

Finance and Technology: What is changing and what is not

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Abstract

Technology has long had a profound impact on financial services. Today, it is changing the range of services offered, as well as their delivery, cost, and accessibility. Yet, despite the explosion of small firms applying new technologies, very few of these new *fintech* companies have a broad influence on financial activity. Even in some sectors with significant entry, unit costs of financial intermediation remain stubbornly high. At the same time, there are notable successes, especially in the provision of payments and credit in China. Going forward, the impact of fintech is likely to be greatest where existing suppliers lack competitive incentives or sophistication.

Over the next decade, the decisions of regulators will have a profound influence on the array of financial services available, on how they are delivered and to whom. In the advanced economies, regulators generally support greater fintech competition, favoring lower costs and improved access. Furthermore, as Big Tech firms and large, incumbent financial institutions vie for dominance of financial services, their large fintech investments make them increasingly alike. Over time, it is anyone's guess which of these firm types will win the race to dominate financial services.

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Table of Contents

Sections

I.	Introduction	2
II.	Setting the Stage	4
III.	The Role of Finance in the Economy	15
IV.	How is Technology Changing Financial Services	20
V.	Regulatory Responses	27
VI.	Where is the Financial System Heading?	31
VII.	Concluding Remarks	34
	References	36

Boxes

A.	What is fintech?	3
B.	Recent technological innovations that enable finance	21
C.	Privately issued digital currency: the case of Libra	29
D.	Central bank digital currency	33

Figures and Tables

Figure 1:	Unit costs of financial intermediation in the United States, 1860-2015	6
Figure 2:	Changing composition of financial intermediation, banks and nonbanks	7
Figure 3:	Number of fintech financing deals, globally, 2015-2019	8
Figure 4:	Average cost of sending US\$20 across border, 2008-2019	10
Figure 5:	Relationship between interest rates charged and realized returns, 2010-2018	13
Table 1:	Primary services of the financial system	16
Table 2:	Traditional financial institutions	18
Table 3:	Functions provided by traditional intermediaries	19
Table 4:	Examples of how technology is changing delivery of financial services	22

I. Introduction

How is technology influencing the structure of the financial system? How are traditional intermediaries evolving? To answer these questions, we distinguish between the financial services and the institutions or mechanisms that deliver them. Driven by changes in technology, both have changed significantly over recent decades, and are continuing to evolve.

We have gone from paying with coins and paper to cards and electronic wallets. Online creditors now provide loans within moments of receiving an application. Virtually anyone can trade corporate equities using a mobile phone or tablet. Index-linked mutual and exchange-traded funds have fueled a shift toward low-cost, passive investing, while robo-advising supplies customized portfolio selection. Derivatives make it possible to separate and price virtually any set of payments and risks. The list goes on.

To understand the evolving relationship between finance and technology, we start with a description of the fundamental services that finance provides to society. How do individuals and businesses use finance? What are the functions of the system?

Simply put, traditional intermediaries—banks, insurance companies, asset managers, pension funds, and the like—exist for reasons that technological progress has not changed and will not change. We will always have need for access to the payments system and financial markets, for the ability to diversify risk, for loans, and for safekeeping, among others. In addition, every effective financial system must contend with the information asymmetries that are inherent in all financial relationships. To overcome pervasive adverse selection and moral hazard problems, nearly all intermediaries collect and process information in order to screen and monitor counterparties.

Technological progress in recent decades has vastly reduced these costs of collecting information, just as it has slashed other costs of transaction—such as the cost of implementing, communicating and verifying payments and trades. So, it is natural to think that technical advances will continue to change the financial industry. Will they alter the delivery of financial services, the organization of the industry, or both?

The answer is almost surely *both*.

Examples of changing services abound. Cloud computing services provide storage and analytics for extremely large data sets. Combined with artificial intelligence and machine learning systems, these improve the speed and accuracy of credit assessment, aid regulatory compliance, and help prevent fraud. Smart phones, in use by more than half of the world's adult population, provide access to a broad array of services including payments and online banking, even for people who have never been near a physical bank.¹

With regard to the organization of the industry, the most obvious change is the large increase of small, new firms: around the world, thousands of startups are vying to provide financial services, either directly to users, or to the intermediaries currently serving them.² In some markets—especially China—what were startups less than a decade ago have become the dominant players in areas like e-commerce payments and online credit provision.

To explore how technology will further transform the financial industry, we begin by describing the traditional functions of the financial system and discussing the configuration of intermediaries providing them. This simple exposition makes clear where incumbents are relatively competitive. Unsurprisingly, we currently see the most entry in the areas where cost-cutting opportunities and gains from scale are greatest, such as the provision of electronic payments and credit. To continue, we discuss where technological innovations are likely to lead legacy institutions to change and where they are more likely to lead to (potentially disruptive) entry. Next, we look at examples of fintech entrants by service. Who is doing what?

In the final sections of the paper, we ask what regulators are doing to meet their established objectives of protecting consumers, ensuring markets operate effectively, and safeguarding the resilience of the financial system. Finally, we speculate on what the financial system will look like a decade now. Will incumbent banks retain and expand their dominance, or will Big Tech

¹ See Gomber et al (2018) for a discussion of the key forces driving what they call the fintech revolution and Gomber et al (2019) survey of recent academic research.

² Findexable (2019) counts 7,000 companies in 230 cities across 65 countries in 2019. Other sources, such as [statista.com](https://www.statista.com), suggest that, globally, there are over 20,000 fintech firms.

firms take their place? The two are becoming more alike, so which one wins the race is anyone's guess.

Box A: What is fintech?

There are two approaches to defining the term “fintech.” The first is *implicit*: take different financial services, and then list the new firms that are providing them in innovative ways. For example, Loo (2016) provides such an implicit definition when he writes that fintech “focuses on consumer services such as bank accounts, payments, financial advice, and loans.” KMPG (2019) takes a similar approach in their publication entitled *Fintech 100: Leading Global Innovators*. Based on observing the activity of firms, an implicit definition means that you know fintech when you see it.

An alternative approach (and the one we follow) is based on a set of *explicit* attributes. Here are a few examples:

- Arner et al (2015): “the application of technology to finance.”
- Boot (2017): “new technology driven players entering the financial services industry.”
- Ehrentraud (2020): “technological innovations in financial services.”
- Financial Stability Board (2017): “technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services.”
- Navaretti et al (2017): “the novel processes and products that become available for financial services thanks to digital technological advancements.”
- Thakor (2020): “the use of technology to provide new and improved financial services.”
- Philippon (2016): “digital innovations and technology-enabled business model innovations in the financial sector. Such innovations can disrupt existing industry structures and blur industry boundaries, facilitate strategic disintermediation, revolutionize how existing firms create and deliver products and services, provide new gateways for entrepreneurship, democratize access to financial services, but also create significant privacy, regulatory and law enforcement challenges.”
- World Bank (2017): “companies or innovations that employ new technologies to improve or innovate financial services.”

From these, we derive the following working definition:

Fintech is the application of technology to finance that lowers the unit costs of providing financial services, and makes them better, faster, cheaper, broader, and more accessible.

II. Setting the Stage

To set the stage, we start with a definition of fintech. While no definition can be both precise and comprehensive, simplicity has its own virtue. As a working definition in this paper, we use the following:

Fintech is the application of technology to finance that lowers the unit costs of providing financial services, and makes them better, faster, cheaper, broader, and more accessible.

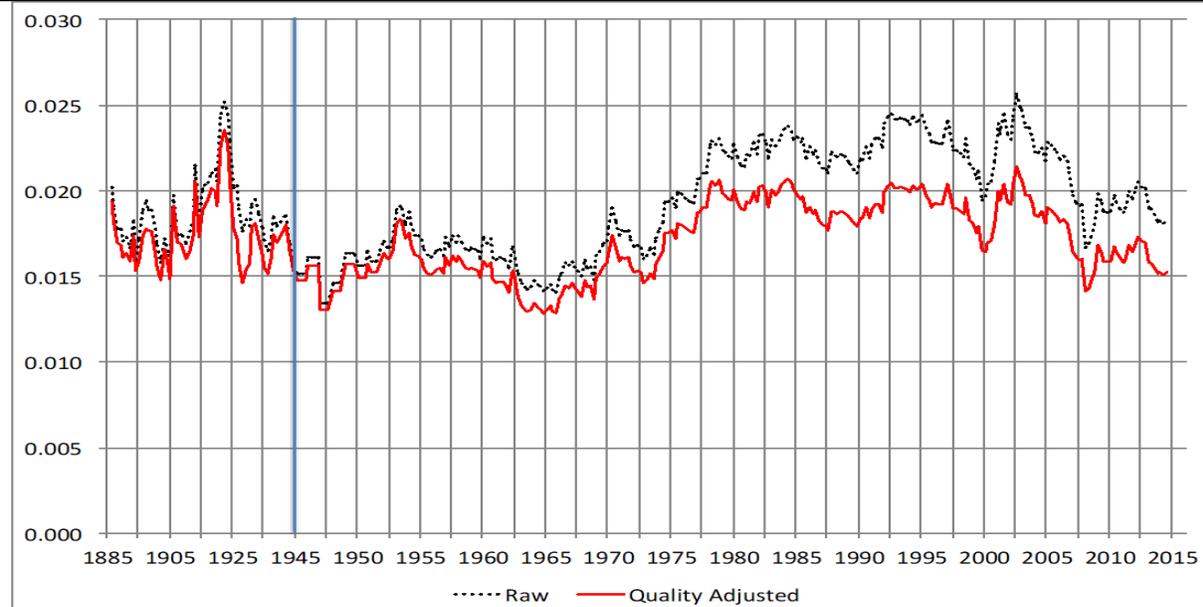
In practice, fintech may alter both how financial services are delivered and who delivers them. While regulators generally should welcome these changes, fintech also may have undesirable side effects (for example, with regard to privacy, criminality and cross-border capital flows) that require that authorities remain vigilant. (See Box A for various alternative definitions of the term fintech.)

To build on this definition, we provide some evidence on costs and on the composition of the financial sector, and illustrate using two examples of where fintech is trying to make inroads.

The most striking fact that we know of in finance is that, despite massive and continuous technological advances over many decades, the unit cost of financial intermediation (measured as the ratio of financial institutions' income to the volume of liquidity, credit and asset services they provide) has changed little. Thomas Philippon (2016) estimates that, in the United States, this unit cost has been stuck in the 1½% to 2% range for the past 130 years (see Figure 1)! That is, it still costs nearly 2 cents for the financial industry to create one dollar's worth of assets. Put differently, intermediaries have not passed on the full benefits of technological progress to finance's end-users: the providers and the users of funds. This raises the obvious question: Who will reap the benefits of the rapid changes we are seeing now?³

³ Recently, Philippon (2019) suggests that these costs may be falling. Time will tell.

**Figure 1: Unit cost of financial intermediation in the United States
(as percent of assets intermediated), 1886-2015**



Notes: The data is annual through 1944 and quarterly thereafter, with the horizontal axis expanded from 1945 to make the data more visible. Source: Figure 3 in Philippon (2016).

Yet, despite the stubbornness of unit costs, over the past half-century, advances in financial theory and operations, combined with changes in the regulatory environment, have transformed the structure of the financial system around the globe. In domestic financial services, the biggest trend is the move away from bank-based finance toward a combination of market and non-bank intermediation. Illustrating this shift over a long period of time is difficult because of the lack of consistent data for a broad cross-section of countries.⁴

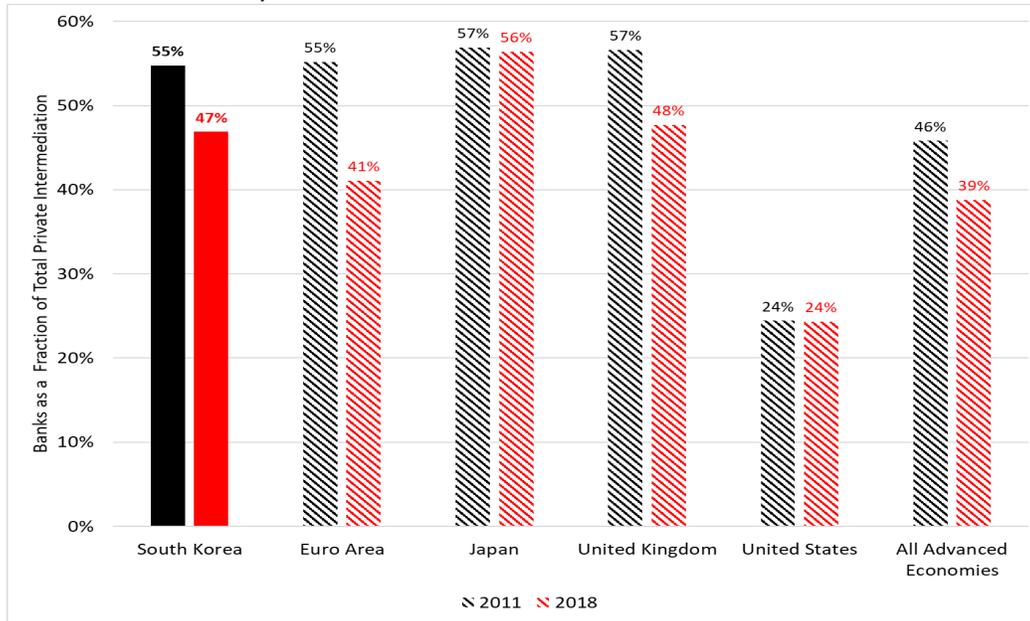
Over the past decade, however, the Financial Stability Board (FSB) has been collecting information on the distribution of financial intermediation. Panel A of Figure 2 shows the change in the share of intermediation performed by banks in advanced economies over the 2011 to 2018 period. With the exceptions of Japan and the United States, banks are less important today that they were nearly a decade ago. Focusing on Korea in the lower panel, we

⁴ The World Bank database allows us to compute for OECD countries since 1960 the ratio of domestic credit to the private sector to broad money. That measure rose from just over 1.0 to 1.25, suggesting that on average, banks' role has declined quite a bit. Additionally, the BIS reports that over the period 1999 to 2019, bank credit to the private nonfinancial sector in advanced economies fell from 51.6 to 48.3 percent of total credit.

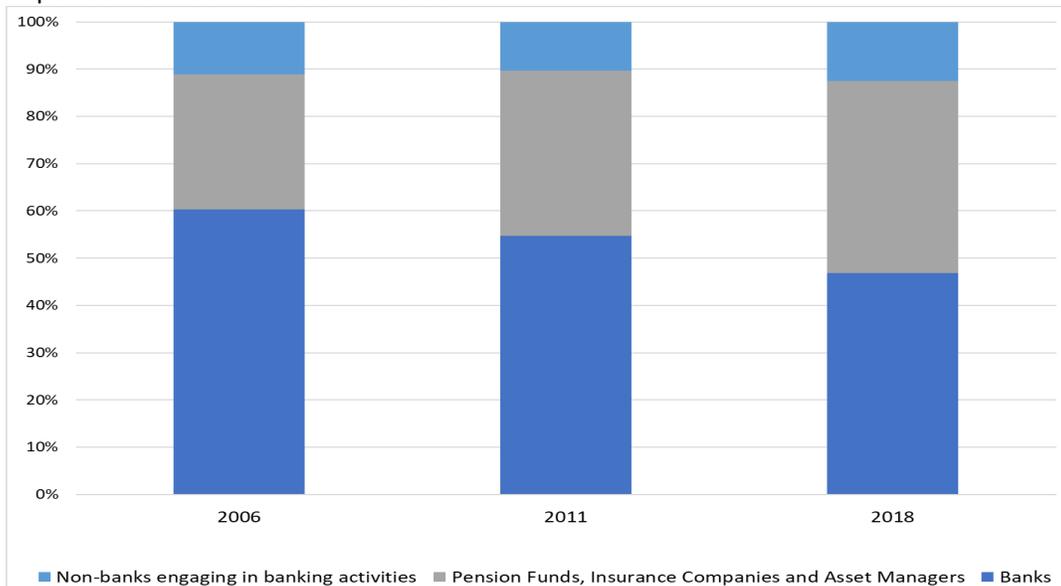
see that the role of banks has diminished notably. However, nonbank intermediaries engaging in banking activities (the FSB’s “narrow” measure of *de facto* banking) barely increased. Instead, other traditional intermediaries—pension funds, insurance companies and asset managers—grew notably as market-based finance expanded.

Figure 2: Changing composition of financial intermediation, banks and nonbanks

A. Share of Intermediation by Commercial Banks

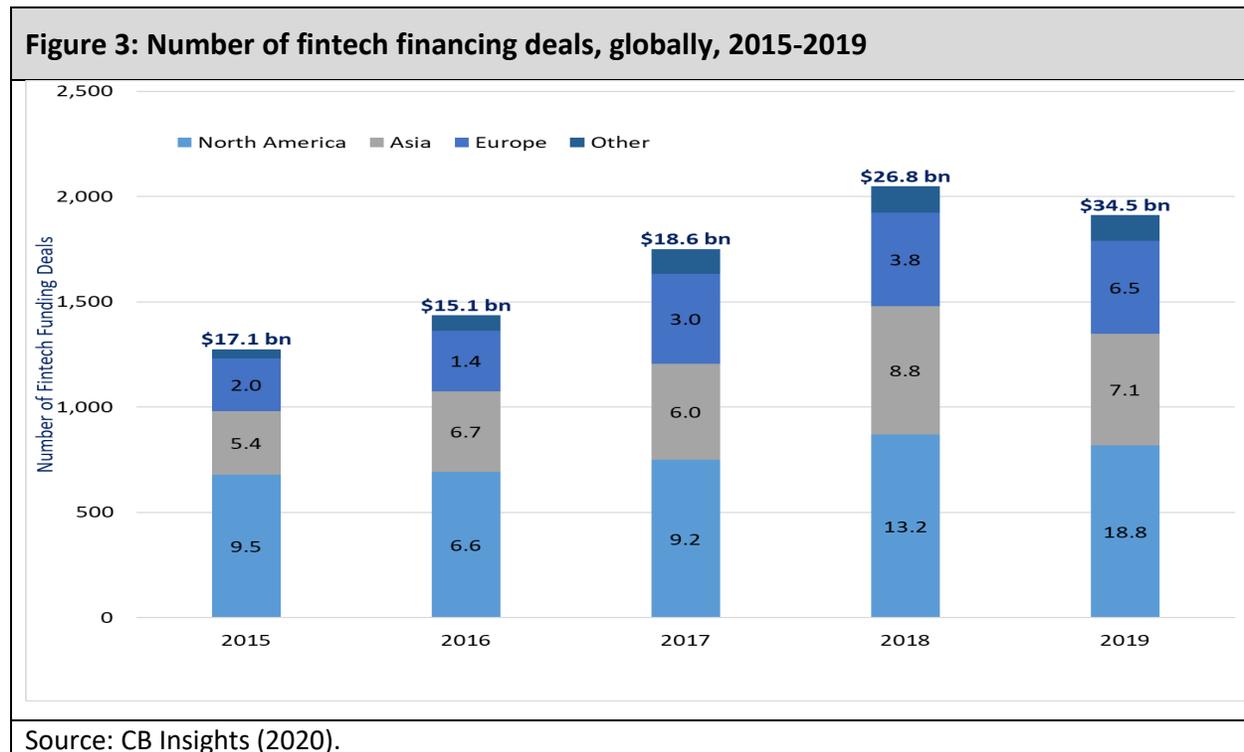


B. Composition of Intermediation in Korea



Source: [Financial Stability Board](#) (2020)

Reducing reliance on commercial banks has a number of benefits. First, it lessens the likelihood that trouble in the banking system will undermine the supply of credit to healthy borrowers. Second, by limiting the scale of runnable liabilities and of what are likely to be very large and complex banking organizations, it can reduce systemic risk. Third, the expansion of capital markets diversifies the sources of funding. Finally, the entrance of small, nimble rivals can raise the quality of services, lower prices, and broaden access, while motivating large incumbents to compete more effectively.



Turning to fintech, there is little comprehensive data on a global basis. One proxy for the scale of fintech is the number of fintech-related venture capital (VC) financing deals by region. According to CB Insights, from 2015 to 2019 there were 8,425 deals worldwide, with a total value of \$112.1 billion. (This excludes \$18.5 billion raised by Ant Financial in 2018.) It is important to emphasize two things about these numbers. First, there may be 10 times this many fintech startups overall, but the vast majority fail even before initial VC funding. Second, the CB Insights sample is only a fraction of total startup financing. For example, KPMG (2020) estimates that, over the 2015 to 2019 period, there has been roughly \$80 billion in fintech financing per year globally. This is nearly three times larger than the value reported by CB

Insights, but the figure still seems low compared to the overall investment in financial services. That is, if total investment in finance were roughly proportional to its share of global value added, then at \$80 billion per year, fintech investment would account for only about 5 percent of overall investment in finance.⁵

In our view, any catalog of fintech innovations ought to include closely related public infrastructure improvements and the expanded provision of financial services by governmental entities. For example, a number of central banks have developed small-value payments systems that the private sector can utilize to make instantaneous transfers from one bank account to another across the central bank's balance sheet. Such systems now exist in the United Kingdom and in India, while the Federal Reserve is in the process of developing FedNow to serve this need.⁶

We provide an overview of financial services and their delivery in the next section. Before we do, however, it is worth illustrating the fintech challenge by examining two specific financial services where the arrival of a substantial number of new entrants has *not* yet led to a plunge in unit costs, or to a large improvement of service. We focus here on *cross-border remittances* and *peer-to-peer lending*.

Remittances. When migrants send money across borders to their families, it promotes economic activity and supports incomes in some of the poorest countries of the world. Prior to the COVID crisis, annual cross-border remittances exceeded US\$700 billion, three quarters of which flow to low- and middle-income countries. To put that number into perspective, total development assistance worldwide is \$150 billion. Indeed, for many countries, these transfers

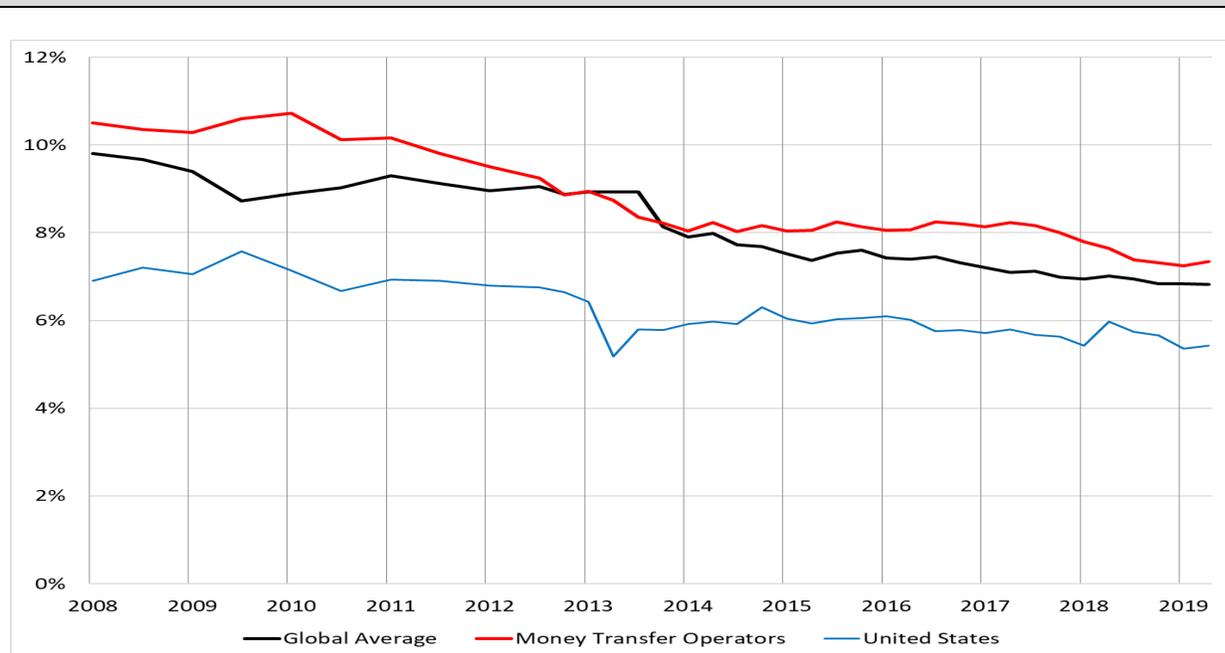
⁵ To compute this number, we start with the IMF's WEO database for January 2020, which allows us to estimate global gross investment at an average of \$21 trillion per year from 2015 to 2019. Next, using information from the World Bank, we know that finance accounts for roughly 6 percent of value added in the advanced economies. Assuming that investment is proportional to the share of value added, the annual gross investment in finance is approximately \$1.5 trillion per year. Fintech deals of \$80 billion per year is 5.3 percent of this total. German Council of Economic Experts (2019) also emphasizes that, outside of China, fintech remains small.

⁶ For the United Kingdom, see <http://www.fasterpayments.org.uk/>; for India, see <https://www.npci.org.in/product-overview/upi-product-overview>; and for the United States, see Brainard (2019).

account for a significant fraction of people’s incomes. For example, in Haiti, Nepal and Honduras, remittances exceed 20 percent of GDP.

Yet, despite the remarkable technological advances of recent decades, remittances remain very expensive. On average, the charge for sending \$200—the benchmark used by the World Bank to evaluate cost—is over \$13. That is, the combination of fees (including charges from both the sender and recipient intermediaries) and the exchange rate margin typically eats up nearly 7% of the amount sent. It is less expensive to send larger amounts, with the global average cost of sending \$500 closer to 4½%. Even so, the aggregate cost of sending remittances in 2019 was about US\$36 billion, roughly equivalent to the total non-military foreign aid budget of the United States!

Figure 4: Average cost of sending us\$200 across a border (percent of total), 2008-19



Source: [World Bank](#) (2019).

You might think that the massive volume of remittances would promote cost-reducing advances in technology, but there is little evidence of a big fintech-driven improvement. Rather, as Figure 4 shows, costs have trended lower only gradually, while the differences across types of transfer agents and across sender countries remain glaringly persistent. The black line is the simple, unweighted average for all providers—banks, money transfer operators (MTOs,

including fintech companies) and post offices—of sending \$200 from the full sample of 48 sending countries. Over the past decade, this global average has fallen from 9.8% to 7.3%. Despite the hope for a fintech- and competition-related slashing of unit costs, the pace of decline for MTOs since 2008 is about the same as the global average. Moreover, in the United States (the blue line), the cost has declined even more slowly, falling from just over 7% in 2009 to roughly 6%, where it has stayed since 2013.

Going forward, can a combination of education, competition and technology reduce these costs? Perhaps. But this would require overcoming a key challenge: most forms of cross-border funds transfer need the cooperation of a bank at some point in the process. An MTO, for example, utilizes accounts at banks on both ends of the transfer corridor. However, in response to stronger anti-money-laundering (AML) standards, banks have been terminating or restricting their relationships with MTOs.

The question is whether technology can reduce the substantial compliance costs associated with know-your-customer (KYC) regulations. One way to do this would be to institute trusted personal identification (ID) systems that make it easier to track whether a person is engaging in some criminal behavior. While it is possible to imagine such structures, they come at substantial expense and require a willingness for individuals to forgo personal privacy.⁷ They also may require extensive government coordination, as in India's comprehensive biometric ID program.⁸

Peer-to-peer lending. Our second example is peer-to-peer (P2P) lending. Even in wealthy economies with the most sophisticated financial systems, it can be difficult for individuals and small businesses to obtain credit. To counter this, firms like Lending Club in the United States, Zopa in the United Kingdom, Auxmoney in Germany, LenDenClub in India, and Lendit in Korea, seek to match individual borrowers and lenders. Yet, the market remains small. Most estimates put 2019 volumes at well below \$50 billion worldwide. Similarly, in China—once the global leader in P2P lending, with more than 3,500 lenders and outstanding loans exceeding ¥1 trillion,

⁷ For more detail on remittances, including further discussion of the challenges of reducing costs, see Cecchetti and Schoenholtz (2019a).

⁸ To understand the extraordinary impact of India's ID program on financial access, see Cecchetti and Schoenholtz (2018b).

the market has shriveled following a 2018 tightening of regulation, when a number of internet lenders shut down.⁹

Can schemes like these deliver credit to underserved households and firms? Determining a person's creditworthiness and ensuring they repay are difficult and costly activities. As we discuss below, one of the most important functions of the financial system—possibly the single most important—is to screen and monitor borrowers to ensure that resources are allocated to their most productive use. For borrowers with a credit history, traditional lenders have advanced statistical models based on very large data sets that allow them to do this fairly well.

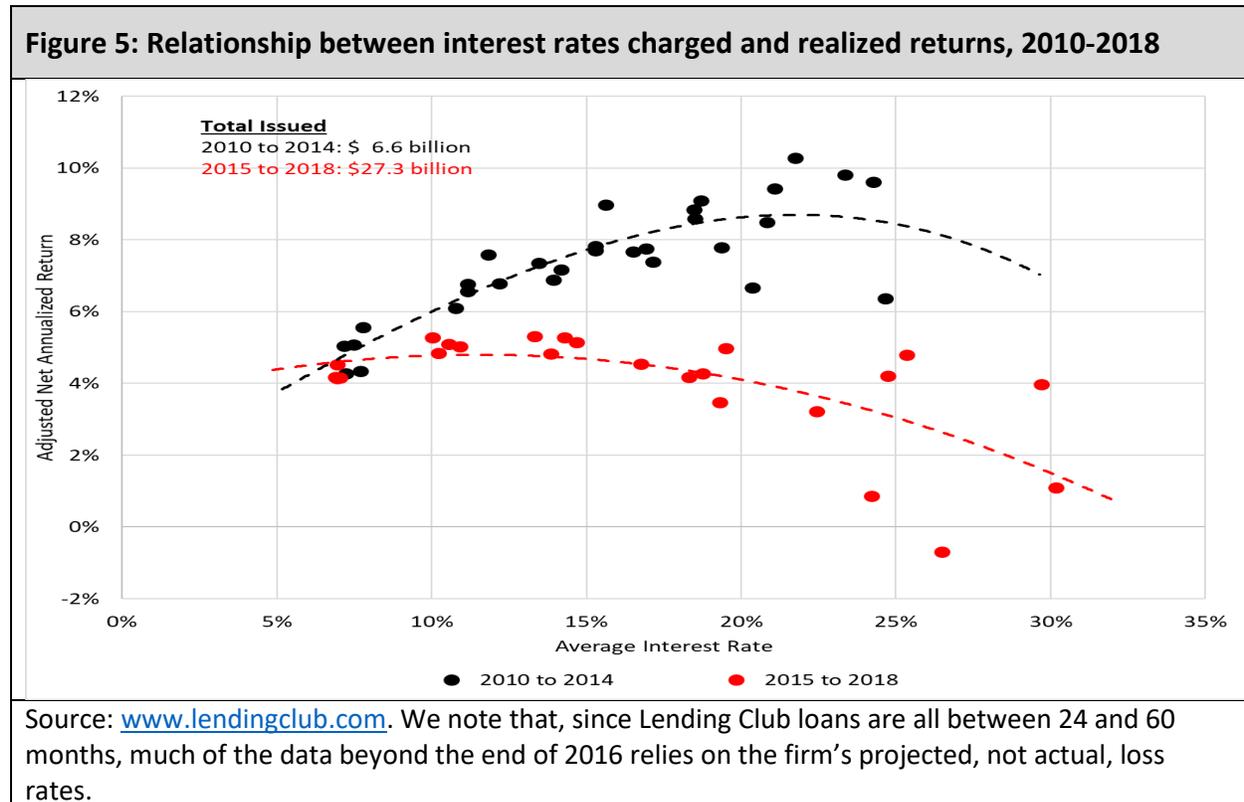
Peer-to-peer sites that we know of specialize in unsecured lending. Such lending suffers from a severe problem. As the probability of default rises, a lender will require a higher interest rate to compensate for the risk. But, higher interest rates attract borrowers who are worse risks. Put differently, the pool of willing borrowers at a high interest rate shifts adversely relative to the universe of those wishing to borrow at a rate they expect to pay. The stark implication is that as the interest rate on loans rises, lenders' profit margins will at first increase, but then fall.

Knowing that higher interest rates attract a riskier pool of borrowers, banks and other traditional lenders have a number of mechanisms to reduce loan losses and increase profitability. Not only are there rigorous screening processes, but many lenders require collateral. Auto loans, secured by the cars themselves, are a clear example. For consumer credit, at the first sign of trouble, banks can reduce credit lines. For corporate loans, banks use covenants to restrict borrowers' activities and to require repayment should borrower cash flow slip.

As it turns out, data from the largest U.S. peer-to-peer lender, Lending Club, shows exactly what theory predicts. In Figure 5, we plot the adjusted net annualized returns against the average interest rate charged on loans for two sample periods. The black dots (and black dashed fitted line) use data from 2010 to 2014, a period when the P2P lender originated \$6.6 billion of loans.

⁹ See Chao and Xie (2020).

The red dots and fitted line are for the 2015-2018 interval, when origination surged to \$27.3 billion.



The figure highlights the impact of adverse selection on the expanding pool of loans. Looking at the 2010 to 2014 period, the black line turns down, but only starting at an average interest rate above 20%. However, as new originations attract more borrowers, the pool becomes markedly worse. Looking at the red line, we see that the realized return starts to turn down at an interest rate that is somewhere between 10% and 15%. Not only that, but with interest rates of 25% or more, realized returns are close to zero or negative. Over the past few years, as far as we can tell, Lending Club severely cut back originations in the lowest credit category.¹⁰

We draw three conclusions from the experience with remittances and P2P operations. First, to be effective, fintech must overcome the well-known and costly screening and monitoring challenges that pervade all financial services. Second, as with business innovations more generally, fintech is a trial-and-error process in which only a few efforts prove robust and gain

¹⁰ For more detail on peer-to-peer lending, see Cecchetti and Schoenholtz (2020).

scale. Third, it is difficult to anticipate which innovations will survive this very Darwinian selection process.

There is, however, promising news for *digital* lenders more broadly. Using large databases, machine learning, and non-traditional information on entrepreneurs' online payments, e-commerce, social media behavior, and networks, lenders can improve the quality of credit scoring of small and medium-sized enterprises (SMEs) that lack a credit history.¹¹ Presumably, this approach will be of greatest value not to small P2P lenders, but to large intermediaries that already have extensive internal information about payments, and can augment it with behavioral data to assess credit applications.¹² In China, for example, three banks currently are granting about 10 million SME or personal loans annually with nonperforming loans of just around 1%.¹³

To sum up, over recent decades, financial innovations have vastly altered the mix of services that households and businesses use. The key shift is toward market-based and away from bank-based finance. Some promising innovations can aid in expanding access to credit for firms and households that lack a credit history. However, there is little evidence that innovation has lowered the unit cost of intermediation substantially. In addition, peer-to-peer firms have had little impact on the market for uncollateralized loans, even as other online lenders—including specialized banks (in China)—have had greater success. Perhaps the greatest disappointment is the stubborn cost of cross-border remittances, reflecting the need to control money laundering and other illicit use of finance.

¹¹ See Gambacorta et al (2020). The incremental information benefits appear to erode once a credit history is established, but these non-traditional scoring tools can help provide access to credit where it did not exist to firms that are likely to repay.

¹² As Vives (2017 and 2019) discusses, these techniques also allow for increases in price discrimination, which can also increase access. See also Consumers International (2017).

¹³ See Huang (2020).

III. The Role of Finance in the Economy

To understand how the technology might change the financial system going forward, we start with a discussion of the role of finance in the economy. Financial firms provide a broad array of services to individuals and firms. We all use these on a virtually constant basis. The payments system allows us to transfer funds. Individuals and firms can save and lend to smooth consumption and expenditure in the face of volatile income and revenue. We all need a place to store our financial assets safely, as well as methods to turn them into a means of payment (what most people call think of as “money”). Through a combination of contingent contracts (like insurance) and access to both underlying and derivative securities, the financial system provides methods for households and firms to diversify, hedge and pool the risks that they face. In addition, the system allows firms to issue equity and bonds into financial markets. Table 1 summarizes these financial services.¹⁴

Table 1: Primary services of the financial system
<i>Payments system access:</i> offering methods to transfer funds between individuals and firms.
<i>Lending and credit provision:</i> supplying funds both for investment and to allow individuals and firms to smooth expenditure in the face of volatile income and revenue.
<i>Safekeeping and accounting:</i> keeping customers’ financial assets safe and providing information to help them track their income and expenditure.
<i>Deposit taking and liquidity provision:</i> providing liabilities that can serve as or be transformed into money reliably, quickly, easily, and cheaply.
<i>Diversification and risk pooling:</i> giving investors the ability to diversify, even small amounts; and to pool and hedge risks of all kinds.
<i>Financial market access and market making:</i> providing individuals with the ability to purchase and sell securities or derivatives reliably, quickly, easily, and cheaply.
<i>Equity and debt underwriting:</i> allowing firms to issue new securities into markets.
<i>Derivatives-based risk transfer:</i> allowing individuals and firms to transfer risk using contingent contracts.

This is already a very long list, but there is one activity underpinning all of these services.

Financial intermediaries *collect and process information*. Information allows intermediaries to

¹⁴ For more details on the financial services, see Chapter 11 of Cecchetti and Schoenholtz (2021).

screen and monitor users of funds in an effort to reduce the impact of information asymmetries.

Arguably, the primary goal of finance is to channel resources from savers to users of funds; from those who have income in excess of their consumption, to governments and firms who provide public services or invest in projects. To channel these resources to their most productive use, intermediaries require sophisticated information. The challenge is that those attempting to obtain loans, or to issue bonds or stocks, know much more about the factors influencing their ability to repay (such as their business and employment prospects) than do the fund providers. The same information problems are relevant for insurance, where the insurer knows far less about the insured's risks or risk-avoidance efforts.

Asymmetric information creates two obstacles to the smooth provision of financial services—adverse selection and moral hazard. Adverse selection refers to the problem of distinguishing a good feature from a bad feature. The degree of adverse selection depends on how costly it is for the uninformed actor to observe the *hidden attributes* of a product or counterparty. Adverse selection occurs *before* a transaction. For example, the supply of used cars will shift toward lemons if buyers are unable to distinguish the good from the bad. In the world of finance, when such key characteristics become sufficiently expensive to discern, adverse selection can make an otherwise healthy market suddenly disappear.¹⁵

Moral hazard arises when a principal cannot costlessly observe the *hidden actions* of an agent, and so cannot judge whether a particular outcome—good or bad—reflects the agent's effort or mere fortune. Moral hazard occurs *after* a transaction, when the agent already has received funding or insurance.¹⁶

Solutions to the adverse selection and moral hazard problems are of two types. The first is to try to collect more information, while the second is to align the incentives of the agent (the user of funds or the insured) with those of the principal (the provider of funds or the insurer). In

¹⁵ See Cecchetti and Schoenholtz (2017b). Note that the key problem of peer-to-peer lending, described in the previous section, is adverse selection.

¹⁶ For further discussion of adverse selection and moral hazard, see [Cecchetti and Schoenholtz \(2017a\)](#) and [Cecchetti and Schoenholtz \(2017c\)](#).

the case of adverse selection, there is government-required disclosure and private information collection to lower the cost of *screening* prior to a transaction; and requiring users of funds to invest their own resources (“skin in the game”) as well as pledge collateral to align incentives. For moral hazard, solutions include post-transaction reporting requirements to facilitate *monitoring*, restrictions on activities, and requirements that users of funds invest own-resources.

Financial systems have been managing information asymmetries since the rise of civilization. Evidence of various banking and insurance systems date back 4,000 years to the Code of Hammurabi in Babylon. Rome already had jointly held firms.¹⁷ Banking as we know it is a creation of the Italian Renaissance; the bank Monte dei Paschi di Siena, founded in 1472, has been operating in its current form since 1624. Modern property and life insurance first arose in 17th century Europe. In 1602, the Dutch East India Company issued shares tradable on the first official stock exchange in Amsterdam. Moreover, the first modern limited liability law—the legal cornerstone of contemporary financial markets—dates from New York in the early 1800s. While we have an image of finance as a sector that is constantly evolving, the basic challenges have persisted for a very long time.

Turning to modern finance, we can list the types of firms that characterize the early 21st century financial system. In Table 2, we briefly describe these institutions and their current activities. While we list each of these separately, financial firms often combine these activities into one organization. Universal banks, for example, may offer the services of a depository bank, an investment bank, an asset manager, an insurer, a pension fund, *and* a custodian. Market utilities, such as central clearing parties and exchanges, tend to be separate, although large financial institutions may be their owners. In an attempt to reduce the potential for conflicts of interest, credit rating and credit scoring agencies tend to be independently owned and operated.

¹⁷ See Malmendier (2005).

Table 2: Traditional financial institutions

Depository bank: Provides deposit liabilities and holds cash, securities and loans.

Investment bank: Offers advisory services and raises funds through issuance of securities

Pension fund: Holds assets in order to make payments to beneficiaries in retirement.

Asset manager and hedge fund: Offers investors stakes in funds holding a portfolio of assets.

Private equity and venture capital fund: Investment firms that acquire and restructure existing companies, or invest in new ones.

Life insurer: Offers policies protecting against loss of earning from disability or death.

Property and casualty insurer: Offers policies that protect against losses from theft, accident, fire, and natural disaster.

Central clearing party: An entity that takes on counterparty credit risk between parties to a transaction and provides clearing and settlement services for trades.

Exchange: An organized market where commodities, securities or derivatives trade.

Custodian: Safeguards a firm's or individual's financial assets.

Credit rating and credit scoring agencies: Assess the willingness and ability of a firm or individual to repay debt in a timely way.

Putting the services or activities and the institutions together, we can create a matrix that shows who does what in a traditional financial system. Table 3 is the result. The columns show the institutions and the rows are the activities, with some activities conducted directly and others indirectly. We order the columns and the rows by the item with the most entries. For example, asset managers tend to provide the widest range of services, while the focus of credit rating agencies is quite limited.

Looking at the rows, everyone collects information. At the other end of the spectrum, only depository banks provide access to the payments system.

Table 3: Functions provided by traditional intermediaries											
Function/ Activity	Traditional Intermediaries & Delivery Systems										
	Asset Managers & Hedge Funds	Investment Banks⁺	Depository Banks	Life Insurers	Pension Funds	Private Equity & Venture Capital	Central Clearing Parties (CCPs)	Exchanges	Property and Casualty Insurers	Custodians	Credit Rating and Scoring Agencies
Collecting and processing information	X	X	X	X	X	X	X	X	X	X	X
Diversification and risk pooling	X	X	X	X	X	X			X		
Safekeeping and accounting	X	X	X	X	X	X				X	
Lending and credit provision	X	X	X	X	X	X					
Derivatives-based risk transfer	X	X	X	X	X		X				
Financial market access and market making	X	X		✓	✓		X	X			
Liquidity provision	X	X	X	X							
Deposit taking	✓		X								
Equity and debt underwriting		X				X					
Payments system access	✓		X								

* Investment banks include both brokerage and underwriting services.
Note: X's represent direct provision of services and ✓'s represent indirect or partial provision of services.

One way to think about this table is that as we go from the top to the bottom, the traditional financial system appears less and less competitive—at least in terms of the range of providers. Access to the payments system offers the most obvious example. In the past, depository banks faced little competition from other types of intermediaries. This could explain why there are now so many entrants into this line of business.¹⁸

There is no such pattern along the columns. However, some of the firm types exhibit extreme returns to scale that limit competition. This applies particularly to central clearing parties (where large network externalities promote the concentration of transactions) and to custodians, where unit costs appear to decline with scale, resulting in natural monopolies.

IV. How is Technology Changing Financial Services?

Finance and technology have a long history, with progress coming in both *theoretical* and *operational* form. Practitioners developed or refined concepts like double-entry bookkeeping, joint stock companies and limited liability in the 14th, 17th and 19th centuries, respectively. More recently, we have securitization, option-pricing theory and the creation of numerous contingent claims such as credit default swaps. On the operational side, advances in communication and computation have made feasible vast increases in the scale and speed of transactions. Arner et al (2016) divide the last 150 years into three eras, starting with the introduction of the telegraph in the mid-1800s; continuing with electronic payments, ATMs and online banking during the 50 years to 2008; and then the most recent era, defined less by the products or services than by who delivers them.

According to the most recent World Bank survey of financial inclusion, as of 2017, 93 percent of adults in high-income economies and 79 percent of those in developing economies have mobile phones, while one-half of those with accounts at financial institutions access them using the internet.¹⁹ Because of the extraordinary diffusion of mobile telephony, the delivery of financial

¹⁸ We should note that there are alternative categorizations. See, for example, CBInsights (2019) and Ehrentraud et al (2020). Differences in the category architecture then lead to slightly different ways to classify new fintech firms.

¹⁹ See Demirgüç-Kunt et al (2018).

services in many emerging economies has leap-frogged the tools and practices that were widespread in advanced economies until quite recently.

Box B: Recent technological innovations that enable finance

A number of recent innovations are helping to lower transactions and information costs, as well as barriers to entry, in finance. In some cases, these innovations also ease regulatory and compliance requirements.

A partial list based on Ehrentraud et al (2020) includes:

- Cellular phones allow transactions with or through a financial institution from almost anywhere at any time. In addition to cutting costs, this improves the availability and reliability of services, as well as the speed of delivery.
- Open source frameworks provide low cost (or free) modular software that can be quickly adapted to enhance products.
- Applied programming interfaces (APIs) standardize protocols for the use of software applications, enabling non-banks secure and regulated access to the financial information of individuals.
- Artificial intelligence and machine learning algorithms facilitate the use of large amounts of data, lowering the costs of product pricing, risk assessment, fraud detection, compliance, advising, and trading.
- Cloud computing delivers computing services (including storage, database management, networking, analytics, and software) over the internet. It offers security, speed, scalability, continuity, and flexibility, and limits barriers to entry by reducing the IT capital investment needed by new financial entrants.
- Biometric identification facilitates authentication of users, improving security, preventing fraud, and lowering the cost of complying with know-your-customer (KYC) rules.
- Cryptography (including advances such as Distributed Ledger Technology (DLT)) permits secure, transparent, tamper-proof transactions, provides an audit trail, and allows for decentralization that reduces the risk from single points of failure in a financial network. In theory, it also eliminates the need for a trusted third-party intermediary.

In various combinations, these technologies make possible large changes in both the scope of financial services and the structure of the delivery system.

Modern technology provides us with information at low cost and allows us to transact quickly and efficiently. Yet, it does not change the fundamental services we require. That is, the question is not whether we need the financial services discussed in the previous section, but how we will obtain them, and how we will supplement them.

An example helps to illustrate what we have in mind. Starting with payments, many of us recall the days when we used paper—currency and checks—to make payments. Over the course of several decades, debit cards slowly replaced a portion of this. Today, we use bank websites, smart phones, and a range of bank and nonbank digital payment providers. The welfare gains from these changes are clearly enormous. Fifty years ago, someone wishing to make a purchase might go to a bank to withdraw the requisite amount of currency and then hand it to a merchant, who would then have to take it to the bank. This process was time consuming and risky. Today, shifting the fund balance from the buyer to the seller requires no more than the tap of a phone. There is no need to travel, and no risk of theft or loss of the paper currency.

Advances in the payments system are just the most visible innovations. There have been analogous developments elsewhere in the financial system. The combination of a theoretical advance (an idea) and an operational mechanism (an organizational arrangement) underlies the provision of mutual funds composed of various combinations of commodities, real estate, bonds, equities, and cash instruments. Similarly, the spread of securitization across a wide range of loans—including residential and commercial mortgages, auto loans, credit card receivables, and student debt—is the result of both intellectual and operational innovations.

But recent technological innovations (such as those we list in Box B) could change the provision of finance far more extensively. Importantly, using their access to data and high-quality algorithms, fintech firms can improve screening of potential borrowers and customize products at individual prices to meet the needs of specific customers. Information from mobile devices can help overcome adverse selection and moral hazard. As a result, fintech providers can offer superior products at lower costs, focusing on business areas and activities with relatively high returns on investment where competition has been lacking.²⁰ And, new fintech entrants can provide specialized services either to existing financial institutions or to customers directly. Through peer-to-peer networks, they can link customers directly.²¹ Table 4 presents a set of current financial delivery mechanisms and providers organized by the function or activity that

²⁰ See Vives (2019).

²¹ See Consumer International (2017) and International Monetary Fund (2019) for a general discussion of the types of fintech firms. Thakor (2020) identifies peer-to-peer interaction as the critical innovation in fintech.

they perform. While several firms included in this table are independent providers—such as the online internet banks in China—the bulk of them overlay their systems onto the existing financial infrastructure of traditional intermediaries. For example, while Betterment is a registered adviser and regulated broker-dealer, firms like Square and Transferwise are payments providers that connect to banks.

Table 4: Examples of how technology is changing delivery of financial services		
Function/Activity	Alternative Delivery Systems	Examples
Payments system access	Mobile payments platforms, cryptocurrencies	Waymo, Stripe, Ripple, Square, Transferwise, Alipay, WeChat, M-Pesa
Liquidity provision	Provided through mobile wallets or using API links to depositories	(same as above)
Lending and Credit Provision	Automated small business lending and consumer credit; Peer-to-peer systems	WeBank; MYbank; XW Bank; Affirm, Prosper, Lending Club, Kabbage, Sofi
Diversification and risk pooling	Robo-advising	Betterment, Wealthsimple, Acorns, Sofi
Screening and monitoring	Automated (AI) credit rating and scoring	Credit Karma, Wecash, modeFinance
Financial market access	Market platforms	Robinhood, IEX, kantox, Sofi
Equity and debt underwriting	Automated underwriting, direct firm issuance, and crowdfunding	Kickstarter, AngelList, Crowdbnk
Financial market making	Smarter, faster machines and new market structures	Axoni
Derivatives-based risk transfer	Improved multilateral netting and trade compression	Axoni
Deposit taking	Digital wallets	Atom
Safekeeping	Blockchain	Bitfury
Sources: CB Insights (2020) and KPMG (2019).		

As Cortina and Schumkler (2018) and Financial Stability Board (2019a) point out, the frequent linkage of incumbent institutions and fintechs means that their relationship is complementary and cooperative. One reason for this is that most fintechs are small. They do not have access to

low-cost funding or a large customer base, nor do they have the resources to meet what can be relatively high fixed-cost barriers to entry in numerous financial services.

The few exceptions, however, are notable. A handful of internet banks in China have tapped a previously unexploited opportunity of lending to SMEs. Two of these (WeBank and MYBank) can benefit from the massive databases of the payment firms operated by their largest shareholders (Tencent and Ant Financial, respectively). Similarly, M-Pesa offers bank-like service using proprietary structures that are not a part of the traditional ecosystem.²²

Before speculating about the future of fintech and the financial system, we turn to three questions: First, how is technology affecting the economies of scale and scope in finance? Second, what is the impact of technology on financial competition and concentration? Third, what is the impact of fintech on financial stability?

Starting with scale economies, information technology creates what the BIS (2019) describes as the *DNA* loop: a tech firm uses a large stock of user data (D) to offer a range of services exploiting natural network effects (N), generating further user activity (A), which then results in more data. This is the Big Tech model driving the successes of Alibaba, Amazon, Facebook, Google, and Tencent. The result is enormous scale. Google's market share of search engine business is 87 percent worldwide, while Amazon has half of the U.S. e-commerce business. In China, Alipay has more than a 50% share of the online payment market, while its competitor Tencent reported for the fourth quarter of 2019 more than one billion daily commercial payment transactions (involving 800 million active users and 50 million merchants).²³

Several Big Tech firms are building on their foothold in key financial services to expand their footprint more broadly. A recent Financial Stability Board report enumerates how the largest

²² Frost (2020) notes the uneven adoption of fintech around the world, suggesting that it is most likely to arise where there are unmet demands for financial services, high costs of traditional finance, and a supportive regulatory environment.

²³ See Ge (2020).

technology firms have a presence in payments, lending and short-term credit, asset management, and insurance, among others.²⁴

Turning to economies of scope, we can ask where there are important complementarities in the provision of financial services. Put slightly differently, which of the services currently frequently offered in combination can be profitably unbundled from the others?²⁵ To see what we mean, start by looking back at Table 3. Note that exchanges, custodians and credit rating agencies each provide only one service (other than information processing). One might think, as a result, that certain aspects of information collection, safekeeping and market access are *not* complementary to any other service. However, we doubt that this accounts for the organization of these activities. More likely, the mix of high fixed costs and extensive network externalities in the operations of exchanges and custodians favors declining unit costs, while credit rating agencies face potentially costly conflicts of interest if linked too closely with other financial services. So, while it may be possible to unbundle these activities, economies of scale and diseconomies of scope create significant barriers to entry.

In contrast, looking at Table 4, we see significant entry into the provision of payments services. In some cases, entrants overlay their systems on existing institutions, taking advantage of banks' compliance and access to interbank transfer networks. If a particular provider becomes large enough, so that the bulk of their transactions takes place among their own subscribers, then they can evolve into proprietary systems. As we have noted, the most successful examples are the digital payments providers in China that, having entered the business just a few years ago, now dominate it.

There is, however, an important limit in the unbundling of payments from other financial services. Making a payment requires the transfer of liquid assets from one party to another. This is the reason that banks, which historically have been the only real liquidity providers, also provide payments. The implication is that a fintech company providing payments will have to have access to liquid assets. As we survey the landscape, this is what we see: payments system

²⁴ See Financial Stability Board (February 2019).

²⁵ As Vives (2019) points out, technologies like APIs support the unbundling of some services.

providers either they have a relationship with banks or they become a (possibly de facto) bank.²⁶

Another limit to unbundling arises from the strong complementarities between deposit services and lines of credit to potential borrowers. That is, an institution specializing in providing liquidity can do it on both sides of its balance sheet. Historically, such institutions have been banks.²⁷

In comparing banks with fintechs, Petralia et al (2019) and Financial Stability Board (2019b) argue that banks have the advantage of size, brand, customer loyalty, lower cost of funding, data and privacy protection schemes, and political power. By comparison, fintechs have cutting-edge technology, limited regulatory burden, and network externalities. However, when incumbent banks fail to compete effectively, entrepreneurial fintech firms can grow rapidly (as in China), quickly developing many of the size/power advantages that have been associated with the largest banks.

Finally, fintech raises a number of other concerns. The most obvious is a virulent form of cyber risk: namely, the risk that a hostile actor disrupts the system. A financial network is only as strong as its weakest link. A network that links a large number of small firms is more difficult to fortify and police. At the same time, a network that is heavily dependent on a few key nodes (like central counterparties) also can be vulnerable. Indeed, precisely because of their massive interconnections, the largest CCPs are vital to financial resilience, so any resolution scheme must focus on continuity of service.²⁸ And, what is true for disruptions is true for data breaches and identity theft as well.²⁹ The more firms that have our financial information, the more risk of it being stolen and misused.³⁰

²⁶ Navaretti et al (2017) note that it is hard to see how fintechs can offer liquidity management services on their own.

²⁷ See Kashyap, Rajan and Stein (2002).

²⁸ See "A Path Forward" (2020).

²⁹ Ironically, improving fraud protection reduces the incentive to monitor the system in the first place, so there is a delicate balance.

³⁰ This also brings up the question of who should own personal data. Jones and Tonetti (2020) show that under quite general circumstances, the optimal outcome is what we intuitively expect: individuals should own their own

Another concern is that, by improving access and information, technology can increase opportunities for exploitation. For example, there is the risk of basing credit decisions on inaccurate information. If you feed incorrect data into an automated system, you will get a fast answer that is wrong. And, if you train the automated system on data that contains biases, the system will provide advice that accentuates those biases. Related to this, fintech systems may be able to exploit behavioral biases of customers by offering them products at inflated prices that are not in their best interest. Protecting individual users of financial services against such manipulation may be difficult, but it is essential.

We should also mention that, by enabling monitoring, technology facilitates price discrimination that can undermine the provision of financial services. Casualty insurance is the most obvious example. By utilizing information from a driver's smart car or smart phone, an automobile insurer can cream the lowest risk customers, reducing the ability of individuals at large to pool risks. Of course, the insurer also incentivizes safer driving habits.

V. Regulatory Responses

The wide array of fintech innovations has prompted a similarly broad range of regulatory responses. In some financial centers, regulators have sought to attract fintech innovation to their jurisdiction in order to enhance the efficiency of financial services. For example, they have introduced regulatory "sandboxes" to allow testing of fintech ideas in the presence of temporary regulatory forbearance. At the same time, many regulators view selected innovations as a potential threat to the safety and soundness of their financial systems (see below Box C on "Privately issued digital currencies: the case of Libra").

data. As a result, we are likely to see the creation of *data custodians* who offer to safeguard our personal data while we control (and receive compensation for) the access of large data users.

Box C: Privately issued digital currency: the case of Libra*

On June 18, 2019, Facebook announced the creation of a Geneva-based entity with plans to issue a digital currency called [Libra](#). Their stated objectives are to improve the efficiency of payments, reducing costs and speeding transfers; and to improve financial access. Will a privately issued digital currency meet these goals while keeping the financial system safe? Our answer is an emphatic no.

The idea behind Libra is that every individual with a smart phone will be able to purchase tokens using their own domestic currency, with the proceeds invested in a portfolio of bonds and in bank deposits denominated in a few major currencies. Owners can then use their tokens to purchase goods and services, or to extinguish debts.

Will Libra really make payments faster, cheaper and safer both domestically and internationally? In most advanced countries, the vast majority of the population already has access to low cost payments technologies (like bank debit cards or digital wallets). As for cross-border remittances, there a number of systems in place, but they rely on the banks' compliance operations to "know your customer" and ensure against money laundering and terrorist finance. That is, payment systems are cheap when someone else bears the high fixed costs of verifying that criminals are neither sending nor receiving the funds. So, we doubt that Libra will be faster or cheaper than existing systems.

As for financial access, bringing the 1¾ billion unbanked adults into the financial system will yield large economic and social benefits. Experience in places like India suggests that doing so requires lowering costs of knowing your customer (through something like universal biometric identification) along with the provision of subsidized access to the banking system. Libra is not proposing either of these, so it is hard to see how it can do better than a government.

Perhaps most important, were it to be successful, Libra is likely to become a source of systemic risk for the global financial system. First, if Libra replaces a significant fraction of the existing payments system, then its failure would be catastrophic for those who rely on it. Second, if the Libra Association guarantees convertibility into a national currency, then the Libra Reserve will operate as an open-end mutual fund that would be subject to runs.

Finally, for three reasons, it would be unwise for any country whose currency is not in the Libra basket to allow its citizens to use the new currency. First, the shift from domestic currency to Libra would reduce the government's seignorage revenue, damaging public finances. Second, if domestic residents are transacting in Libra, the central bank risks losing control of the country's monetary and payments systems, making it difficult to maintain price stability. Third, since acquiring Libra rather than a domestic asset constitutes a capital outflow, it reduces resources for domestic investment and facilitates capital flight in a crisis.

Perhaps the ultimate challenge a privately issued currency like Libra poses comes from the fact that it would operate across multiple jurisdictions without a true "home." For the most part,

payments systems are set up to handle domestic institutions operating within national boundaries under domestic law. Even “global” banks have a home supervisor that examines them on a consolidated basis. The prospect of Libra serves to dramatize the existing asymmetry between this largely domestic approach and the rise of global, multi-jurisdictional entities that could choose any home temporarily and could shift at will.

The bottom line: Facebook’s proposed creation of Libra is a wake-up call. It makes inescapable the need for rapid, international coordination of financial regulation. Without mechanisms to ensure consistent application of coherent global rules, we may find ourselves in a world full of “low-quality finance havens” that exist to evade financial regulations—just like “tax havens” that exist merely to evade taxes.

*This box is a condensed version of Cecchetti and Schoenholtz (2019b).

Philippon (2016) proposes guidelines for regulators that would enhance the competitive impact of fintech innovation. First, officials should actively encourage entry, especially where incumbents are large and entrenched (as one might expect in the presence of state-sponsored banks or too-big-to-fail institutions). Second, to encourage resilience while supporting competition, regulators should require high equity ratios and discourage leverage, especially in the form of runnable liabilities. Third, authorities should be wary of a large incumbent’s acquisition of fintech startups, as this can hinder competition and reinforce market power.

Ehrentraud et al (2020) describe a set of public policies that *enable* the provision of fintech services (see their Table 10 on page 37). Their list includes:

- digital identity systems (such as India’s [Aadhar](#) biometric ID program),
- data protection regimes that provide clear rules for ownership, access and sharing,
- cyber security strategies that support efforts to prevent (and to recover from) attacks,
- open banking initiatives that promote data sharing, given customer consent,
- and various forms of innovation facilitation, including “hubs” that provide information on regulatory practices, sandboxes that allow for testing of new tools and services, and “accelerators” that involve partnerships with (and possibly funding from) central banks and supervisory authorities.

At the same time, some innovations pose a severe challenge to regulatory goals and practices. Private digital currencies are probably the leading example. Where these instruments provide

anonymity, they facilitate the criminal use of finance. They also may enable the violation of financial rules (such as cross-border capital controls). Not surprisingly, some jurisdictions (like China) have virtually shut down the trading of private digital currencies.³¹

In other jurisdictions, regulators are still trying to determine which rules (in addition to standard anti-fraud and anti-money laundering provisions) should apply to private digital assets. In the United States, for example, the Securities and Exchange Commission has rejected several applications for exchange trading of funds that include a digital currency. They also have warned about the potential for fraud and manipulation in the case of initial coin offerings (ICOs), noting that “the markets for these assets are less regulated than traditional capital markets.” At the same time, the SEC’s “Strategic Hub for Innovation and Financial Technology” has published a framework for deciding whether to treat a digital asset (like an ICO) as a security for regulatory purposes.³²

Before speculating on where the financial system is heading, we should note one more big challenge for regulators: technology facilitates cross-border finance. With further innovation, we can expect reductions in the cost both of transferring funds across jurisdictions *and* of obscuring transactions from authorities. This raises the importance of global cooperation and coordination of authorities in both setting regulations and in supervising compliance. Since no one will allow the weakest and most lax authorities to control global financial standards, the alternative will be fragmentation or bans on cross-border activity. (The discussion of Libra in Box C describes some of the risks.)

³¹ See Cecchetti and Schoenholtz (2017d).

³² See, SEC (2018), SEC (2019) and SEC (2020); as well as Chapter 4 in Casey et al (2018).

VI. Where is the Financial System Heading?

What might the financial system look like a decade from now? To explore this question, we focus on the case of the United States. Here, we can envision two quite different futures. In the first, the four Big Tech firms, Amazon, Apple, Facebook and Google, take over a large part of the U.S. payments system—much as Tencent and Ant Financial have done in China—cutting costs and improving the efficiency and quality of intermediation.³³ In this scenario, two things seem likely. First, the Big Four capture a significant share of U.S. value added in finance. Second, through a mix of cost-cutting and aggressive competition, they could lower the unit cost of financial services.³⁴

In the second scenario, leading financial-sector incumbents respond aggressively to the threat from Big Tech. In this case, Big Banks continue to dominate the U.S. payments mechanism, partly in cooperation with a handful of smaller fintech entrants who find and develop profitable niche products. For the largest incumbent banks to maintain their share of value added in the face of Big Tech competition, their evolving platforms would need to reduce costs, while exploiting internal information resources from the payments mechanism to improve the allocation of credit. As a result, just as in the first scenario, the result could be lower unit costs.³⁵

Of course, every day seems to bring new small fintech entrants. However, because network externalities are so strong in key areas of finance—including the payments system and the trading of many financial instruments—technological progress likely will continue to favor economies of scale. Put differently, where fintech has been most successful at changing the financial landscape in recent years, it has had a “winner takes all” character. Consequently,

³³ We do not include a third scenario in which China’s two mobile payment leaders also become the leaders in the United States. We doubt that U.S. regulators would welcome that outcome. However, we note that Tencent and Ant Financial are expanding abroad and appear aimed at gaining global share. See *The Economist* (2020).

³⁴ For a detailed discussion of the role of Big Tech in finance, see Bank for International Settlements (2019) and Frost et al (2019).

³⁵In both the case where Big Tech takes over and the one where the Big Banks maintain their dominant position, total value added in finance could go up or down depending on what happens to demand for services at the lower unit cost.

concentration in the U.S. financial sector is likely to be at least as great 10 years from now as it is today.

It is important to consider the role of the central bank in the evolution of the financial system. This can take several forms. First, the central bank can introduce digital currencies, offering nonbank firms and households direct access to its balance sheet. We see this as very unappealing, and doubt that large, advanced country central banks like the Federal Reserve will go down this road. But, if they do, it has the potential to completely change the structure of the financial system (see Box D for details).

The second form of intervention is through the payments system, where central banks have always had a strong presence. As it develops the [FedNow 24/7/365 instant payment scheme](#) in coming years, as an unintended side effect, the U.S. central bank could tilt the balance between the two scenarios described above. The Federal Reserve has promised to “enable financial institutions of every size” to deliver payments safely and efficiently. However, among private entities, only banks today have access to accounts at the Federal Reserve. Assuming, as we do, that this restriction persists, the banks would maintain a start-line advantage over the Big Tech firms. However, the banks would still need to innovate with sufficient speed and effect to win the competitive race. If they become complacent oligopolists, then they will not be able to maintain their market share. Indeed, if the banks fail to innovate, the Big Tech Four could introduce a de facto bank (like a money market fund) to enhance their competitive position.³⁶

³⁶ As White (2017) notes, the U.S. government has prevented firms engaged in commerce—that is, nonfinancial services—from establishing or acquiring banks. However, the promise of fintech could elevate political pressures to relax this restriction.

Box D: Central bank digital currency*

The appearance of cryptocurrencies is driving central banks to reconsider their role in the issuance of currency. Should they shift from issuing paper bank notes to providing central bank digital currency (CBDC)?

First, in advanced economies, about half of the monetary base—currency plus commercial bank reserve deposits at the central bank—already is digital. Second, the vast majority of money that households and businesses use for transactions is digital, including more than 90% of broad money aggregates like M2. Given this, it is unsurprising that almost all payments are digital.

In a world dominated by digital money, should central banks issue *retail* digital currency? Put differently, should central banks offer accounts to nonbanks, private individuals and nonfinancial firms, as they do for banks and governments?

The concept of retail central bank digital currency raises a number of interesting questions: Would it be: anonymous, in unlimited supply, have universal access, and pay zero interest? For central bank *paper* currency, the answer to all of these questions is yes. For wholesale CBDC—the stuff commercial banks now have and people call reserves—the answer is no, except that supply is effectively unlimited.

Retail CBDC is again different. On anonymity, to address problems of money laundering and financial fraud, international standards mandate verification of the identity of all account holders. On unlimited supply, central banks exist to provide an elastic supply of currency, preventing scarcity, so that is what they do. As for universal access, it would be hard to keep any legitimate user from opening an account (although foreigners might need to access it through domestic representatives). Finally, on interest payments, it would be difficult to pay interest on bank reserve deposits (as many central banks do) without paying interest on others' holdings, so again the answer is yes.

To summarize, retail CBDC would almost surely be supplied elastically, be universally accessible, and pay interest, but *not* be anonymous. What happens to the financial system in the presence of retail CBDC? How would it alter the central bank and the role of commercial banks?

The introduction of retail CBDC probably would cause a substantial fraction of deposits to shift to the central bank, with the remainder prone to exit in a period of financial stress. Moreover, if a large and trusted central bank in a politically stable jurisdiction were to issue retail CBDC, the impact would not stop at its borders.

Over time, the central bank will tend to displace commercial banks in the provision of credit. As its CBDC liabilities grow, its assets will need to expand as well, while commercial banks lose funding and trim assets. In theory, the central bank could fund financial intermediaries that on-lend these resources to nonbanks. However, it may be tempted to become a “state bank,”

substituting for the discipline of private suppliers and markets and inviting political interference in the allocation of capital and slowing economic growth.

While technology will allow the issuance of retail CBDC, the associated risks are enormous.

*This box is a condensed version of Cecchetti and Schoenholtz (2018a).

Of course, there are good reasons why no one knows how this competition will play out. Above all, the enormous potential reward for success means that there are many people and firms trying to invent new ways of providing financial services. And both groups—Big Tech and Big Banks—have deep pockets and technological know-how.

We suspect that what matters most is who gets there first, creating a strong motive to invest early and aggressively. Even in China, where the central bank has occasionally squeezed the largest fintech firms (for example, by requiring that they hold all customers' funds at the central bank without compensation), they have remained successful in part because have utilized their payments system dominance to provide additional services that their customers find attractive. In effect, they are strengthening their clients' attachment to their networks while their competitors, the big state banks, lack an effective strategy. In addition, the fintech leaders have now developed operations of such large scale—covering most of e-commerce and serving so many customers—that they are very difficult to displace (unless, of course, the state takes them over).

VII. Concluding Remarks

The financial system facilitates the flow of resources in the economy, enabling commerce and investment. However, information problems plague virtually all financial activities. The fundamental role of modern finance is to collect and process information to ensure safety and improve efficiency. Thousands of private firms are working to employ new technologies to reduce information and transactions costs, improve the nature and scope of services, and increase access at all levels of the financial system. Simultaneously, governments are exploring the social benefits of these innovations, while remaining attentive to any risks to consumer and investor protection, as well as to systemic resilience.

As in any area of business, innovation in finance is a matter of trial and error. In advanced economies with well-developed private financial systems, the result of many fintech attempts over the past decade is only modest changes in the organization of financial services. Even when innovations are successful, as in the case of payments, what we frequently see is the overlay of new technology on incumbent banking institutions' platforms. There are, however, a few stunning successes. China is the prime example, where Ant Financial and Tencent are completely reshaping finance for households and SMEs.

It is difficult to know how widely these changes will diffuse. There is clearly potential in emerging market countries where incumbent financial institutions remain either rigid or less sophisticated. What happens depends both on the willingness of incumbents to modernize and compete in the fintech arena and on whether regulators promote or discourage entry of technologically advanced competitors.

Conditions in advanced economies are different. This leads us to speculate about how fintech innovation could influence the U.S. financial industry over the coming decade. In our view, there are two quite different possibilities. In one, Big Banks consolidate their current position; and in the other Big Tech comes to dominate.

Importantly, large modern financial intermediaries are already technology companies. They employ tens of thousands of engineers and invest heavily in both hardware and software. To give some sense of the scale, the four largest U.S. banks' combined technology budget averages \$10 billion a year—twice the global value of fintech financing that we reported in Section 2.³⁷ That said, Big Tech firms are entering the financial services business. They are doing it both in partnership with banks and on their own, exploiting their platforms to offer financial services to their very large customer base.

In other words, financial intermediaries and Big Tech companies are looking increasingly alike. Who wins the race is anyone's guess.

³⁷ See Shevlin (2019).

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