from investments in longer term assets. Banks are, therefore, closely regulated and further supported by government-sponsored deposit insurance schemes, both to protect customers who may not fully understand the risks taken by banks and to avoid disruption of payments in the event of a bank failure or a systemic banking crisis.

Providing this protection to bank customers does not, however, come without costs. Regulation of bank risk exposures may reduce the supply of credit to some bank customers. Taxpayers are exposed to risk through the provision of the bank safety net. The costs of regulatory compliance, especially capital requirements since the industry regards these as onerous, may be passed onto customers through a widening of interest rate spreads (lower deposit rates and higher loan interest rates) and – to the extent that regulation acts as a barrier to entry – inhibit competition and discourage innovation that would improve customer pricing and services. Protected by regulation, banks have little incentive to make the necessary steps and investments in information technology and bank systems to make their portfolios and the risks they take transparent to outsiders. Banks must be regulated to protect customers but not so heavily regulated that customers and taxpayers pay an excessive cost for this protection.

P2P lending also requires regulation, to ensure that investors who put money into P2P lending platforms as an alternative to an interest bearing bank deposit properly understand the risks they are taking and the prospective returns; and also that the platforms themselves are effectively run with minimal risk of operational problems that would impose unanticipated losses on customers.

Both banks and P2P lending platforms must be regulated. But is the development of P2P lending – and the opportunity this offers for increased competition with banks that will benefit both borrowers and investors – being handicapped by an unfair regulatory regime and level of protection relative to that enjoyed by banks? It will be argued that – especially to the extent that bank regulation allows banks to offer term-deposits protected by deposit insurance – there is indeed an un-level playing field in the competition between P2P lenders and banks. This imbalance can be corrected by removing or reducing deposit insurance on term deposits. This will moreover motivate banks to respond by developing their own platform-based lending products, in which term funding is obtained by shifting their loans off balance sheet and directly funding them through peer-to-peer investment in diversified loan pools. This will provide banks with welcome additional risk absorption that will substantially reduce their own need for capital and incentivize the transparent recording of loans in a manner that will facilitate orderly resolution of failing banks.

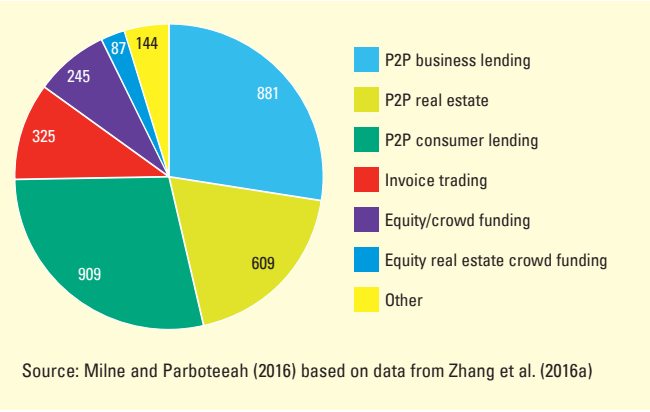
The paper is organized as follows. Section 2 presents a brief review of the development of P2P lending in the U.S., the U.K., and other countries. Section 3 discusses the regulatory response to P2P lending, as it has developed in the U.K., the U.S., and Australia from the perspectives of consumer protection, prudential safety, and competition policy, arguing that these responses have failed to treat banks and P2P lenders on a comparable basis. Section 4 concludes, with a short discussion of the practicalities of limiting current arrangement for bank deposit insurance to put banks on a more even footing with P2P lenders.

AN OVERVIEW OF P2P LENDING

This section provides a brief review of P2P lending, focusing on developments in the U.K. and the U.S. The analysis draws on a longer research paper [Milne & Parboteeah (2016)] and on various reports on the growth of the alternative finance sector by the Cambridge Centre for Alternative Finance [Wardrop et al. (2016); Zhang et al. (2016)]. It begins by reporting some of the available statistics on P2P lending. It then reviews the variations in business model used by platforms, including the allocation of investor funds and the assessment of the credit worthiness of borrowers.

The development of P2P lending

In recent years, the U.K. has witnessed rapid development of an active "alternative finance" sector, supplying loans and other types of funding outside of conventional banks or established financial markets. P2P lending – i.e., debt finance in which the platform or intermediary does not have to take on credit risk or open positions – accounts for more than three-quarters of this flow of alternative finance (Figure 1).



Source: Milne and Parboteeah (2016) based on data from Zhang et al. (2016a)

Figure 1 – The £3.2 billion alternative finance market in the U.K., 2015 (£ million)

Most of this P2P lending is provided by the members of the U.K. Peer-to-Peer Finance Association, which according to its website represents over 90% of the U.K. peer-to-peer and invoice trading market (see http://p2pfa.info/). The business models of their members vary considerably; two, Zopa and LendingWorks, provide only unsecured consumer loans, Funding Circle and ThinCats, in contrast, provide only unsecured lending to small businesses and lending secured on residential property. Two other platforms, LendInvest and Landbay, support only lending secured on property. RateSetter is the only platform supporting lending to all three categories of lending. While most attract retail investment, with the required minimum investment as low as £25.00, Market Invoice is for professional and wholesale investors only.

With the exception of Market Invoice, the other seven platforms all provide a simple and easy-to-understand portal for retail investors. Market Invoice, on the other hand, provides business lending secured on invoices (note there are a number of other invoice-lending finance companies in the U.K. that are not members of the P2P Finance Association). As Market Invoice makes clear on its website, they do not accept investment from retail lenders – instead all their investments come from sophisticated investors, such as asset managers, who are expected to understand fully the risks of this form of lending.

While these platforms account for the bulk of P2P lending in the U.K., there are many other providers. The U.K. regulator reports that as of March 2016, a total of 86 firms had applied for authorization as P2P platforms in the U.K. [FCA (2016)] and that 52 had full or interim authorization.

Table 1, using data from the P2P Finance Association, reports the 2015 share of the members of the association in the total flow of U.K. lending during the year to the three market segments in which they operate and in the end-year outstanding balance for all market segments (the association does not publish data on end-year balances by market segment). Even though P2P lending has been taking place in the U.K. for more than a decade, since the launching of Zopa in 2005, it still accounts for less than half a percent of the total balance of loans outstanding when combining these three lending segments.

Table 1 also reports the share of P2P lending measured on a flow basis (columns three through six). This allows the comparison to be made separately for each of the three market segments in the U.K. It is a tricky comparison to make, however, since lending flows go in both directions, first the initial loan then its subsequent repayment, and as a result the outcome is different according to whether the comparison is made on a gross or net basis. On the net flow basis shown in the table, P2P lending in 2015 was 3% of total unsecured consumer lending. It also appears to be a similar proportion of lending on buy-to-let property (3.6% with the caveat that the numerator and denominator used in this calculation are not entirely comparable, P2P lending including some other forms of property lending such as short-term bridge loans and finance of property development).

On this net flow basis, P2P lending to SMEs (invoice trading and unsecured business lending) is a comparatively high 12.6% of total lending including that by monetary financial institutions. But this figure has to be treated with caution. The net flow of P2P lending to businesses is relatively small (only £2.3 bln) but the denominator is also small because most bank lending to small business is repaid relatively quickly, within a few months (in the previous years the denominator was negative with substantial net repayment by SMEs to monetary institutions).

	Balance	Net lending flow, 2015 (£mln)				Number of:	
	End-2015 (£mln)	Unsecured consumer	SME	Secured on property (mainly buy-to-let)	Total	Lenders '000	Borrowers '000
Total P2P	2,155	456	332	246	1,033	128.3	273.6
All lenders	522,620	14,606	2,294	6,784	21,380		
P2P (% of total)	0.4%	3.0%	12.6%	3.6%	4.8%		

Notes. All P2P data were calculated from tables in the press releases of the U.K. Peer-to-Peer Finance Association (2016b, 2015a, b, c). The data on all lenders is computed by adding in lending data obtained from the Bank of England: BankStats Table 5.2 for stock and flow of consumer credit from monetary financial institutions (banks and building societies); BankStats Table A8.1 for the stock and flow of lending to small- and medium-sized enterprises (SMEs) by monetary financial institutions. Lending secured on property is calculated using Bank of England MLAR Table 1.33 to compute stock and flow for buy-to-let residential mortgage lending only and deducting P2P. We restrict comparison in this way because most U.K. P2P lending secured on property goes into the buy-to-let market, itself about 15% of total U.K. stock and flow of residential mortgage lending. All figures given here on lending flows are net of repayments.

Table 1 – P2P lending volumes compared with other credit markets in the U.K.

Another way of estimating the share of P2P business lending is to calculate its share of gross rather than net lending to the smallest companies in the U.K. On this basis, the gross P2P platform lending to SMEs in 2015 reported by the P2P Finance Association (£881 mln, excluding invoice finance and debt securities) represents 13.1% of the £6.7 bln of gross new loans to the smallest companies, as reported in the quarterly survey conducted by the British Bankers Association (BBA) [BBA (2016)] (these are loans to companies with turnover of less than £1-2 mln, the precise threshold varying from one reporting bank to another). However, the gross lending shares do not differ much for unsecured consumer lending.

In the U.S., marketplace lending (as P2P lending is referred to there) has also been active for a decade. The oldest and largest platforms, Prosper and Lending Club, were established to offer consumer lending and refinancing of student loans. Other well established platforms competing with them are Avant (focusing on personal loans) and SoFi (specializing in refinancing of student loans). There also a number of providers of marketplace loans for small business, including OnDeck, CAN Capital, and Kabbage. GroundFloor and LendingHome provide short-term bridge mortgage finance, though their total lending is still small. Wardrop et al. (2016) report that the amount of consumer marketplace lending in the Americas (predominantly in the U.S.) is about ten times the amount of small business marketplace lending.

Marketplace lending in the U.S., just as in the U.K., has not yet succeeded in capturing a substantial share of the loan markets in which they compete. Morgan Stanley Research (2015) puts the level of marketplace lending at U.S.$12 bln at the end of 2014. This is still only a very small fraction – 0.36% – of total U.S. unsecured consumer lending of U.S.$3.3 tln (this statistic is from Frame (2015), who also provides a succinct overview of the development of marketplace lending in the U.S.).

In other countries, P2P lending appears to be at a much earlier stage of development than in the U.K. or the U.S. Data from Wardrop et al. (2015) reveal that the U.K. is the clear leader in the alternative finance market in the E.U. For the year 2014, €2.9 bln was the size of the entire alternative finance market in the E.U., but only €620 mln was outside the U.K. Alternative finance as a whole, however, grew 144% in 2014 in the E.U., other than in the UK, compared with 2013. It does appear, however, that interest in P2P lending is spreading rapidly across much of the E.U. One indicator of this is the index of P2P lending constructed by the website AltFi. According to this index, 2015 P2P loan volumes across continental Europe (other than the U.K.) amounted to some €674 mln [Shoker (2016)]. These figures seem to involve some underreporting, when compared to the data cited in Wardrop et al. (2015), but they suggest rapid growth of more than 100% per annum with many new platforms being established.

Another jurisdiction where P2P lending now appears to be quite active and is receiving the close attention of regulators is Australia. While at least eight P2P platforms are now licensed in Australia, including two – RateSetter and ThinCats – that also operate in the U.K., the Australian market is still somewhat behind the level of development reached in the U.K. or the U.S.

Brief mention can also be made of P2P platform lending in China, mainly to small businesses, which is reported to have nearly quadrupled to an astonishing U.S.$150 bln in 2015, more than ten times the size of U.S. marketplace lending originations [Xinhua (2016)]). There are apparently more than 2,000 online P2P lending platforms in China [Williams-Grut (2015); Deer et al. (2015)]. At the same time, however, there are substantial concerns about fraud, especially since the early 2016 failure of the platform Ezubo, which lost some U.S.$11 bln of investors' money [Wu (2016)]. The development of P2P lending in China has, however, been so different from that in the U.K., the U.S., and other countries that it will not be considered further in the present paper.

The variation in P2P business models

The common feature of P2P lending platforms is the matching of investors and borrowers without the platform itself needing to take a direct loan exposure. An analogy can be made with other "sharing economy" ventures such as AirBnB for temporary accommodation and Uber for taxi rides. Similar to those sites, P2P platforms match an individual demand for a service (the borrower) with the supplier of that service (a lender). The analogy, however, is oversimplified and P2P platforms must play a greater role in the exchange than in these other examples. An investor in a P2P unsecured consumer or business loan is committed to an exposure that extends for two or three years. It is difficult to assess the potential for losses until the loans are repaid. P2P platform investments are moreover subject to cyclical risks, an economic downturn can be expected to lead to increased losses (in the jargon of credit risk management a rise of "unexpected losses"), which do not affect returns on insured bank deposits. It is true that P2P lenders offer substantially higher returns than bank deposits in order to attract investors but it is difficult for customers to assess the risk return trade-offs of P2P lending. For this reason, platforms take responsibility, employing a variety of different approaches, for assessing creditor risk and for matching investors to loans.

The range of possibilities is wide and varies substantially, between platforms, across countries, and over time. Only a relatively shallow summary can be given here, in this and the following paragraphs. It would be a substantial research project to fully document and summarize all of the different approaches taken to classify borrower risk and matching borrowers and lenders on the large number of P2P lending platforms now active in many countries.

Beginning first with the allocation of investors to borrowers, a feature common to all P2P lending platforms is using technology to diversify exposure by spreading investments across a large number of loans, typically two hundred or more. However, this still leaves a great deal of variation in how these allocations are made. Davis and Murphy (2016) and Murphy (2016) draw a helpful distinction between active and passive investment on P2P platforms. Active investment mechanisms allow investors to select or bid for individual loans or more commonly for loans within narrowly defined risk classifications (these bids may still be made for many hundreds of loans). More often, retail investment in P2P lending is based on passive investment mechanisms, with the investor making a broad choice over their risk preference (e.g., for lending within a range of platform risk categories, such as A-C, A-E, and/or a particular lending segment, such as unsecured consumer lending or real estate) and the platform automatically allocating the funds to a large number of borrowers according to this choice. Zopa in the U.K., for example, offers its retail investors a choice between only three different broad products, in order of increasing risk, Zopa Access, Zopa Classic, and Zopa Plus, with only Zopa Access giving an option for resale without a fee [Milne and Parboteeah (2016)]. It is usual also with passive investment mechanisms for repayments of interest and principal to be automatically reinvested in new loans.

The distinction between active and passive is not clear cut. Different platforms offer a range of approaches, some more active and other more passive, depending upon how much choice of investment allocation the platform gives to the investor. For example, some platforms allow investors to choose individual risk categories and set minimum levels of return, borrower lending requests within that category are then allocated in small amounts, with the platform supporting an auction that sets the final loan rate at the lowest interest rate at which the loan can be fully funded.

This auction process for loans, in some cases, supports a secondary market in which loans within a particular risk category can be resold at the current best rate available on the platform. This approach is more common in the U.S., hence the preference there for the name "marketplace lending." Other platforms – this is more common in the U.K. – may be willing to buy loans directly from investors, but sometimes only for a relatively large fee and at a price related to current interest rates for that particular risk category on the platform. In either case – active or passive – the interest rate on lending has to be set to balance the supply and demand for loans on the platform, either administratively (the platform setting loan rates and adjusting them periodically to clear any imbalance between supply and demand in different risk categories) or through loan auctions.

A further difference is the extent to which platforms draw funding from institutional investors. Zhang et al. (2016) report a growing share of investment in U.K. P2P lending platforms from institutional investors. They report that in 2015 institutional investment accounted for 32% of gross lending in peer-to-peer consumer lending, 26% of peer-to-peer business loans, and 25% in peer-to-peer lending secured on real estate, with all these proportions rising steadily through the year. By year-end, about one-third of all P2P lending in the U.K. was from institutional investors (see their Figure 18, p. 29).

The U.S. industry has evolved even further away from the concept of directly linking individual lenders and borrowers, becoming instead largely a mechanism for the sale of loans to institutional investors. For example, in the third quarter of 2015, only 15% of the originations of Lending Club, the largest U.S. marketplace lending platform, were financed by individual investors; 85% were taken by institutional investors, such as banks, asset managers, and hedge funds [Wack (2015)]. The major U.S. platforms have also used loan securitizations as a source of funding, by transferring loans into special purpose vehicles that issue asset-backed securities and sell these to institutional investors.

While it has helped raise funding, this reliance on institutional investor funding has also created problems, most notably in the first half of 2016, when a moderate rise in default rates, concentrated amongst the highest risk borrowers, led to a decline in investor confidence in this asset category, a substantial drop in the flow of institutional funding onto the platforms, and, as a result, quite substantial increases of platform interest rates [Demos and Redegeiar (2016); Wack (2016a)]. This slowdown in funding is a particular problem for U.S. platforms because of their practice of relying on one-off origination fees, built into the loan, for revenue. As a result, platform revenues and profits can be volatile because of their dependence on lending flows. In the U.K., the usual practice is to obtain revenue through a small per annum deduction from investor returns, making a more stable revenue stream that is less affected by the current volume of lending.

Another difference between countries are the sources of credit information used by the platforms. In the U.K., the credit classifications are based on detailed credit information from credit referencing agencies: the most important being Experian, Equifax, and Callcredit. In the U.S., credit bureaus, Experian, Equifax, and Transunion provide the same service (so two companies operate in both countries while CallCredit in the U.K. has a technical co-operation agreement with Transunion). They provide credit scores and credit histories for most persons and incorporated businesses in the U.K. and the U.S. This credit referencing is the main source of information used by U.K. P2P lenders to assess borrower credit risk and place them into different risk categories. The allocation of risk categories is proprietary to each platform, making it difficult to compare risk of borrowers on different platforms. In the U.S., as well as information from credit bureaus platforms may use the FICO score (an overall numerical credit assessment computed by the Fair Issacs Corporation using information from the credit bureaus) and also further credit analytics based on additional data, such as transaction histories, mobile phone contracts, and other sources of "big data." Many U.S. marketplace lenders claim substantial improvements in understanding and pricing credit risk from these sophisticated methods, but they, of course, have no monopoly on such techniques, which can equally well be used by banks or other lenders.

Many of the U.S. platforms, in contrast to the U.K., have developed partnerships with U.S. banks [PwC (2015); Aranoff (2016)]. Marketplace lending is increasingly seen in the U.S. not as competition to banks but rather as an opportunity, providing a new source of investment assets for banks with surplus funds, as an alternative way of financing loan assets for those in need of funds, and as a model for improved technology offering to both deposit and loan customers. Another institutional difference between the U.S. and the U.K. is the well-established U.S. practice of third-party servicing of bank loans. It is standard practice for U.S. banks to outsource such servicing of the loans. This outsourcing plays an important role in the securitization of U.S. lending, allowing loans to be sold between institutions with no impact on the process of collection. This, in turn, means that there is a clear identification of servicing costs for platforms. As we suggest below, in Section 4, achieving similarly clear identification of servicing costs may be a potential challenge for U.K. P2P lenders. An issue in the U.S. is the regulatory limits on consumer loan interest rates applicable in many states. To deal with these controls, U.S. marketplace lenders work with partner banks, who formally grant loans once they are agreed on the P2P lending platform (for example Lending Club works with WebBank, a Utah-chartered financial institution) before selling them back to the platform investors. This practice, however, has been thrown into doubt by rulings on a case currently before the U.S. Supreme Court and the industry awaits clarification of its legal position [Wack (2016b)].

A final point that needs to be made about the business models of P2P platforms is that, to date, all the extant platforms are either loss making or only marginally profitable. As documented in Milne and Parboteeah (2016), the major U.K. platforms for which accounts are available operate with substantial losses, amounting to as much of 2% or more of the stock of outstanding loans. In the U.S., Lending Club, the largest P2P platform in the world, has reported profits of a little over U.S.$4 mln for first quarter of 2016, less than 0.05% of its outstanding loan stock, and because of the dependency on origination it is unclear that these can be sustained at the same level for the full year. In fact, Lending Club reported a second quarter loss of U.S.$80.1 mln. Lack of transparency on revenues, costs, and strategic expenditure decisions makes it difficult to analyze fully the prospects for the platforms becoming sustainably profitable, but it appears that lack of sufficient scale to cover platform costs is a serious challenge that no P2P platform has yet adequately overcome.

REGULATION OF P2P LENDING

This section summarizes the regulation of P2P lending in the U.K., the U.S., and Australia. P2P lenders do not themselves take deposits or issue loans and are thus able to operate without requiring a banking license. They do, however, still fall within the scope of financial regulation: both for their function as loan servicers (managing the initial loan provision and the repayment of interest and principal) and as providers of an investment service (assessing the credit quality of borrowers and providing investors with mechanisms for portfolio allocation and for loan resale).

In the U.K., the regulation of P2P lenders has attracted relatively little public attention. Platforms must be authorized by the Financial Conduct Authority (FCA) (until March 2014 they operated with licenses from the Office of Fair Trading). FCA regulation aims to ensure

that platforms provide investors with access to clear information to assess risks, comply with core consumer protection requirements, such as protection of client money, holding of sufficient capital, and having in place a resolution regime that can ensure investors continue to be paid even if a loan platform collapses [FCA (2015)]. The FCA stress that P2P investments are not deposits and that it must be made clear to investors that there is risk of loss and that these investments are not covered by deposit insurance (the U.K. Financial Compensation Scheme). The Prudential Regulation Authority (PRA) does not, as yet, perceive any substantial systemic risk from the growth of P2P lending and so has left all regulation of the sector to the FCA. In the March 2015 budget, the U.K. government announced that P2P lenders would be able to offer tax exempt investment products (ISA investments) and subject to FCA approval they have been able to offer these since April 2016. The FCA is currently engaged in a consultation on regulation of the sector.

The U.S. has seen a much more active public discussion of marketplace regulation. There have been information hearings by Congressional Committees [Alois (2016)], and the U.S. Treasury has conducted and reported on a public consultation on the industry [U.S. Treasury (2016)], reviewing the benefits and risks of marketplace lending. This report highlights the potential of the new online lending technologies to better serve the financial needs of the American public, in particular through providing credit to some borrower segments who are underserved by the traditional lending channels; but also expresses concern about a number of risks, including insufficient transparency of the marketplace and the performance of novel techniques of credit assessment in unfavorable credit conditions.

There has also been a somewhat greater focus in the U.S., compared to the U.K., on the need for consumer and prudential regulation. The U.S. Consumer Financial Protection Bureau is increasingly involved in the oversight of marketplace consumer lending, including a well-publicized enforcement action against Lending Club for lack of clarity on interest rates paid by one group of borrowers [Adler (2015)]. The Federal Deposit Insurance Corporation (FDIC) has stated that it wishes to keep a close watch on developments in marketplace lending, including potential risks to insured banks partnering with marketplace lenders.

For these reasons, and also the relative complexity of the U.S. framework of financial regulation with its multiplicity of agencies, marketplace lending in the U.S. is subject to a wide range of regulatory requirements. Manbeck and Franson (2015) summarize the regulations applicable to marketplace lenders in the U.S. These include securities laws (they list no less than 10 different requirements, including securities law, private placement rules); lending laws, including state level usury laws, state level registration and licensing requirements, and limitation on third-party use of bank charters; and a wide range of consumer protection laws, including fair lending, debt collection practices, privacy, and electronic commerce laws.

In Australia, regulation of marketplace/P2P lending comes under the scope of the Australian Securities and Investment Commission. These regulations are summarized by ASIC (2016). Platforms are required to hold an Australian financial services license and also, if the loans include consumer loans, an Australian credit license. Schemes offered to retail investors must also be registered with ASIC. A range of further regulations apply, including, for example, following good practice guidelines for advertising of products, for disclosure of the details of their operations, such as how interest rates are set and the matching of borrowers to investors, and for ensuring that investors adequately understand marketplace lending products and the relevant risks.

Davis and Murphy (2016) provide a critical review of the Australian regulation (though their analysis also has implications for regulation in other jurisdictions), arguing that marketplace lenders combine the functions of market operators and investment management. They are market operators because their platforms provide a primary market for assets that determines the interest rates/prices for loan assets, while they are at the same time investment schemes because they assess the credit worthiness of borrowers and then assist investors (in active investment arrangements) with allocation of investments amongst loans. Australian regulation treats marketplace lenders under the existing regulations for other investment schemes, such as mutual funds, even though the platforms do not share the features of collective investments, where each participant has a pro-rata share in a pool of assets. This approach, however, ignores several other possibilities. Marketplace lending also bears comparison with securitization structures used for selling tranched claims on pools of loans on financial markets (although many of the features of loan securitizations, such as tranching and credit enhancement, are not provided and the marketplace platform also undertakes loan origination). Marketplace platforms could also be viewed, like credit bureaus and credit rating agencies, as assessors of credit risk in return for fees. There is a substantial regulatory challenge because the novel business model of marketplace lenders cuts across all the conventional regulatory categorizations. This suggests that the regulation of marketplace lenders, along with that of other new technology based financial services, may require substantial regulatory reform, placing what are currently treated as different activities within a single regulatory framework and rethinking the current separate legislative treatment of financial products and credit.

Does regulation of P2P lending – in the U.S., the U.K., or Australia – treat P2P platforms and banks on an equal footing? This brief review suggests that it does not. The two activities are treated as being almost entirely distinct from a regulatory point of view. The FCA in the U.K. and other regulators emphasize the need for platforms to make

clear that P2P investments are subject to risk of loss. This, in turn, has led to an emphasis on the responsibilities of platforms as investment advisers, ensuring that retail customers are given appropriate information on risks and prospective returns. The treatment of banks and P2P platforms also differs in other ways; for example, in that U.S. regulation imposes a very complex regime on what can be a relatively simple investment product.

Little of the regulation or public discussion of P2P lending, if any, has focused on the question raised in this paper, ensuring that the bank product that most closely competes with retail investment in P2P loans, the bank term, or time deposit, is regulated in a way that puts P2P lenders and banks on an equal competitive footing. Regulators understandably insist on platforms making clear to retail investors that P2P investments are not deposits, returns are not fixed, and they have neither the support of an intermediary balance sheet nor protection from deposit insurance. Still, from the perspective of retail investors, P2P investments are substitutes for time deposits with banks. They have provided investors, over the decade they have been available, much better returns than bank deposits of a similar medium term maturity of one to three years.

The assets that bank deposits fund are not risk free, but the deposits that fund them are effectively risk free because banks benefit from a variety of risk mitigations that guarantee repayment. The risk of loss has been transferred, away from depositors to shareholders, to wholesale investors and ultimately to the tax payer. It is, of course, appropriate to give banks protection of this kind. The role of banks in payments systems is an essential economic infrastructure that must be protected. Their role of maturity transformation, which supports the provision of short term liquidity to sight and overnight depositors or through lines of credit is also a critical economic function, whose interruption could have damaging economic consequences. But the question is not "Should banks be regulated and protected?" but rather "What is the appropriate regulation and protection?". This should be designed to provide to protect their essential economic functions, but not allow other banking functions and services to be insulated from competition with new non-bank providers using business models built on financial technology.

Term deposits – where money is left with a bank for a period of a few months to two or three years – are a widely used bank product. These, however, are investment not banking services. They are, of course, a valued source of stable funding for banks, but they do not involve maturity transformation, or only to a limited extent, and they are unrelated to other core services such as payments. Consequently, it must be questioned whether bank term deposits need to benefit from deposit insurance in the same way as transaction and sight deposits. Removing, or reducing, this protection would put banks and P2P platforms on a much more level competitive playing field.

CONCLUSION: THE PRACTICALITY OF A BALANCED REGULATORY TREATMENT OF BANK TIME DEPOSITS AND P2P PLATFORM INVESTMENT

This paper has reviewed the development of P2P (or marketplace) lending and argued that regulation creates an un-level playing field in the competition between banks, who enjoy deposit insurance on term deposits, with P2P platforms, where investment of a similar term is not similarly supported.

A brief look at the statistics for the U.K. indicates that this is a significant issue. According to Table A6.1 of Bank of England Monetary and Financial Statistics, interest bearing time deposits held by households with U.K. monetary financial institutions amounted to £187.2 bln at the end of 2015. This is about two orders of magnitude, or one hundred times, greater than the £2.2bn stock of U.K. P2P lending at that date, as reported in Table 1 above. Even if P2P lenders were able to capture only an additional one percent of household time deposits, this would nearly double outstanding P2P lending in the U.K.

The means of correcting this regulatory bias is at hand, removing at least in part the 100% deposit insurance offered on U.K. bank and building society time deposits up to the insurance limit of £75,000. There are, of course, challenges. The justification for this being that time deposits are not used for the bank service of maturity transformation that provides customers with liquidity on underlying illiquid loan portfolios and, therefore, should be regulated and insured pari-passu with P2P platform investments.

There are practical objections. There is a degree of maturity transformation service involved in, for example, a three months or six months time deposit that might need protection. But this could be addressed by a sliding scale of deposit insurance, starting at 0% for time deposits with an original maturity of say two years and above and then rising linearly as original maturity falls, to 50% for one year deposits, 75% for 18 month deposits, etc. Reduction of deposit guarantees, when the costs fall as they currently do not on depositors but on others, will not be easy to sell politically. But the potential benefits, in terms of increased competition and opportunities for the development of the efficient P2P model of lending, are substantial. If withdrawal of deposit insurance can establish P2P lending on a sustainable scale, in turn widening access to credit and helping provide retail investors with better returns than are available on bank deposits, then it is a step that merits serious consideration, especially in an era that seems to be set to continue for some years to come of low growth and low real interest rates.

REFERENCES

- Adler, J., 2015, "CFPB Makes LendingClub unit repay $700K to customers," American Banker, http://bit.ly/2cQSnLx
- Alois, J., 2016, "Congressional Committee reviews marketplace lending," Crowdfund Insider, http://bit.ly/2dQBwpD
- Aranoff, A., 2016, "Line between banks and marketplace lenders thinner than you think," American Banker, http://bit.ly/1UbBpWv
- ASIC, 2016, "Marketplace lending (peer-to-peer lending) products," Australian Securities and Investments Commission, http://bit.ly/2dPBF0f
- BBA, 2016, "Bank support for SMEs – 4th Quarter 2015," British Bankers Association, http://bit.ly/2d1nVwE
- Davis, K. and J. Murphy, 2016, "Peer-to-peer lending: structures, risks and regulation," JASSA, http://bit.ly/2dIaEfl
- Deer, L., J. Mi, and Y. Yuxin, 2015, "The rise of peer-to-peer lending in China: an overview and survey case study," ACCA, http://bit.ly/2dcZUR1
- Demos, T. and P. Redegeiar, 2016, "LendingClub's newest problem: its borrowers," Wall Street Journal, July 12, http://on.wsj.com/29zmkzv
- FCA, 2015, "A review of the regulatory regime for crowdfunding and the promotion of non-readily realisable securities by other media," The Financial Conduct Authority, http://bit.ly/2dvgZHp
- FCA, 2016, "Statement on peer-to-peer applications for full authorisation," The Financial Conduct Authority, March 31, 25, http://bit.ly/2dpLHWa
- Frame, W. S., 2015, "Marketplace lending's role in the consumer credit market," Federal Reserve Bank of Atlanta, http://bit.ly/2dCLRYh
- King, B., 2010, "How customer behavior and technology will change the future of financial services," Marshall Cavendish International Asia Pte Ltd.
- Manbeck, P. and M. Franson, 2015, "The regulation of marketplace lending," Chapman and Cutler, http://bit.ly/1NAxieD
- Milne, A. and P. Parboteeah, 2016, "The business models and economics of peer-to-peer lending," Centre for European Policy Studies, report no.: 2016, no 17, http://bit.ly/2dI2AGR
- Moldow, C., 2015, "A trillion dollar market, by the people for the people: how marketplace lending will remake banking as we know it," Foundation Capital, http://bit.ly/1TUnMc1
- Morgan Stanley Research, 2015, "Global marketplace lending: disruptive innovation in financials," http://mgstn.ly/1k71VjZ
- Murphy, J. P., 2016, "P2P lending: assessing sources of potential competitive advantage," Dissertation
- Peer to Peer Finance Assocation, 2015, "Strong growth continues in peer to peer lending market."
- Peer-to-Peer Finance Association, 2015a, "£500 million new P2P loans in last three months," http://bit.ly/2dpWEqX
- Peer-to-Peer Finance Association, 2015b, "P2PFA unveils new transparency standards," http://bit.ly/2cRsaHY
- Peer-to-Peer Finance Association, 2015c, "Strong growth continues in peer-to-peer lending market," http://bit.ly/2dpWEqX
- Peer-to-Peer Finance Association, 2016, "Record growth for peer to peer lending in 2015," http://bit.ly/2dIaMeZ
- PwC, 2015, "Where traditional and tech meet: how banks and marketplace lenders can partner up," http://pwc.to/2dZOWST
- Shoker, S., 2016, "2016: a booming P2P market for Continental Europe," http://bit.ly/2dd0qOO
- U.S. Treasury, 2016, "Opportunities and challenges in online marketplace lending," Washington, D. C., http://bit.ly/27bRLDC
- Wack, K., 2015, "Shift away from retail investors heightens risks in online lending," American Banker, http://bit.ly/1kthaUx
- Wack, K., 2016a, "Marketplace lending's big investors grow anxious," American Banker, http://bit.ly/2dtIr8J
- Wack, K., 2016b, "Supreme court throws curveball in big case for online lenders," American Banker, http://bit.ly/22shHe8
- Wardrop, R., R. Rosenberg, B. Zhang, T. Ziegler, R. Squire, J. Burton, E. Arenas Hernadez and K. Garvey, 2016, "Breaking new ground: the Americas alternative finance benchmarking report," Judge Business School, University of Cambride, http://bit.ly/2dCPc9Y
- Wardrop, R., B. Zhang, R. Rau, and M. Gray, 2015, "Moving mainstream: the European alternative finance benchmarking report," Judge Business School, University of Cambride, http://bit.ly/2cQVbbt
- Williams-Grut, O., 2015, "There's another Chinese market growing explosively — and Beijing wants to take control before it "blows up," Business Insider, http://read.bi/2dtzmwH
- Wu, W., 2016, "Risky business of P2P lending and a "battle we must not lose."" South China Morning Post, http://bit.ly/2dCOx8l
- Xinhua, 2016, "China's online P2P lending almost quadrupled in 2015: report," Xinhua, http://bit.ly/2dvirtn
- Zhang, B., P. Baeck, T. Ziegler, J. Bone, and K. Garvey, 2016b, "Pushing boundaries: the 2015 UK alternative finance industry report," Judge Business School, University of Cambride, http://bit.ly/1OKUY1y
- Zhang, B., P. Baeck, T. Ziegler, J. Bone, and K. Garvey, 2016a, "Pushing boundaries: the 2015 UK alternative finance industry report," Judge Business School, University of Cambride, http://bit.ly/2cpzr3T

Blockchain in a Digital World

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Abstract
Blockchain technology has certainly attracted attention since 2014; from Bitcoin's murky reputation and increased adoption, to the World Economic Forum paper published in 2016 pointing to the technology as one to revolutionize financial services' infrastructure. Somewhere in between, the financial services industry has leapt into gear and an ecosystem is emerging that comprises incumbent banks and financial institutions, FinTech start-ups, peer-to-peer payments, and distributed autonomous organizations built on top of blockchain technology. The definition of disruption put forward by Clayton Christensen in 1997 has been built on and revised over the last two decades to describe a continuous and relative process. Certain methods have been shown to arm against disruption, in particular, business model innovation. This research is based on a series of interviews with high-profile industry players with the aim to gather insight as to how business models could change. The interviews cover insight from within highly regulated financial services, where process and entire markets are said to be disrupted, and outside of financial services, where new business models are emerging with the aim to reach new customers whose needs are not being currently met.

"Blockchain is a vast, global distributed ledger running on millions of devices and open to anyone, where anything of value – money, but also titles, deeds, identities, even votes – can be moved, stored and managed securely and privately. Trust is established through mass collaboration and clever code rather than by powerful intermediaries like governments and banks." Tapscott [2016]

In 2008, the pseudonymous Satoshi Nakamoto (2008)[1] outlined a new concept for a cryptocurrency called Bitcoin, with a view to disrupt existing financial services by circumventing the value chain. Bitcoin is a currency, intertwined with a mechanism of recording transactions without spending the same coin twice: the blockchain. The new currency achieved notoriety and intrigue in equal measure. Its volatile price and murky commerce were journalistic fodder.

The funfair had begun. Exchanges shot up and down like a game of whack-a-mole and its price rose over time relative to the dollar, hitting a peak of U.S.$1100 for 1 Bitcoin (BTC) late 2014. It would be remiss not to mention the numerous scandals that temporarily engulfed the ecosystem, such as exchange hacks or accusations of terrorist financing, but blockchain technology, to its credit, remained steadfast throughout.

Blockchain, or as it is often referred to, distributed ledger technology (DLT), captured the hearts and minds of the very sector it was set to disrupt. Many existing financial services firms have reacted quickly and innovatively to this potential disruption, appearing to embrace its characteristics by launching joint ventures, creating industry alliances, joining consortia, and implementing proof-of-concept use cases. But will this be enough to combat the effects of disruption? Disruption leads to growth in new markets, and historically novel business models have emerged as a result.

This research is based on a series of interviews with high profile participants representing either their own views or the views of their company, which are mostly blockchain or distributed ledger technology focused start-ups. Each was asked the same core set of questions to investigate their views on business model innovation in a blockchain paradigm. The aim is to gain insight into the potential for change and to add to the literature some forward-looking insight in what has the markings of an early stage disruption.

ECONOMIC PROPERTIES OF DIGITAL GOODS

"Bitcoin is a remarkable cryptographic achievement and the ability to create something that is not duplicable in the digital world has enormous value" – Eric Schmidt, Chairman of Alphabet (Google's parent company)

In order to understand the broad significance of blockchain technology, let us first take a step back and look at the economic properties of digital goods and their effect on businesses. Digital goods are public, durable information goods. In an analog world, an information good such as a book, a photo, or a music track cannot be replicated without a lot of work and a large potential for loss of information. In a digital world, these can be replicated easily without loss of information. This makes them durable. A public good must satisfy the conditions of being non-rival and non-excludable. A digital music track, for example, can be copied and consumed concurrently, making it non-rival. Moreover, its non-excludable property simply means that in practice no one can be excluded from listening to it.

This almost unfettered access to an abundance of music, coupled with a drastic decrease in reproduction, distribution, and even initial production costs, has led to a significant loss of market power for incumbent music companies since the turn of the century. Yet, this has not undermined the very fabric of the industry itself.

In fact, new business models have emerged, such as Spotify, which leverage its durable and non-rival properties via streaming services. Emerging artists can exploit the non-excludable property of a digital good shared over the internet and achieve fame and fortune via platforms such as YouTube or SoundCloud. The difference between the music industry and the financial services industry, however, is that to avoid undermining the very concept of money, it is necessary to combat the issues that arise from these public, durable information goods.

Simply put, sending a music track doesn't diminish the value of the song, but sending money without recording the transaction destroys the value of the currency.

1 Nakamoto, S, 2008, "Bitcoin: a peer-to-peer electronic cash system," Bitcoin.org, http://bitcoin.org/bitcoin.pdf

Blockchain and its significance to digital goods

In the fairground of digital goods, music can run rampant in the house of mirrors. But money must remain on the rival roller coaster, riding a fixed journey.

Nakamoto (2008) put forward an elegant solution to the "double spend" using a nexus of existing technologies: a timestamp server, public/private key encryption, and a proof-of-work consensus. This solution became known as the blockchain. In short, a blockchain is a ledger of all existing transactions, which can be either public or private, and a consensus mechanism to cryptographically secure transactions into the chain. Pilkington (2016)[2] gives a detailed and technical breakdown of the innovation.

A blockchain is a way of recording possession and transfer of digital goods. A digital good is non-rival, a digital good secured on a blockchain exhibits rivalness. Put another way, a blockchain underpins the transfer of a digital good and traces its provenance to negate the replicable and non-rival properties that arise from being a public, durable, information good.

Blockchain as a disruptive innovation

"You can't stop things like Bitcoin. It will be everywhere and the world will have to readjust. World governments will have to readjust" – John McAfee

Although conceptually dating back much further, disruption only became formally defined in 1997. In The Innovator's Dilemma,[3] widely regarded as one of the most important business books ever written,[4] Clayton Christensen defined disruptive innovation as "a new product or service that initially takes root at the lower end of the market, servicing a niche segment, and then gradually moving its way up the chain to replace the existing product or service." More recently, disruption is regarded as a process and not an event that one can retrospectively label, and that it is relative and not absolute.

What Bitcoin and other cryptocurrencies offer is the opportunity to send money electronically over a peer-to-peer network without passing through a financial institution; certainly a different set of features than traditional payment mechanisms.

Other entirely new features exist, such as the ability to encode secret messages into the blockchain. In the very first Bitcoin block, known as the genesis block, Nakomoto encoded the phrase "The Times 03/Jan/2009 Chancellor on brink of second bailout for banks."[5] Noted security researcher Dan Kaminsky also encoded a tribute to his friend, Len Sassaman,[6] after he passed away.

Bitcoin has flourished in niche markets where Bitcoin evangelists "fighting the power" (or at least circumventing the power) laud the ability to cut out the middle-man: banks.

Blockchain technology, having decoupled from Bitcoin around 2014/15, has gone through significant testing and evolution and become more appropriate for regulated industries.[7] For example, private chains were considered preferable to public chains for financial services, which meant the energy intensive proof-of-work mechanism could be replaced with a simpler consensus mechanism. Successful proof-of-concepts have been reported,[8] start-ups have emerged, alliances and consortia formed,[9] and now the first end-to-end trade finance transaction has been completed.[10]

According to research released in August 2016 by the World Economic Forum,[11] 80% of banks are predicted to initiate DLT projects in 2017, more than 90 corporations have joined blockchain consortia, and more than U.S.$1.4 billion has been invested in blockchain technology since 2013. The report states "new financial services infrastructure built on DLT will redraw processes and call into question orthodoxies that are foundational to today's business models."

Recognizing the signs of disruption, reports and white papers emerged along with the insightful and eminently readable books by Tapscott and Tapscott (2016) and Mougayar and Buterin (2016).[12]

2 Pilkington, M., 2016, "Blockchain technology: principles and applications," in Olleros, F. X., and M. Zhegu (eds.), Research handbook on digital transformations, Edward Elgar, 2016

3 Christensen, C. C., 2011, The innovator's dilemma: the revolutionary book that will change the way you do business, HarperBusiness

4 Economist, 2011, "Aiming high," June 30, http://econ.st/2cTyhvt.

5 http://bit.ly/2dtXPSY

6 http://bit.ly/2dsYeGa (Slide 13)

7 Swanson, T., 2015, "Consensus-as-a-service: a brief report on the emergence of permissioned, distributed ledger systems," April 6, http://bit.ly/1IDWPm9

8 Grygo, E., 2016, "Rabobank, D&H complete blockchain proof-of-concept Project," Financial Technologies Forum, October 4, http://bit.ly/2dEXjmm

9 Kelly, J., and G. Chavez-Dreyfuss, 2016, "Thomson Reuters joins R3 blockchain consortium," Reuters, August 2, http://reut.rs/2aIJXTk

10 Allison, I., 2016, "Barclays and Wave complete world's first blockchain trade finance transaction," International Business Times, September 7, http://bit.ly/2c7IxBe

11 World Economic Forum, 2016, "The future of financial infrastructure," report, http://bit.ly/2aObRdV.

12 Tapscott, D., and A. Tapscott, 2016, Blockchain revolution: how the technology behind bitcoin is changing money, business, and the world, Portfolio; Mougayar, W., and V. Buterin, 2016, The business blockchain: promise, practice, and application of the next internet technology, John Wiley & Sons Inc

How to ride the wave of disruption

By definition, disruptors will find a way to cater for a segment of the market that has been priced out, or their needs overlooked. Incumbents, on the other hand, cater for the needs of their existing customers [Christensen et al. (2015)].[13] Alliances, joint ventures, acquisitions, and licensing can be tools for incumbents to react to disruption [Helfat and Lieberman (2002)][14] and this rings true of the current ecosystem, as financial institutions partner with startups to find solutions to existing problems.

However, Christensen (2006)[15] observed similarities amongst incumbents that had succeeded with disruptive innovations. He found that those that had succeeded had in common the freedom to forge different business models to the ones they were founded on.

Business model innovation as an antidote to disruption

Many firms have failed because their business model was inappropriate to capture value: "business model innovation may be far more potent than market dominance or technological or product leadership" [Rayna and Striukova (2014)].[16]

The most straightforward way to envisage business model innovation is to consider the changes in each of the value components [Abdelkafi et al. (2013)].[17] In short, the more business model components that change, the more radical the innovation.

The five components of a business model are [Rayna and Striukova (2016)]:[18]

1. **Value proposition:** e.g., product or service offering, pricing model.
2. **Value creation:** e.g., core competencies, governance, complementary assets, and value networks.
3. **Value delivery:** e.g., distribution channels and target market segments.
4. **Value capture:** e.g., revenue model, cost structure, and profit allocation.
5. **Value communication**: e.g., communication channels, ethos, and story

The research that underpins this piece is a series of interviews with high profile players in the industry. The aim was to explore their views on the extent to which business model components could change, or are changing, in a post-blockchain world. The participants are working on solutions within four use cases or application layers, which are outlined below. The participants were asked the same set of questions for consistency. The interviews were semi structured, meaning the questions were open-ended and provided room for ideas. The idea behind this was to capture opinions and nuances shaped by experience.

Use cases or application layers

Bitcoin (cryptocurrencies)

Bitcoin is a new method of sending peer-to-peer payments and has generated a new market, which reaches new customer segments, such as the unbanked. The Bitcoin blockchain is currently the most prolific proof-of-concept for blockchain technology.

Identity

Identity could be described as both a use case and an application layer. In financial services, billions of dollars a year[19] are spent on arduous and redundant KYC and AML processes, which could be streamlined and made more efficient by using blockchain technology. An identity use case also has wider implications, such as ownership of one's identity and reputation management. The concept of identity does exist today, but it is fragmented and in many cases the data is owned by the firms that hold it, for example Experian or Facebook. The unification of digital identity-related information is of "utmost political, legal, societal (and arguably philosophical) relevance" [World Economic Forum (2016)].

Capital markets post trade

There have been vast improvements to front office functions this century; however, middle and back office functions have been left woefully behind. A high-frequency trade can be executed in microseconds, but settlement can take between three days and three weeks [Masters (2015)].[20]

As Morgan Stanley (2016)[21] puts it: "Blockchain technology could help banks reduce the clutter and cost of numerous processes." Current regulatory and cost pressures have driven capital markets firms to investigate methods of achieving significant efficiency

13 Christensen, C. M., M. E. Raynor, and R. McDonald, 2015, "What is disruptive innovation?" Harvard Business Review, December, http://bit.ly/1HT2VUc.
14 Helfat, C., and M. Lieberman, 2002, "The birth of capabilities: market entry and the importance of pre-history," Industrial and Corporate Change 11:4, 725-760.
15 Christensen, C. M., 2006, "The ongoing process of building a theory of disruption," Journal of Product Innovation Management 23, 39–55.
16 Rayna, T., and L. Striukova, 2014, "The impact of 3D printing technologies on business model innovation," Digital Enterprise Design & Management 261, 119–132
17 Abdelkafi, N., S. Makhotin, and T. Posselt, 2013, "Business model innovations for electric mobility - what can be learned from existing business model patterns?" International Journal of Innovation Management 17:1, 1-41
18 Rayna, T., and L. Striukova, 2016, "From rapid prototyping to home fabrication: how 3D printing is changing business model innovation," Technological Forecasting and Social Change 102, 214–224
19 Chan, K., and A. Milne, 2013, "The global legal entity identifier system: will it deliver?" working paper, Loughborough University, August 12.
20 Masters, B., 2015, "Blockchain: the financial challenge of our time", Presentation made at the Exponential Finance conference, June 2, retrieved from http://bit.ly/2dfyLNq.
21 Morgan Stanley, 2016, "Global insight: blockchain in banking: disruptive threat or tool?" report, http://bit.ly/1XZtWuv.

improvements by applying mutual distributed ledgers to securities settlement [Mainelli and Milne (2016)].[22]

Smart contracts

The term "smart contract" was an abstract concept coined in 1997 by Nick Szabo, which was later formalized as Ricardian contracts. This designed a way of linking a contract of law to systems such as accountancy or issuance of value [Grigg (2004)].[23] One benefit of a smart contract in financial services is to reduce counterparty risk due to the automated execution of clauses, instead of relying on the willingness of a counterparty to meet its obligations. Additionally, a smart contract could negate the need for some entities that mediate disputes and resolve business outcomes. This could reduce manual effort to support execution of financial agreements and accelerate business outcomes [World Economic Forum (2016)]. Smart contracts can have varying complexity, from automating existing processes, to creating new concepts, such as distributed autonomous organizations. Ethereum, the second most prolific blockchain, features such smart contract functionality. In this paper, a smart contract is described as an application layer and not a use case.

Participants

Antony Lewis is a sought-after public speaker and consultant on blockchain and cryptocurrencies to large banks and writes the popular and accessible bitsonblocks.net blog. Prior to this, Lewis was an FX-spot trader at Barclays Capital and product manager and change agent for fixed income and equities trading systems at Credit Suisse.

Toni Lane Casserly is a cofounder of CoinTelegraph, a Bitcoin and blockchain media network and an advisor or board member to several blockchain start-ups, such as BitNation, ChangeTip, Factom and Mycelium. Notably, Casserly used Bitcoin as a tool for direct response to the Ebola crisis in Sierra Leone.

Rayan Goutay is a keynote speaker and regulatory advisor to FinTech and blockchain firms on cryptocurrency regulations, currently working on Identity Derivatives using cutting edge technology. Prior to that Goutay has worked as regulatory consultant at Goldman Sachs and the FCA. Now founder of DeepTechInSight.

Rouven Heck is product manager for uPort, a self-sovereign identity solution on Ethereum and part of the ConsenSys spokes. uPort recently won the Demo Day at Devcon2 in Shanghai. Prior to joining uPort, Heck spent over 12 years at Deutsche Bank in IT & program management, architecture and strategy roles. Heck represented Deutsche Bank in the R3 distributed ledger consortium working group.

Tyler Welmans is a blockchain specialist at Deloitte Digital working on identity on the blockchain and was previously a digital transformation specialist at Deloitte. Welmans has a total of 13 years' experience in technology consulting.

Peter Randall is CEO of SETL.io, a proprietary, permissioned blockchain settlement and payments platform. Randall was also the founder and CEO of Chi-X Europe, the first pan-European equity exchange, and has 35 years of financial market experience.

Thorsten Peisl is CEO of RISE Financial Technologies, a proprietary, permissioned blockchain for multi-asset and multi-currency settlement and safe-keeping. RISE recently won SWIFT's annual industry challenge, announced at the September 2016 Sibos conference. Prior to RISE, Peisl worked at State Street, driving multi-million dollar revenue products from concept to market adoption and launched a firm wide corporate venture program to scout and invest in innovative and strategically aligned FinTech start-ups.

Olaf Ransome is a consultant at 3C Advisory and has over 25 years' experience in Financial Services covering investment banking and private banking. Ransome was one of the pioneers in the CLS business. He worked extensively with the industry and clients to help CLS establish itself and Credit Suisse to build one of the leading CLS franchises and set-up full service in-house custody organisation for Goldman Sachs in Switzerland.

Colin Platt is cofounder of DPactum, a next-generation listed derivatives clearing solutions leveraging smart contract and blockchain technologies. Prior to this, Platt spent six years at BNP Paribas in advisory and strategic transformation and subsequently as Blockchain Lead in Global Markets Innovation.

Vinay Gupta is a technologist and policy analyst with a particular interest in how specific technologies can create or close off avenues for decision makers. This interest has taken him through arenas including cryptography, energy policy, defense, security, resilience, and response to natural disasters. He was a strategic architect at ConsenSys and release coordinator at Ethereum and now runs a venture capital project http://hexayurt.com/capital.

Professor Michael Mainelli is the chairman for Z/Yen, a commercial think-tank he founded in 1994. Mainelli has been working with mutual distributed ledgers for over 20 years, was commissioned by the SWIFT Institute to write a paper exploring DLT and has published numerous articles and run community events, amongst other things.

22 Mainelli, M., and A. Milne, 2015, "The impact and potential of blockchain on the securities transaction lifecycle." SWIFT Institute working paper no. 2015-007.

23 Grigg, I., 2004, "The Ricardian contract," in Proceedings of the First IEEE International Workshop on Electronic Contracting, http://bit.ly/2dyiqET

Sebastien Meunier is a senior manager at Chappuis Halder & Co., where he is Head of Digital for North America and in charge of the FinTech watch for CH&Co globally. He was Blockchain Keynote Speaker at the European Identity & Cloud Conference 2016 and has been named FinTech influencer. Meunier has over 10 years' experience in financial services and consulting.

THOUGHTS FROM THE FIELD

"I'm reasonably confident that the blockchain will change a great deal of financial practice and exchange." – Larry Summers[24]

What follows are excerpts from the interviews that underpin this research. The participants were from start-ups looking to solve current solutions in financial services, and also from firms propagating new business models or providing new products or services to market segments whose needs are not being catered for. The structure loosely follows the business model components from above and starts by looking into the solutions in the existing financial services infrastructure, followed by those reaching new markets.

A value proposition has many interpretations, but in short, it is the reason customers should purchase the product or service from a particular firm.

Michael Mainelli believes that the value proposition for trusted third parties at scale will change significantly: "A central third party takes on three roles: validation of either membership of a trading community or existence of an asset; safeguarding against fraudulent transactions; and preservation of the records. They can easily become natural monopolies because the central third party needs to be on both sides of every transaction. What we are disrupting here are natural monopolies, largely because mutual distributed ledgers move two of the three roles – safeguarding and preservation – into the technology." The effect, he believes, will diminish the ability of trusted third parties to set the price by being the sole owner of data; distribution of data also distributes ownership.

Colin Platt highlighted reduction in downtime as a competitive advantage for a blockchain firm due to distribution, but also the need for a firm to review its value proposition: "It is for banks to figure out their value is not transmitting payment, their value is not actually holding deposits. Their value is not being a behemoth where you can get a mortgage. Their value is helping you along the journey of your financial success, in the case of retail banks – your savings, your planning for the future. If we are talking about the capital markets and related financial services, managing your risk, ensuring that you can effectively correlate and hedge or reduce unforeseen circumstances, or increase in some cases your exposure to financial circumstances and economics." This technology is evolving in conjunction with other threats faced by banks in this environment.

Value creation is often thought of as creating value for shareholders and creating value for customers via superior products or services. More recently, however, a broader definition of value creation has been taken to include less tangible concepts such as value networks, governance, and core competencies.

Olaf Ransome describes a potential threat to the existing ecosystem of a trade life-cycle: "If you look at the life cycle of financial services transactions, they go through a lot of stages which create work. We execute trades at one place that we make sure that we record them, we then pass those recorded trades from a trading system to a back office system and make sure that those are in sync with the back office system, we get a confirmation from the other side of trade of agreement. We then pass them to be settled somewhere and blockchain technology threatens to seriously disrupt that ecosystem. If you do not have to do that "passing in," then whole swathes of activity will disappear."

Bitcoin and other cryptocurrencies are a way to access and transfer funds peer-to-peer without using the existing infrastructure, thereby reducing the value network of the current system. Similarly, in capital markets, as described above, the reduction of value networks compared to the current environment was a sentiment shared by many, with Peter Randall predicting: "those that will survive will be the ones closest to the consumer." Although Thorsten Peisl believes in theory that parts of existing value networks could be replaced, he is more pragmatic about the execution in capital markets: "Yes, in theory, we can go very far with technology. In practice no, because you cannot ignore market position and interests of dominating incumbents and you are not going to change the regulation overnight."

Governance, in particular regulation in the current environment, and standards, were common themes that emerged in value creation across participants from all use cases. Peisl stressed the need for governance in order to successfully deploy this technology. Both Platt and Antony Lewis noted market standards as the primary reason for market timings: "What takes the time in the existing systems is market structure, market habits and the reluctance from markets to, as a whole, change the way they do things, probably because of the cost of change makes it, possibly, not worth doing it this year, so you keep punting it to next year, because whatever you're doing now still works" said Lewis, adding "but that's not a reason to stop

24 http://cnb.cx/1SZfkYZ

experimenting." In order to create value under this new technological paradigm, the right flavor of governance is important. Rayan Goutay went a step further to say regulators need to disrupt themselves, as their rules were created for the old, centralized world where they were supervising every firm from their ivory tower. He suggested the creation of a global governance protocol that could be a mandatory layer in every blockchain stack. This sentiment was shared by Sebastien Meunier: "For cryptocurrencies to be widely adopted, you first need to change the existing environment: regulations, business models, the whole financial system."

Greater value creation could come through optimization and efficiency that could be achieved using the technology to automate processes, leading to greater profits. This view was shared by Randall, Lewis, and Goutay, while Ransome and Meunier hoped that these cost reductions are passed onto the customer.

Platt and Mainelli warned, however, that using a blockchain can be expensive and slow in comparison to a centralized database and urge innovators to ensure the use case fits the technology. "There's a lot of overhead in these systems when you decentralize them, when you put on a consensus mechanism, and if you don't have a network where adding this level of complexity and cost brings value, don't do it," said Platt.

Value delivery can be thought of as the way to deliver value to the customer directly, or in reaching customers through new distribution channels and or reaching new target market segments.

In capital markets, from an end-to-end perspective, the value delivered will not change significantly, but the way it is delivered – in other words, it is not that what, but the how. This could be a reduced necessity for reconciliation, or even compliance functions by using a shared ledger with a single source of the truth. During a demo of the OpenCSD platform, Randall demonstrated near instant settlement, as well as the record of each trade across multi-asset and multi-currency on one system, simplifying both reconciliations and some compliance functions. Randall stressed that for general use in financial markets, a blockchain had to process billions of transactions per day. He also noted it must do KYC/AML as a native, use real world money and assets, and be able to communicate between chains.

Value capture is the ability to retain some of the value for every transaction, usually defined by the revenue model, cost structures, or profit allocation in a company.

Cost reduction could be achieved by optimization of the value chain, both within a company and across the ecosystem. Reduced need for reconciliations and a transparent and consistent data source could increase efficiency internally for a firm, especially in the case of multinational institutions, which are naturally distributed. Transaction fees for the end customer should be reduced as the value chain collapses, challenging the current revenue model for some. Moreover, regulatory pressure to report transactions could ease if regulators had direct visibility over the canonical source of data. Cost reduction was an important discussion point amongst the participants looking to use the technology to solve current financial services inefficiencies.

Value communication of a company is the story of what differentiates them or their ethics, or it can be the distribution channels used to communicate that value.

Many participants did not believe that the underlying technology would change the method by which value is communicated, and moreover that the technology that underpins these products or services will not be a contributing factor to the communication of a firm's value.

From an ecosystem perspective, however, trust was a theme that emerged from several discussions, in particular those wishing to replace technology or replace markets. Peisl described the trust model that exists within and in between banks: "There is a lot of trust in the industry; an entire segment has their business model based on trust. So you cannot render that as being completely redundant because those institutions are the cornerstone of the financial markets today." This view was shared by Ransome, Randall, and Goutay.

Platt believed this necessity for formalized trust in the market precludes banks from implementing a permissionless blockchain solution, as privacy and confidentiality are of utmost importance to users of financial services. Ransome specified that for capital markets, a lot of the value proposition and creation comes from non-technological capabilities, such as customer insight, and did not believe that a technological paradigm shift will change that value-add. Reputation is an important communicating factor in the existing model of financial services.

Trust has been a recurring discussion in the field of blockchain and distributed ledger technology.[25] The recent BitFinex hack[26] adds to this discussion, as around U.S.$70m worth of bitcoins were drained from customers' accounts. To be clear, this was not a blockchain hack, but a hack to a piece of software in the surrounding economy,

25 Economist, 2015, "The trust machine: the technology behind bitcoin could transform how the economy works," October 31, http://econ.st/1kdABAZ

26 Kaminska, I., 2016, "Bitcoin Bitfinex exchange hacked: the unanswered questions," Financial Times, August 4, http://on.ft.com/2axwaj4

an exchange. Public/private key encryption, the method used to secure Bitcoin balances, relies on keeping the private key secret and safe. Unfortunately, this was not the case in the BitFinex hack and some members found their accounts completely drained. It is of the utmost importance to have somewhere safe and secure to store these keys. Perhaps somewhere that provides a level of protection akin to what we see in the traditional banking services now.

Within the existing financial services infrastructure, solutions are being sought for problems and inefficiencies that exist now. Although the trusted third parties may find their monopoly diminished, value propositions of intermediaries may become defunct and some value networks may collapse under the weight of this technology, massive cost reductions are predicted across markets, which will hopefully be passed onto the consumers. An institution that currently deals in trust could extend their value proposition to provide a secure storage for private keys and find they open up to new markets.

Outside of financial services directly, new markets and new customer segments are being sought. Propositions are emerging that create value for those unable to access services and enable users to deliver value to one-another directly and quickly.

Ownership as a value proposition was a common theme that emerged; from ownership of identity to emergent services such as voting and ownership of one's creative wares. Lewis specifically referenced being able to own, as a bearer, a digital good. "Bitcoin came along and suddenly we have the concept of self-custody of digital assets. I control my digital asset because I have the private key. I do not have to open an account with a third party and I do not have to request a specific third party to take action with my digital assets. I create a payments instruction, I broadcast it to the network and if it conforms to the rules of the network then the payment happens. I think there's something actually very profound about this concept in Bitcoin of being able to control your own digital assets." Meunier agrees: "I think the whole purpose of decentralization is to give back the ownership to individuals: ownership of their identity, of the content they produce, of their financial assets."

Live examples of new value propositions exist, often outside of financial services directly. Toni Lane Casserly described Steemit.com, which allows peers to tip other peers in cryptocurrency for written content, highlighting the possibility for artists to monetize their creations in a peer-to-peer manner instead of traditional payments traversing existing value chains in finance. Mainelli referenced SafeShare, which use blockchain technology to provide insurance solutions to sharing economy platforms and their users.

Rouven Heck also agrees that a value proposition will change: "[Application of] this [technology] will fundamentally change company's value position. Companies need to rethink what their actual value is." and elaborates: "I think with blockchain we can dismantle a value proposition into individual, modular ones and generate more competition in each of them rather than have everything bundled together. I think that's where it gets really interesting." An individual, modular value proposition could be safeguarding an identity or reputation, for instance. Tyler Welmans sees potential for a new value proposition whereby a firm attests to the validity of an identity. Goutay describes a future value proposition for a KYC firm, where tapping into data could result in a service offering currently not available that could give rise to new pricing models. "Identity data is fundamental to business and markets today so changing how it shared could drastically transform the way businesses operate."

Alterations of existing value networks and ecosystem were subthemes that emerged during discussions about value creation in a blockchain paradigm, in particular network effects. Welmans emphasized the network effect of identity on the blockchain; it is at its most powerful when the majority of services are connected and the user only has to change their details once, which is then communicated across the network. Conversely on network effects, Heck describes how current value creation in some models is ultimately an aggregation of reputation, and the largest network locks in users on both sides of transaction. This allows these firms to set the price on the size of their network, not the actual value of the service.

These are the two sides of the coin on network effects that tie back to Mainelli's assertion that distributed shared ledgers can disrupt monopolies. A trusted third party that sits necessarily on both sides of the transaction benefit from a network effect that can lead them to be able to set the prices. With the distribution of the data, or indeed the ownership of one's portable identity, we could see value creation for intermediary firms diminish in favor of value creation for the customers.

When it comes to key competencies in financial services, the current set consists of gathering and providing access to data, aggregating services, providing trust, storing assets, and facilitating transfer of those assets. With distributed ledger technology, competencies may move towards creating customer-focused solutions, facilitation of ownership, and attestation of proof-of-existence and transparency. Welmans believes blockchain could be the next step in the platform economy: "I think there's already a lot of focus on how organizations can reconsider some of the core competencies and structural components of their businesses and really evaluate whether or not some of the traditional parts of the business are necessary anymore, or whether there would be advantage in outsourcing or changing the way that they're managed. I think blockchain is the next step in that evolution. I don't think it's something totally new, but I think it is a continuation of that evolution towards much more digital, asset-light and

intermediation-based processes, products, and services that bring people together around platforms that contain the business logic."

Delivering value outside of traditional financial services, new customer segments and markets could be achievable by lowering the cost of KYC. Heck said: "We often hear about the unbanked. If we are able to provide a digital identity, there would be less friction to provide smaller services. To get a $5 loan or $20 loan, you might not need to go through an extensive KYC process because money laundering is less of a concern. I think there is a lot of potential in expanding the market." The global unbanked population of adults stands at over 2 billion. The World Bank has set itself the target of universal financial access by 2020, which will require them to "think about what they need to do differently" when it comes to current financial services infrastructure.

On a global level, blockchain has the potential to be a mechanism to provide heightened stability. Vinay Gupta is someone who does think differently. This global stability could be achievable by giving a token created on a blockchain intrinsic value: "We take the couple, 3, 5, 10 thousand most stable companies on earth with the most fundamental productive value. We take no more than 1% or 2% or 5% of the stock in any given company. We put all of that into an enormous ETF, Exchange-Traded Fund, and then we buy, sell, and trade using that token on a blockchain. At that point, you have a stable currency and the money supply expands and contracts according to the needs of the economy, because the share prices go up and down in harmony with demand. Then, if you want to put some politics on top of that, you could then have selection processes, the biased companies against the green or the socially just, when they're negotiating for inclusion inside of that fund.

Those kind of mechanisms, I think, are much more likely to be a real disruption caused by blockchain than banks doing their transaction processing without having to go through reconciliation."

When capturing value, a more equitable revenue or profit allocation through peer-to-peer models could be achieved by using a blockchain. In cryptocurrencies, the process of mining allows members of the ecosystem to capture value by participating in validating transactions onto the chain. Not only is this more equitably allocating the overall revenues, it incentivizes the network to continue.

Some noted the potential for declining ability to capture value. Casserly used the example of Steemit, the content creation platform, that facilitates direct peer-to-peer payments, circumventing both traditional publishing models and traditional payment models. Heck believes firms will be driven towards marginal costs through unbundling of services and increased competition. "I think identity and reputation will become more and more important. A portable reputation or identity could make it even harder for some platforms to monetise in the long term. Take a company that provides attestations or verifications of a cars or drivers, for example, issuing a certain token to the reputation of the driver after a successful inspection. This is a new service that doesn't exist in itself; it's something that Uber provides today implicitly, and that could be extended outside their network to other taxi drivers. I think that's back to this whole market economics that the platform, is the unbundling of existing service of today into its more modular, purest form of value that should drive to a more real cost."

Gupta ponders whether blockchain as a technology could be as difficult to capture value from as email: "I think what we're dealing with is a massive increase of baseline efficiency. Nobody has really succeeded at capturing very much of the value that is generated by email, yet email continues to generate enormous amounts of excess value for everybody that touches it."

Trust also emerged as a value communication theme within the new markets or new segments participants. The other side of the trust equation, however, aligns closer with Nakamoto's original intent. The technological characteristics of blockchain enforce the trust that payments will not be censored due its distributed nature, said Lewis and Gupta, or records altered due to immutability, said Casserly.

Another aspect of the change in communicating value is offering a more direct access by the customer to the product or service. For example, Gupta describes an example of an information market that can support a search across a number of platforms for the best solution, given a "fuzzy" criteria. In that sense, what is being communicated is efficiency of the solution, as opposed to a brand communicating the size of their platform. Heck described how people frequently return to the same few websites to access a product or service, and therefore the brand makes a difference in today's model.

Further building on the above, some respondents felt that the technology could lead to more customer-oriented solutions than today's offerings. For example, being able to self-custody assets, as noted by Lewis and Welmans, or products and services that enhance financial inclusion as described by Heck.

For Casserly, the value of a network is based on the community that uses it: "what all of these cryptocurrencies are about is actually the tangible value of the community existing in them. Money is actually becoming a tribal culture, not a symbol of nationalist pride that's controlled by one source."

Mainelli also discussed the community of a cryptocurrency: "Money is a technology that communities use to trade debts across space

and time. A cryptocurrency is a virtual element, not a currency, until there is a community for it." He highlighted the difference between a cryptocurrency and a digital currency, pointing out that a digital currency does not need a validation algorithm, such as the one employed in the Bitcoin blockchain or Ethereum blockchain, because the central bank would want to maintain control of transaction validation.

To move into new markets, these participants are using novel thinking to generate new business models. Propositions that allow one to self-custody value and retain ownership and control over one's own portable identity records could remove friction and may lead to the waning ability to capture value from network effects. Smaller and more modular value propositions and a review of core capabilities appear to follow the trend away from vertical integration towards a more open and collaborative ecosystem. While the technology might not be the protagonist of the story, it may well change the plot.

PARTING THOUGHTS

Blockchain, or DLT, shot to fame in payments and continued its trajectory in financial services. But some of the more interesting and genuinely innovative solutions occur by using the mechanism to transfer value of non-financial assets, such as identity. These new markets are nascent and even embryonic when compared to the colossal institutions that comprise global banking and capital markets. However, these emergent players intend to cater for overlooked needs and generate new business models around the technology. These are signs of both actively disrupting markets and ways to leverage disruption, respectively.

Banking and capital markets have ancient architecture and the industry as a whole is right to look for solutions to increase efficiencies and reduce cost. There is certainly a lot of work to be done. While the immediate disruption by blockchain, or distributed ledger technology, may not occur within the regulatory rigidity of the current infrastructure – after all, what are financial services if not a record of balances and transactions – traditional financial services should be mindful of the emerging model and ecosystems that are developing. They might look up and realize the world has changed around them.

FinTech in Developing Countries: Charting New Customer Journeys

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Abstract

A customer's journey is the path the customer travels to satisfy their needs and wants and will typically consist of several separate processes. FinTech product and service developers in advanced economies often understand how difficult many customers find their journey with banks and have been able the make the journey more pleasant and seamless. They are aided in this by their personal similarities to their customers in terms of background, education, and technological literacy. However, these similarities do not exist when products and services are being designed for customers in developing countries. In these markets, product designers need to rely on an evidence-based assessment of customer needs and wants, which will usually have to be specially commissioned, coupled, ideally, with visiting local villages and speaking to the local people who will be the potential customers for the products and services. The failure to appreciate the nuances of local customer journeys underlies many of the FinTech failures in the developing world.

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INTRODUCTION

Since the 1990s, customer relationship management (CRM) has been increasingly integrated into businesses worldwide. CRM has at its heart a sense of cross-functionality. It is a multifaceted organizational process of value creation,[2] aimed at developing and strengthening relationships with customers.[3] While many firms have implemented CRM systems, there is a mounting pile of literature indicating they now need to become acquainted with the concept of the customer journey or "experience."[4] The growing need to adopt a journey mindset is particularly apparent in the financial services sector, where CRM strategies adopted by established financial institutions have fallen short of embracing the customer journey. FinTech firms have stepped into this breach, by leveraging their understanding of the customer journey and providing superior, streamlined experiences. However, their efforts have largely focused on the journey of customers in the developed world. Most FinTech firms are yet to comprehend fully the markedly different journey faced by customers in developing economies. This matters for two reasons: first, there is real potential for FinTech firms to drive financial inclusion in developing economies and secondly, pioneering firms have demonstrated it can be a profitable enterprise. This chapter will accordingly seek to explore how FinTech firms have harnessed the concept of the customer journey and the scalability of existing strategies moving into the future, and out of the developed world.

CANVASSING THE CUSTOMER JOURNEY

It has been suggested that CRM aims to enhance "customer satisfaction before, during, and after a particular sale or service'[5] and that the technology supporting CRM has "moved toward covering the entire customer journey."[6] Whether this is the case demands greater scrutiny. Arguably, in the financial services sector, existing CRM strategies have failed in at least one of two ways: either they have failed to grasp adequately the distinction between a journey and a process;[7] or they have failed to reflect tangibly that understanding in the way they do business.

The first failure can result from an inadequate understanding of the customer journey. Similar to CRM, the notion of the customer journey has been subjected to various iterations.[8] As Zomerdijk and Voss explain, the customer experience can be conceptualized as the amalgamation of a series of "cues" that customers perceive throughout the pre-purchase, purchase, and post-purchase stages, and that can also flow on to new transactions.[9] In other words, such sensations can have a cumulative effect, influencing customers' subsequent interactions with the business. The customer embarks on a sensory experience, comprised of physiological, cognitive, and emotional responses, and accordingly such cues are heavily influenced by the surrounding physical environment. Regelman et al., explain the concept of the customer journey by contrasting the "journey" mindset with the "process" mindset.[10] Processes, such as credit review or loan approval, are to be distinguished from journeys, which are the paths customers take to satisfy their needs and wants. In this sense the customer journey may be comprised of several separate processes. Regelman et al. go on to explain: "Journeys embrace the full suite of interactions for a given activity and work to make the entire end-to-end chain streamlined, efficient, consistent, and personalized from the vantage point of the consumer."

The customer experience or journey is holistic and includes all of a customer's interactions with a product or service and,[11] importantly, is to be viewed from the subjective perspective of the customer as opposed to the company.[12]

In the wake of the digital revolution the customer journey has changed. For this reason, traditional marketing models have been criticized for failing to reflect the complexities of the modern customer experience.[13] The purchase funnel model, for instance,

2 Kotarba, M., 2016, "New factors inducing changes in the retail banking customer relationship management (CRM) and their exploration by the FinTech industry," 8 Foundations of Management 69, 70.
3 Wang, Y., and H. Feng, 2012, "Customer relationship management capabilities: measurement, antecedents and consequences," (50)1 Management Decision 115, 117.
4 For the purposes of this article, the terms "experience" and "journey" will be used interchangeably. See, e.g., Gentile, C., N. Spiller, and G. Noci, 2007, "How to sustain the customer experience: an overview of experience components that co-create value with the customer," (25)5 European Management Journal 395; Regelman, R., D. Hayes, O. Morbe, J. Lingel, and M. Reshef, 2016, "How digitized customer journeys can help banks win hearts, minds and profits," BCG Perspectives, June 2, http://on.bcg.com/1UjfPL8; Klaus, P., 2014, "Towards practical relevance - delivering superior firm performance through digital customer experience strategies," 15(4) Journal of Direct, Data and Digital Marketing Practice 306; Teixeira, J., L. Patrício, N. J. Nunes, L. Nóbrega, R. P. Fisk, and L. Constantine, 2012, "Customer experience modeling: from customer experience to service design," 23(3) Journal of Service Management 362.
5 Kincaid, J. W., 2002, Customer relationship management: getting it right!, Prentice-Hall, cited in Vella, J., and A. Caruana, 2012, "Encouraging CRM systems usage: a study among bank managers," 35(2) Management Research Review 121, 122.
6 Kotarba (2016), 69, 72.
7 Regelman et al. (2016).
8 For a useful summary of the various definitions of customer experience, see Garg, R., and Z. Rahman, 2014, "Measuring customer experience in banks: scale development and validation," (2014) 9(1) Journal of Modelling in Management 87, 89.
9 Zomerdijk, L. G., and C. A. Voss, 2010, "Service design for experience-centric services," 13(1) Journal of Service Research 67, 68.
10 Regelman et al. (2016).
11 See Harris, R., K. Harris, and S. Baron, 2003, "Theatrical service experiences dramatic script development with employees," 14(2) International Journal of Service Industry Management 84.
12 See Meyer, C., and A. Schwager, 2007, "Understanding customer experience," (85) Harvard Business Review 117, 118.
13 See, e.g., Court, D., D. Elzinga, S. Mulder, and O. Jørgen Vetvik, 2009, "The consumer decision journey," McKinsey Quarterly, June, http://bit.ly/20WHo5X.

conceived the customer journey as being segmented into a series of stages: namely awareness, opinion, consideration, preference, and purchase.[14] Its name derives from a metaphor for the process by which customers start by considering a variety of potential brands and filter those down to the one final brand they purchase. However, today's digital reality brings with it greater information richness:[15] customers now have access to unprecedented information by which they can research and compare products. This has significantly changed customer purchasing behavior, by exposing customers to more touchpoints and challenging the linearity of the purchase funnel process.[16] Russell Wager,[17] speaking with regard to the U.S. automobile industry, noted that the model is now more akin to a "funnel cake, where everything is twisting, turning, and inside out."[18] In the midst of all this change, it is clear that the modern customer experience remains a fertile ground for research.[19] One particular area of interest, which we seek to explore, is the changing treatment of the customer experience in the financial services sector.

THE FINTECH REVOLUTION

The FinTech phenomenon is the delivery of financial products and services via the marriage of technological platforms and innovative business models.[20] With its origins often traced to Silicon Valley, FinTech has expanded its reach to New York, London, Singapore, Hong Kong, and most global cities. The FinTech 100 – a list enumerating the top 50 established FinTech companies and 50 most promising startups – has been established to celebrate this success.[21] According to the FinTech 100, success stories include the likes of: ZhongAn (a joint venture between Alibaba Group Holding, Tencent Holidngs, and Ping An Insurance, which harnesses big data to provide online property insurance); Wealthfront (which delivers affordable but sophisticated investment management services); and Kreditech (which provides tailored financial services with a particular focus on access to credit, or as Kreditech calls it, "financial freedom for the underbanked").[22]

FinTech continues to grow globally. According to one survey, a weighted average of 15.5% of digitally active customers across six markets had used more than one FinTech product. In Hong Kong, the take-up was found to be significantly higher than average, with almost a third of digitally active customers using FinTech.[23] In the urban centers of highly developed nations, FinTech is building a momentum that has the capacity to disrupt the banking sector significantly. As it stands, small pockets of traditional banking are being penetrated by leaner, nimbler firms honing in on a limited set of superior online offerings with a "laser-like specific customer proposition."[24] According to a recent report by KPMG, 39% of executives polled consider FinTech to "pose a significant threat to the industry."[25]

FinTech services often provide greater ease of access, more attractive interest rates or lower fees, and "better online experience and functionality."[26] The focus of many FinTech firms on a select number of offerings mean they are better able to streamline business processes, allowing customers to satisfy their financial needs and wants predominantly, if not solely, through user-friendly online channels. When it comes to taking out a loan for instance, FinTech firms have a lot to offer customers who, perhaps due to low credit scores or geographical barriers, face difficulties accessing traditional sources of credit.

Consider, for example, Avant.com, which allows customers to take out an unsecured, personal loan and customize their payment plan online;[27] or Prosper, the first company to establish a peer-to-peer lending marketplace in the U.S.[28] Prosper has worked to increase individuals' willingness to invest in their peers by pooling funds and enabling investors to reduce their exposure by lending as little as U.S.$25. An individual seeking a loan can check their rate online, review and select from options, receive funds (once individual investors have agreed to fund their loan), and track their credit balance using the mobile application, Prosper Daily. Prosper loans are unsecured and online processes of credit review are based on credit history. By combining the concept of crowdfunding with the ease of online accessibility, Prosper has provided greater access to funds as well as opportunities for individual investors. It is a FinTech company weaving a series of processes into one coherent customer journey by staging customer interactions with the service on a digital platform.

14 Humphreys, A., 2015, Social media: enduring principles, Oxford University Press, 193.
15 Yen, Y.S., 2014, "The interaction effect on customer purchase intention in e-commerce," 26(3) Asia Pacific Journal of Marketing and Logistics 472, 475.
16 Bonchek, M., and C. France, 2014, "Marketing can no longer rely on the funnel," Harvard Business Review, May 7.
17 Marketing Vice President for Mazda's North American Operations.
18 Rechtin, M., 2014, "Marketers: auto purchase funnel is dead," 88(6621) Automative News 12.
19 Teixeria et al. (2012), 362, 363.
20 Chuen, D. L. K., and E. G. S. Teo, 2015, "Emergence of FinTech and the LASIC principles," 2, http://bit.ly/2dwKnwG.
21 H2 Ventures, 2016, "Leading global FinTech innovators 2015, FinTech 100, http://bit.ly/1sRaM7K
22 Kreditech Holding SSL GmbH, 2016, Kreditech, https://www.kreditech.com/.
23 Gulamhuseinwala, I., T. Bull, and S. Lewis, 2015, "FinTech is gaining traction and young, high-income users are the early adopters," 3(3) Journal of Financial Perspectives 16, 19.
24 Gulamhuseinwala et al. (2015), 16, 18.
25 KPMG, 2016, "Banks focus on digital platforms to enhance customer experience and keep pace with FinTech leaders," May 4, http://bit.ly/2d2PaHf.
26 Gulamhuseinwala et al. (2015), 16, 20.
27 Avant, 2016, "Personal loans," http://bit.ly/2dse1ov.
28 Prosper, 2016, "Borrow," https://www.prosper.com/.

In contrast, traditional banks have exhibited a tendency to digitize business processes piecemeal. While one process may be able to be completed online, the journey the customer takes to meet their specific need frequently traverses a series of processes, some online, some offline.[29] At the end of the day, the customer may still need to visit a physical branch and provide online and offline data to the "system." Perhaps the glacial pace at which banks have streamlined their processes is attributable to the considerable cultural shift that the move to digital represents. As Kotarba says, "[t]he traditional service of a financial institution in the 20th century was heavily based on personal interactions of advisors...and clients, primarily in the physical channels."[30] The familiar sight of complimentary mints in front of a smiling teller serves as a reminder that to some extent, the traditional notion that personal service is the best service may still linger. One would expect, however, that in an increasingly competitive landscape, the impact that enhancing the customer experience can have on the bottom line will catalyze the streamlining of processes into consistent customer journeys. Indeed, the pressure on banks to enhance the customer experience by integrating FinTech solutions is reflected in a recent KPMG report: of the executives polled, 51% indicated their bank had formed some kind of alliance with lenders operating in the peer-to-peer marketplace.[31]

The FinTech developer and customer profile: a mirror mage?

The Economist has attributed the success of FinTech to the "magical combination of geeks in T-shirts and venture capital."[32] This gives rise to a few questions. In particular, who are these "geeks" and has their background (as opposed to their fashion sense) impacted the products they create? A brief search reveals that the majority of the founders of FinTech start-ups share some characteristics. Ilya Kondrashov is a former Goldman Sachs analyst who graduated with a Bachelors in Economics degree from the University of Cambridge only four years before becoming the Chief Operating Officer at MarketInvoice. His co-founder, Anil Stocker, has the same degree (plus honors) and a finance-heavy background in private equity. James Dear, co-founder of iwoca, graduated with a PhD in stochastic calculus and theoretical physics from King's College London and worked at Deutsche Bank. Renaud Laplanche, founder and former CEO of LendingClub Corp. has (inter alia) a postgraduate degree in Tax and Corporate Law from Université de Montpellier, and an MBA from London Business School with work experience at Oracle Corporation. Nick Hungerford started his career at Barclays before graduating with an MBA from Stanford University and founding Nutmeg, a start-up in investment management services. So the list continues. The resumes of FinTech founders consistently bear degrees from some of the world's most prestigious universities and stints at leading financial services (or technology) institutions. This admittedly small sample suggests that FinTech is often developed by urban, well-educated and financially literate people of means.

Are these characteristics then a prerequisite for customers to effectively use FinTech products? It is tempting to hypothesize that the language of FinTech is only spoken by people with a base level of material wealth capable of supporting an education and familiarity with technology. A recent study sheds light on this issue.[33] FinTech use does indeed appear skewed towards "younger, higher-income groups," with higher use reported among respondents below 44 years of age, and below-average use by respondents aged over 44 years.[34] Only 6% of respondents earning less than U.S.$30,000 had used at least two FinTech products, whereas, among those earning more than U.S.$150,000, 44% were FinTech users. Urban dwellers were also far more likely to use these products and services, especially in New York where individuals were "twice as likely to take advantage" of FinTech. In summary, this study has been interpreted to confirm that "the stereotype of FinTech users being young, urban and higher-income would be on target."[35]

It seems that FinTech solutions have largely been targeted at customers who are like the developers themselves: living a tech-savvy, metropolitan existence with an above average income. Yet when it comes to the potential criteria of education and financial literacy, the answer is murkier, and reliable data is scarce. While financial literacy has been shown to be associated with higher incomes and levels of education,[36] financial literacy worldwide is surprisingly low. While several Nordic countries lead with scores of 71% in Standard & Poor's Global Financial Literacy Survey,[37] countries in which FinTech use is high are unremarkable in this respect. The U.K. ranks 6th with a score of 67%; Australia ranks 9th with 64%; Singapore (another FinTech centre)[38] is 12th on 59%; and the U.S. is 14th with 57%. And while FinTech may target the financially literate, it may also have a role to play in improving financial literacy. In a joint note on this topic, the World Bank and OECD (among others) observed that low levels of financial literacy are frequently "tied to lack of access to financial

29 Regelman et al. (2016)
30 Kotarba (2016), 69, 71.
31 KPMG (2016).
32 Economist, 2015, "The FinTech revolution," May 9, http://econ.st/1H2hwbP.
33 Gulamhuseinwala et al. (2015), 16.
34 Gulamhuseinwala et al. (2015), 16, 21.
35 Marous, J., 2016, "FinTech growth poised to disrupt banking industry," LinkedIn, January 7, http://bit.ly/2duTjDj.
36 Xu, L., and B. Zia, 2012, "Financial literacy around the world: an overview of the evidence with practical suggestions for the way forward," working paper no. 6107, World Bank Development Research Group, 12, http://bit.ly/2dJKJUF.
37 S&P Global, 2016, "Standard & Poor's ratings services global financial literacy survey," http://bit.ly/28NMCtA.
38 International Trade Administration, 2016, "ITA FinTech top markets report," U.S. Department of Commerce, http://bit.ly/2dR9Owi.

products."[39] In providing easy-to-use financial products and services, which focus on a single value proposition and are frequently accompanied by the ability for the customer to monitor their use of the product or service, FinTech may expose more customers to basic financial concepts. These observations become important when we consider the potential of FinTech to provide new solutions to enduring problems in developing economies.

Understanding the customer journey in developing countries

From the cityscapes of Hong Kong to the buzz of Silicon Valley, FinTech has emerged from the world's most urbanized centers. In these places, FinTech developers can safely assume that their target customer demands (and is already familiar with) technological solutions to life's inconveniences and can proceed to develop a product on this basis. Yet developing economies present a far more challenging terrain. For customers in these economies, the experience of obtaining financial services is vastly different and these differences need to be accommodated for FinTech to thrive in new markets.

Each economy presents a unique landscape of customer demand. The importance of understanding local context has been emphasized by Buckley and Malady by contrasting two markets: the Philippines and South Africa. Mobile money payments have flourished in the Philippines, where there is high demand for the international transfer of funds, as well as between urban and rural areas, but have not flourished in South Africa, where customers have "little incentive… to replace their existing methods of accessing funds."[40] The need for FinTech developers to understand local customer demand cannot be understated but the brevity of this analysis precludes detailed consideration of the nuances of each developing economy. Instead, we will proceed to canvas the more general challenges faced by FinTech developers in emerging economies and potential responses to them. The challenges typically include an unaccommodating suite of services provided by formal financial institutions, low institutional quality, low financial literacy, and extensive financial exclusion.

Common barriers to financial access in developing countries

The nature of the banks themselves raises barriers to financial access. In particular, physical distance between borrowers and lenders inhibits the availability of financial services.[41] For most banks, it is not feasible to absorb the fixed costs of setting up branches in rural communities, where demand and population density are low (and where security may be an additional concern). Pedrosa and Do helpfully deconstruct the impact of distance on credit markets, using Niger as a case study.[42] Geographic distance is said to impose a direct transaction cost (that is, the transportation costs associated with providing the financial services), as well as an increase in monitoring costs; and both tend to translate into higher interest rates for credit.[43] Further, for many customers in remote, rural areas where subsistence farming is common,[44] fluctuating weather patterns make it difficult to know precisely when they can afford to start making loan repayments. This serves to increase risk in the eyes of the lender and again translates into higher interest rates. Low competition between financial institutions reinforces the relatively high costs of opening and maintaining a bank account, which can include requirements as to a minimum account balance. Customers who live in remote, financially underserviced areas are, therefore, at risk of being "excluded from the semi-formal credit market" and those who can overcome this obstacle bear the brunt of higher costs.[45]

These obstacles also stand against a background of low institutional quality, which is determined (among other factors) by a country's level of development.[46] Institutional quality encompasses the extent of adherence to the rule of law, the level of protection for investors, the strength of contract enforcement, and the quality of property rights.[47] Rojas-Suarez has measured institutional quality using the World Bank's governance indicators and observed a "clear positive relationship between adherence to the rule of law and financial access."[48] In developed countries, high levels of institutional quality accompany greater access to financial products and services, whereas the opposite is true in emerging economies. Explanations include the view that microfinance institutions (MFI) concerned with their bottom line interpret a weak rule of law as reflecting the presence of a largely informal economy.[49] This in turn may indicate an environment in which loans will be smaller in size, local demands

39 The World Bank, U.K. Department for International Development, Organisation for Economic Co-operation and Development, and Consultative Group to Assist the Poorest, 2009, "The case for financial literacy in developing countries: prompting access to finance by empowering consumers," joint note, 4, http://bit.ly/2dRU8VX.

40 Buckley, R. P., and L. Malady, 2015, "The new regulatory frontier: building consumer demand for digital financial services," 132(1) The Banking Law Journal 35.

41 Gibson, E., F. Lupo-Pasini, and R. P Buckley, 2015, "Regulating digital financial services agents in developing countries to promote financial inclusion," Singapore Journal of Legal Studies 26.

42 Pedrosa, J., and Q-T. Do, 2011, "Geographic distance and credit market access in Niger," 23(3) African Development Review 289.

43 Pedrosa and Do (2011), 289.

44 Blades, D., F. H. G. Ferreira, and M. A. Lugo, 2011, "The informal economy in developing countries: an introduction," 57(1) Review of Income and Wealth S1.

45 Pedrosa and Do (2011), 289, 298.

46 Alonso, J. A., and C. Garcimartín, 2013, "The determinants of institutional quality: more on the debate," 25(2) Journal of International Development 206, 217.

47 Levchenko, A. A., 2004, "Institutional quality and international trade," working paper no. 04/231, International Monetary Fund, December, 2; Chong, A., and C. Calderón, 2000, "Institutional quality and income distribution," 48(4) Economic Development and Cultural Change 761, 761.

48 Rojas-Suarez, L., and V. Gonzales, 2010, "Access to financial services in emerging powers: facts, obstacles and policy implications," background paper for the Perspectives on Global Development 2010 Shifting Wealth, OECD Development Centre, 21.

49 Quintin, E., 2008, "Contract enforcement and the size of the informal economy," 37(3) Economic Theory 395.

difficult to accommodate, and profitable opportunities scarce. In a unique study on the impact of institutional quality on MFI outreach, Barry and Tacneng conclude that shareholder-owned MFIs (particularly banks) tend to engage in credit rationing and other financially exclusive behaviors in countries where the rule of law is shaky and contract enforcement poor.[50] This in turn means that many customers in developing economies are the victims of a self-perpetuating cycle: where a sizeable informal economy limits lending from shareholder-owned banks and forces many customers to use informal loans.

Financial literacy is also particularly low in developing countries,[51] such as Pakistan, where of those aged above 25, a mere 13% have a bank account.[52] This is significant because high levels of financial literacy can benefit quality financial products and services, as they enable better-informed customers to compare options and place competitive pressure on providers.[53] On an individual level, financial literacy can also empower people to take control of their financial position, protect themselves against fraudulent schemes, and boost their overall wellbeing.[54] As Kefela summarizes, the inverse of this is that "those who are less financially literate are more likely to have problems with debt, are less likely to save, are more likely to engage in high-cost mortgages, and are less likely to plan for retirement."[55] The challenge for FinTech developers in emerging economies is that financial solutions must be developed for individuals with a limited understanding of basic financial concepts or who have only been exposed to them in the context of informal loans. In essence, FinTech products and services must aspire to a new level of accessibility and ease of use.

Much ado about microfinance

For all these reasons, financial illiteracy and exclusion matters, particularly as they often lead to a broader social exclusion.[56] In an attempt to improve access to financial services for the unbanked, microfinancing has become increasingly available. Togba explains that microcredit plays a vital role in promoting entrepreneurialism and investment in "poor rural and urban economies where it is difficult to save."[57] In recognition of these benefits, the Asian Development Bank continues to provide multi-million dollar loans to fund microfinance operations in countries such as China, Papua New Guinea, and Uzbekistan. Nonetheless, microfinance is not without its critics.[58] A core concern with microfinancing relates to its long-term implications, taking into consideration the high failure rate of microenterprises. Business failure followed by an inability to repay microloans can potentially "lead to irretrievable poverty."[59] However, Solomon helpfully reminds us that "[t]he poor are not irrational. They are aware of the high failure rates of informal microenterprises funded by borrowing."[60] With this in mind, Solomon suggests that the rigid repayment plans and relatively high interest rates charged by existing microfinance institutions drive borrowers (especially those who are uncertain of precisely when they can begin repayments) to use informal credit sourced from friends and relatives.

It would appear that microfinance has opened up new opportunities for some, but certainly not all, potential borrowers. For many of the poorest households and smallest enterprises, the costs of obtaining microcredit remain too high. There is a considerable segment of the population in developing regions that have "viable investment opportunities [but] persist…in poverty for lack of access to credit at reasonable costs."[61] According to the World Bank Global Findex database, less than half of the adults "in the poorest 40% of households in developing countries" have bank accounts.[62] Low-income households and small enterprises continue to face particular challenges in obtaining access to credit: chief among them is information asymmetry and the transaction costs which arise from it.[63] Small enterprises frequently pose greater risks as they lack collateral, lack diversification when it comes to their sources of income, and lack transparency when it comes to their financial statements.[64] Small transactions attract high costs for formal banks. Certain fixed costs must be borne by the bank irrespective of loan size, rendering monitoring costs for small loans relatively high. Given the high risk associated with the lack of information on the borrower's creditworthiness

50 Barry, T. A., and R. Tacneng, 2014, "The impact of governance and institutional quality on MFI outreach and financial performance in sub-Saharan Africa," 58 World Development 1.

51 The World Bank et al. (2009), 4; Klapper, L., A. Lusardi, and P. van Oudheusden, 2015, "Financial literacy around the world: insights from the Standard & Poor's Ratings Services global financial literacy survey," 1, 7, http://bit.ly/2dsjcVB.

52 Shankar, S., 2016, "Bridging the "missing middle" between microfinance and small and medium-sized enterprise finance in South Asia," working paper no. 587, Asian Development Bank Institute, July, 17.

53 Kefela, G., 2010, "Promoting access to finance by empowering consumers – financial literacy in developing countries," 5(5) Educational Research and Reviews 205.

54 See, e.g., Calderone, M., 2014, "The role of financial literacy and of financial education interventions in developing countries," IDEAS Working Paper Series from RePEc.

55 Kefela, G., 2011, "Implications of financial literacy in developing countries," 5(9) African Journal of Business Management 3699.

56 Claessens, S., 2006, "Universal access to financial services: a review of the issues and public policy objectives," in OECD and the World Bank, "OECD trade policy studies liberalisation and universal access to basic services: telecommunications, financial services and electricity," OECD Publishing, 175, 180.

57 Togba, E. L., 2012, "Microfinance and households access to credit: evidence from Côte d'Ivoire," 23(4) Structural Change and Economic Dynamics 473.

58 Barry and Tacneng (2014), 1.

59 Bateman, M., 2011, "Microfinance as a development and poverty reduction policy: is it everything it's cracked up to be?" Overseas Development Institute, March, http://bit.ly/2dwTSMB.

60 Solomon, L. D., 2014, "Alleviating global poverty," Xlibris Corporation, 93.

61 Asian Development Bank, 2000, "Finance for the poor: microfinance development strategy," http://bit.ly/2cSQ45H.

62 The World Bank Group, 2016, "Overview," http://bit.ly/1PWkuDJ.

63 Behr, P., A. Entzian, and A. Güttler, 2011, "How do lending relationships affect access to credit and loan conditions in microlending?" 35(8) Journal of Banking and Finance 2169.

64 Rojas-Suarez and Gonzales (2010), 20.

and the absence of physical collateral, such transactions are frequently perceived to be not worthwhile.[65] If credit is provided, the increased costs tend to be passed on to the borrower, in the form of higher interest rates or greater security requirements than the banks would otherwise require. Given their preference for smaller loans, low-income households "face disproportionately high transaction costs in the formal financial sector."[66] Formal financial institutions may additionally require individuals to provide considerable documentation to open an account. This requirement is difficult to meet for those who work in informal employment markets and lack formal documentation to support their claims as to income.[67]

While microlending in developed economies suffers from similar ailments of moral hazard and adverse selection, Behr et al. (2011) observe that "weaker or non-existent accounting standards" as well as poor legal enforcement measures serve to exacerbate the problem in developing countries. Through empirical analysis, the authors suggest that relationship building between lenders and borrowers can reduce information asymmetry and improve access to credit over time. Their Mozambique-based study indicates that the greater the strength of the relationship, the greater the chances (and timeliness) of loan approval. Loan conditions also appear to improve, as the development of greater trust between borrower and lender encourages lenders to reduce the level of collateral required for that same borrower's subsequent loans. Until solutions such as these can be implemented, despite microfinance, a significant proportion of the developing world lives beyond the reach of the financial services sector.

It is not only low-income households and the smallest of enterprises that have fallen through the cracks. Among the underbanked are those who fall into the "missing middle": the enterprises that require funding beyond the limits of microcredit, but whose credit needs fall beyond those which commercial banks are typically willing to satisfy for small and medium-sized enterprises.[68] The missing middle is "an entrepreneurial desert": a financing gap that persists in contributing to financial exclusion.[69] This is particularly apparent in African regions with lower levels of economic activity.[70]

Pioneering FinTech companies should map out a new customer journey

In developing economies, FinTech has the capacity to be profitable and pave the way for a more inclusive financial system: one where financial products and services cater to the needs of individuals and enterprises across all income levels.[71] FinTech could play a vital role in reducing financial exclusion in countries such as the Republic of Azerbaijan. Only 29.2% of Azerbaijanis above 15 years of age have a bank account; and, of those, approximately half use traditional savings passbooks rather than debit cards facilitating electronic payments.[71] It should be noted that Azerbaijan has had a recent currency devaluation engendering customer mistrust and a reluctance to save money at banks. Mobile banking is in its infancy and currently limited in both accessibility and functionality. Yet, despite these obstacles, Azerbaijanis have demonstrated a willingness to use innovative financial technologies. The usage of self-service kiosks is steadily increasing as "customers have begun to trust the machines with bill payments and loan repayments alike…[demonstrating that] low-income customers can quickly warm to technology-enabled channels, if well designed."[73] The stance adopted by the Central Bank of Azerbaijan appears to be encouraging innovation as it makes room for new innovators to operate alongside banks in providing financial services.

In countries that have exhibited a willingness to experiment with innovative new products, there are myriad ways in which FinTech can flourish. To provide superior experiences, however, FinTech companies must develop and refine their understanding of customers (and their needs) in the specific developing country and their current experiences with accessing financial products and services. By way of example, by understanding existing pain points in the customer journey, FinTech can provide the avenues by which microlenders can become better acquainted with their customers, which Behr et al. (2011) suggested would reduce information asymmetry and the increased costs that come with it.

Digital payments are another promising field for FinTech companies. These can reduce many of the risks associated with cash-based transfers. They can enhance security and transparency of payments, lower costs, and for many can constitute an important "first entry point into the formal financial system.'[74] This is particularly evident in sub-Saharan Africa, where mobile money accounts have

65 Kalmykova, E., and A. Ryabova, 2016, "FinTech market development perspectives," SHS Web of Conferences, http://bit.ly/2cS8CIc.

66 Togba, E. L., 2012, "Microfinance and households access to credit: evidence from Côte d'Ivoire," 23 Structural Change and Economic Dynamics 473, 483.

67 Rojas-Suarez and Gonzales (2010) 20.

68 Shankar (2016).

69 Anderson-Macdonald, S., 2013, "Transforming the missing middle," 24(1) Business Strategy Review 59.

70 See Fafchamps, M., 1994, "Industrial structure and microenterprises in Africa," 29(1) Journal of Developing Areas 1; Grimm, M., P. Knorringa, and J. Lay, 2012, "Constrained Gazelles: high potentials in West Africa's informal economy," 40(7) World Development 1352, 1352.

71 Buckley and Malady (2015) suggest that regulators have a role to play in facilitating innovation and more generally in encouraging greater provision of financial services in developing countries.

72 Saxena, A., 2015, "Republic of Azerbaijan: electronic payments and financial inclusion," ADB technical assistance consultant's report, September, 8.

73 Saxena (2015), 5.

74 World Bank Development Research Group, Better Than Cash Alliance, and Bill & Melinda Gates Foundation, 2014, "The opportunities of digitizing payments," The World Bank Group, August 28, http://bit.ly/2d2WNxf.

already demonstrated their ability to drive financial inclusion. Mobile money accounts are held by 12% of adults – a high proportion relative to the global average of 2%. In fact, nearly half of those with an account reported it was their only financial account.[75] Mobile money platform, M-Pesa, has clearly been a key driver of this movement. M-Pesa enables individuals to transfer funds and pay bills by using text messages as a vessel to carry digital currency. This service has demonstrated an acute understanding of the nature of the customer experience, particularly from the perspective of those who work in the city and seek to provide financial support to family members in rural communities. These customers were previously constrained by the high cost of transferring money, security concerns associated with carrying cash, and sheer distance from brick-and-mortar financial institutions. By harnessing this understanding of key pain points in the customer journey, M-Pesa has enabled customers to surmount these obstacles through using their existing mobile phones. Customers sign up with M-Pesa and credit money to their M-Pesa account by depositing cash in local corner shops that also serve as Safaricom agents. To send funds to others (who do not have to be registered with the service), customers use a menu on their phone to simply enter the recipient's phone number and the amount to be transferred. Once the text message is received, the recipient can then either deal with the money on the mobile platform (if registered) or can make their own visit to a local Safaricom agent and physically withdraw cash.

By requiring only that customers have a simple, SMS-enabled phone and are able to deposit some cash into an account, M-Pesa leverages existing infrastructure to deliver the simplicity and accessibility required of FinTech offerings in developing countries[76] As one commentator noted: "[p]aying for a taxi ride using your mobile phone is [now] easier in Nairobi than it is in New York."[77] M-Pesa successfully facilitated 4.1 billion transactions by Kenyans in 2015, almost double that facilitated in 2014.[78] M-Pesa has also recently extended its offerings to the provision of credit. It has combined forces with Kenya Commercial Bank to provide small loans to loan applicants previously not considered creditworthy. KCB M-Pesa loans utilize default interest rates with options including 30-day loans at 6% per month and 180 day loans at 4% per month. With approximately 80% of loan applications accepted,[79] the KCB M-Pesa collaboration has demonstrated a high level of accessibility.

Another example of FinTech transforming the financial services landscape is First Access, a data analytics company that has used a combination of weather, market pricing, and agricultural input data to develop unique credit scoring algorithms. These algorithms are specifically designed for borrowers in the agricultural sector of sub-Saharan Africa. Following a pilot study in Tanzania, microfinance organization FINCA has partnered with First Access to provide uncollateralized loans across east Africa. The latter leverages its data analytics capabilities to form credit scores from local mobile phone usage of FINCA's existing client database. In doing so, individuals in countries such as Zambia, Uganda, and Nigeria who lack a formal credit history, but possess mobile phones, can obtain loans more easily. This collaboration was underpinned by a clear understanding of the challenges experienced by its target customers, including low levels of financial literacy, geographical barriers, unpredictability of crop yields inhibiting the development of realistic repayment schedules, and information asymmetry exacerbating loan conditions for borrowers. As CEO of First Access, Nicole Van Der Tuin has explained, the collaboration enables FINCA "to make more reliable, real-time predictions about the creditworthiness of people who have never been a part of the formal financial system."[80] The FINCA and First Access collaboration reinforces: (i) the utility of market research and pilot programs in understanding local context, and (ii) the capacity of FinTech companies to leverage knowledge of customers' current experience and design products that increase access to, and streamline the provision of, financial products and services in developing countries.

CONCLUSION

FinTech has exhibited great promise in developed economies by providing customers with a highly accessible and streamlined path to fulfilling their financial needs and wants. While FinTech remains strongest in developed countries, [81] investment is growing in developing countries and with some exceptional results. Expanding FinTech services into developing countries and tapping into unbanked markets remains attractive. However, as many can attest, failure usually awaits those who simply transfer their existing products and services to different markets. Ultimately, for FinTech to succeed in most developing economies, its developers and providers must begin to familiarize themselves with some different and unique customer journeys.

75 The World Bank Group, 2014, "Sub-Saharan Africa," http://bit.ly/1jwiSAe.

76 See The World Bank, 2013, "Mobile payments go viral: M-PESA in Kenya," http://bit.ly/1lPsYdT.

77 Economist, 2013, "Why does Kenya lead the world in mobile money?" May 27, http://econ.st/1zPLhD.

78 Ondieki, E., 2016, "M-Pesa transactions rise to Sh15bn daily after systems upgrade," May 8, http://bit.ly/2dsorEM.

79 Aglionby, J., 2016, "FinTech takes off in Africa as lenders tap mobile technology," Financial Times, May 17, http://on.ft.com/2d2Z0Jg.

80 FINCA, 2016, "FINCA and First Access announce world's largest microfinance FinTech collaboration," http://bit.ly/2dx0pXu.

81 The U.S. invested U.S.$7.6 bln in FinTech in 2015: KPMG, 2016, "FinTech funding hits all-time high in 2015, despite pullback in Q4" KPMG and CB Insights, March 9, http://bit.ly/1sGpKny.

FinTech product and service designers cannot, in developing countries, rely upon their intuitive understanding of what customers may need. The gulf between the backgrounds and life experiences of designers and customers ensures this is impossible. The designers need to rely on an evidence-based assessment of customer needs and demands. In most markets this will have to be especially commissioned as these markets are typically data-poor environments; and, if broadly relevant data exists, it is likely to be a typical demand-side survey commissioned by the local central bank that is highly unlikely to provide the precise sort of information required. Indeed, we would recommend the product and service designers go beyond commissioning a sanitized survey (necessary as this step is) and actually visit some of the rural villages where the greatest needs for their products and services will exist, and talk to the local people about the difficulties in their financial lives and how technology could assist with relieving them. Local knowledge and understanding of the problems potential customers face and their financial literacy levels is the key to the successful design and implementation of FinTech products and services in developing economies.

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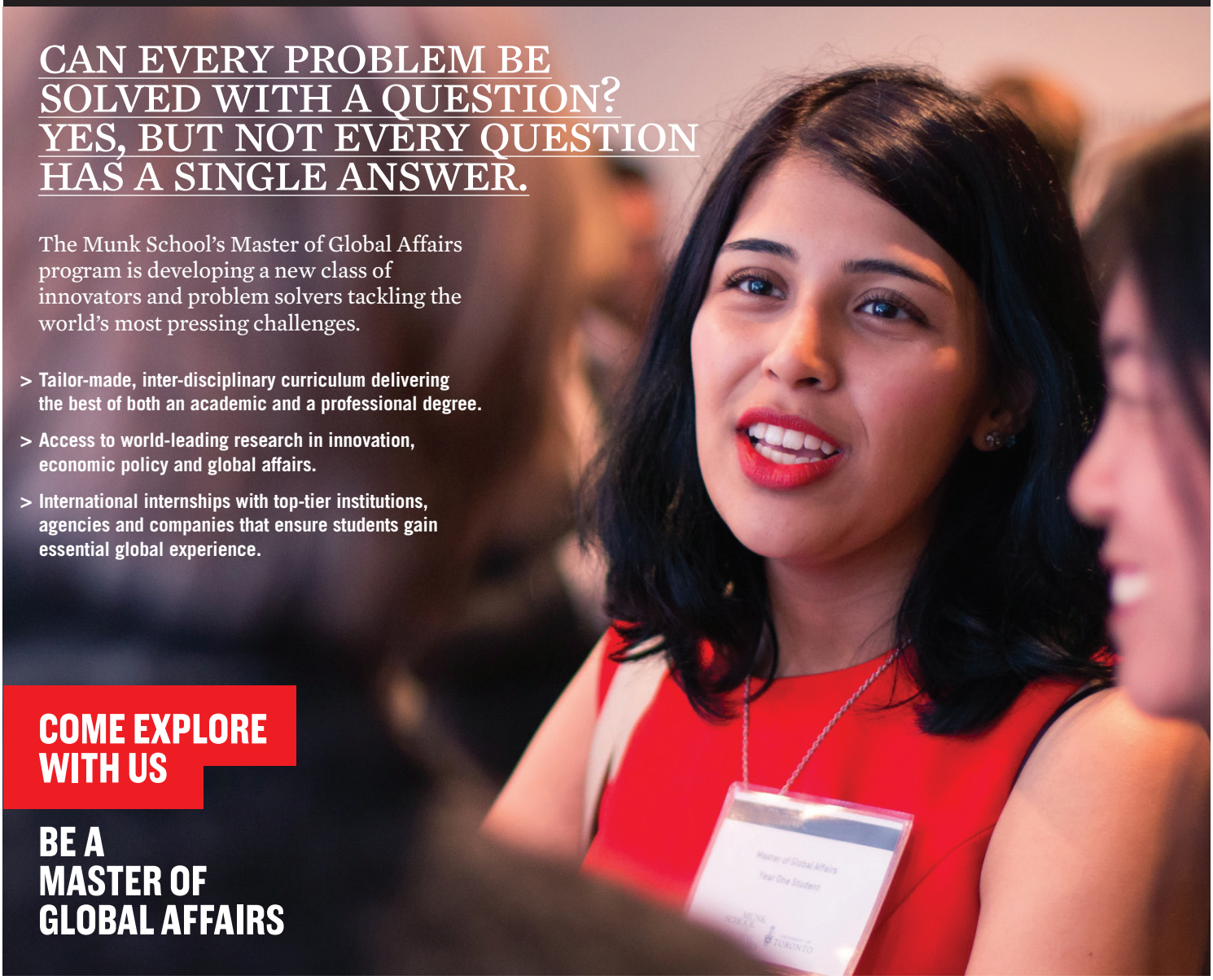

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