



Contents lists available at ScienceDirect

## Journal of Financial Intermediation

journal homepage: [www.elsevier.com/locate/jfi](http://www.elsevier.com/locate/jfi)

## Fintech and banking: What do we know?

Anjan V. Thakor<sup>a,b,\*</sup><sup>a</sup> ECGI, Belgium<sup>b</sup> Olin Business School, Washington University in St. Louis, United States

## ARTICLE INFO

## Keywords:

Fintech  
Cryptocurrencies  
P2P lending  
Banking  
Systemic risk

## JEL classifications:

G21  
G22  
G23  
G24

## ABSTRACT

This paper is a review of the literature on fintech and its interaction with banking. Included in fintech are innovations in payment systems (including cryptocurrencies), credit markets (including P2P lending), and insurance, with Blockchain-assisted smart contracts playing a role. The paper provides a definition of fintech, examines some statistics and stylized facts, and then reviews the theoretical and empirical literature. The review is organized around four main research questions. The paper summarizes our knowledge on these questions and concludes with questions for future research.

## 1. Introduction

“Fintech” is the topic *du jour*, even though the interplay between information technology and financial services is not a new topic. It has been discussed quite a bit in the past few decades. For example, Berger (2003) discussed the productivity and consumer welfare implications of information technology for banking. And twenty years ago, in a discussion of consolidation in financial services, I concluded with the observation that the ongoing consolidation at that time was likely to be followed by specialization-induced fragmentation in the financial services industry. I conjectured that information technology would encourage the emergence of specialized players creating an ever-increasing set of market niches with greater product customization to cater to customer preferences (see Thakor, 1999). In a sense, this is what we are observing today. As Frame et al. (2019) point out, technological change that generates financial innovations in banking has connotations for developments in fintech. Non-intermediated peer-to-peer (P2P) lending, cryptocurrencies and smart contracts are all parts of an emerging new mosaic of technology-assisted customized financial services. Perhaps one aspect of this development that is somewhat unprecedented and hence surprising is the extent to which these developments involve *non-intermediated* transactions. What do these

developments portend for the future of banking, financial markets, and payments systems?

The purpose of this paper is to review the existing literature and synthesize the insights it provides on this question. In what follows in this section, I begin by defining the term “fintech”. Although widely used as a term, there is apparently such a variety of interpretations of what the term means that it is useful to define it precisely.<sup>1</sup> After this I briefly discuss the different aspects of the development of fintech, leading to main research questions that are raised by these developments with respect to banking. I end the section with a summary of what we know and do not know about the answers to these questions. Hopefully, this will help to set the agenda for future research.

*What is fintech?* At its core, fintech is the use of technology to provide new and improved financial services. Part of the motivation for the emergence of fintech is that, while information technology has made everything – from computers to cars – cheaper and more functional, the unit cost of financial intermediation has apparently not changed much in over a century. Philippon (2014) estimates that the unit cost of financial intermediation in the US has remained at about 2% over the past 130 years.<sup>2</sup> Thus, one promise of fintech is the unveiling of cheaper ways to overcome financial contracting frictions and lower the cost of financial services to improve consumer welfare. The recent evidence

\* Corresponding author at: Olin Business School, Washington University in St. Louis, United States.

E-mail address: [thakor@wustl.edu](mailto:thakor@wustl.edu).

<sup>1</sup> There is even a paper that has reviewed hundreds of papers using the term “fintech”, with the sole objective of extracting a definition of the term (see Schueffel, 2016). While I do not rely on that paper for the definition of fintech, it illustrates the wide range of opinions on this issue.

<sup>2</sup> The unit cost of financial intermediation is defined as income of financial intermediaries divided by total intermediated assets.

<https://doi.org/10.1016/j.jfi.2019.100833>

Received 4 July 2019; Accepted 30 July 2019

1042-9573/ © 2019 Elsevier Inc. All rights reserved.

suggests that this promise may be real – Fuster et al. (2019) provide evidence that fintech has improved the productivity of mortgage lending.

Fintech is part of the process of evolving financial innovation, which has theoretically been shown to be risky but of value (e.g. Thakor (2012)), with supporting recent evidence that it yields substantial value to investors (see Chen, et. al (2019)). The Financial Stability Board (FSB) defines fintech as “technologically enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions, and the provision of financial services.” This definition has also been adopted by the Basel Committee on Banking Supervision (BCBS), in part because “This broad definition is considered useful by the BCBS in light of the current fluidity of fintech developments.”<sup>3</sup>

The areas that fintech covers can be broadly described as: (i) credit, deposits, and capital-raising services; (ii) payments, clearing and settlement services, including digital currencies; (iii) investment management services (including trading); and (iv) insurance.<sup>4</sup> Part of the technological backbone of fintech is the Blockchain technology.<sup>5</sup>

The use of this technology along with other technological advancement is intended to:

- Lower search costs of matching transacting parties.
- Achieve economies of scale in gathering and using large data.
- Achieve cheaper and more secure information transmission.
- Reduce verification costs.

It has been suggested that there have been three phases of fintech and we are currently in the third phase<sup>6</sup> (Fig. 1).

The reason why fintech is generating so much excitement and research interest now is that it is bypassing traditional intermediaries in the offering of financial services. Thus, the estimated 12,000 or so specialized fintech firms<sup>7</sup> present a potential existential threat to traditional financial *intermediation*, and some have wondered if fintech is *the* new paradigm for financial services.<sup>8</sup> Whether this will threaten traditional financial *intermediaries* themselves remains to be seen, and I will pose this as one of the research questions this paper will address.<sup>9</sup>

As Apple Pay offers a virtual wallet, P2P lending platforms offer an alternative to bank loans, and established cryptocurrencies like Bitcoin as well as new ones like Facebook’s proposed Libra provide non-fiat-money-based currency alternatives to cash, numerous profoundly important questions arise that may prove to have substantial research legs:

*Question 1:* How should we modify our theories of financial intermediation so as to accommodate banks, shadow banks, and non-intermediated solutions?

*Question 2:* How will credit, deposits and capital raising be affected by fintech? Will P2P platforms replace bank lending?

*Question 3:* On payments, clearing and settlement, what will be the role of cryptocurrencies *vis-à-vis* fiat money and private money creation by banks? How will this affect central banks?

*Question 4:* How will Blockchain-technology-assisted smart contracts

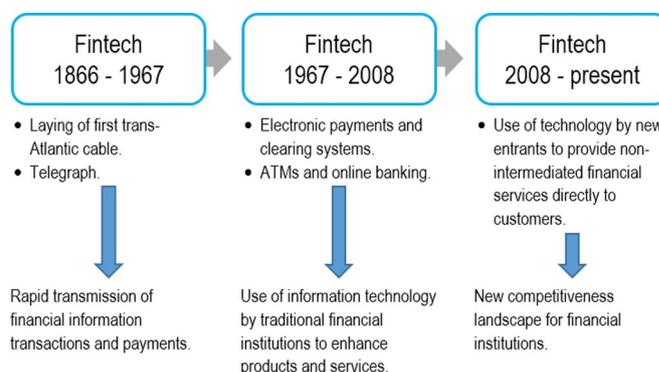


Fig. 1. The three phases of fintech. Consumers International (2017).

transform the financial market, including investment management and insurance?

The key insights generated by the existing literature on these questions are as follows:

- (1) The most fruitful way to address the first question is to create a theory of P2P lending *vis-à-vis* bank lending, at least as a start. Our theories of financial intermediation will need to be modified by taking into account the objective function of P2P lenders, by examining their existing contractual arrangements and endogenizing them based on informational frictions and incentive problems. Such a theory should emphasize that the key distinction between banks and non-banks is in the uniqueness of banks as deposit-gatherers and their specialization in screening, monitoring and relationship banking. It may also have implications for the blurring boundaries between banks and financial markets; see Merton and Thakor (2019) for an analysis of these blurring boundaries. Trust is likely to play a role in this theory, although it is difficult to assess at this stage the nature of this role.
- (2) P2P lending will take some market share away from banks, but will not replace bank lending in the near future. P2P lenders are likely to take risky borrowers, who lack collateral, away from capital-constrained banks. Eventually, banks will either build their own online lending platforms, acquire P2P platforms or partner with P2P platforms, so it is unlikely that the role of banks in the credit and deposit markets and capital raising will diminish significantly.
- (3) On payment systems, clearing and settlement, cryptocurrencies will grow in popularity but are unlikely to replace fiat currency. It is likely that central bank digital currencies – which are centralized rather than being decentralized like Bitcoin – will emerge in the future to replace cash.
- (4) Fintech will significantly affect trading and insurance. Smart contracts are likely to substantially impact financial contracting, at both the intensive and extensive margins. They provide a nice opportunity for future normative research into contracting innovations.

The rest of the paper is organized as follows. In Section 2, I review some basic stylized facts related to fintech, in order to provide a perspective on magnitudes and trends. The section also discusses basic concepts related to the four aspects of fintech mentioned earlier. Section 3 is devoted to addressing Question 1, Section 4 to addressing Question 2, Section 5 to addressing Question 3, and Section 6 to Question 4. Section 7 concludes by wrapping up with a summary of the research questions, our stock of knowledge and issues for future research.

<sup>3</sup> See Bank for International Settlements (2018a).

<sup>4</sup> See Favaretti et al. (2017).

<sup>5</sup> There are many sources of information on this technology. See, for example, Pilkington (2016).

<sup>6</sup> See Consumers International (2017).

<sup>7</sup> See Statista, “The Number of Fintech Startups worldwide as of February 2019, by Region”. <https://www.statista.com/statistics/893954/number-fintech-startups-by-region/>

<sup>8</sup> See Arner et al. (2016).

<sup>9</sup> *The Economist* (June 17, 2015) expressed a view on this: “Bright young things based in San Francisco, New York, London and Stockholm are raising billions of dollars in venture capital to “disrupt” financial services. With much brashness, these t-shirt-wearing whizz-kids are confident they will do to banks what digital photography did to Kodak.”

2. Some stylized facts and basic concepts

In this section, I provide some statistics and stylized facts on fintech, along with a discussion of basic conceptual issues.

2.1. Size of fintech, fintech investments and relationship to banking

The size of fintech is difficult to ascertain because of varying definitions of fintech. For example, the Buchak et al. (2018a) paper views fintech as also including technology-assisted products provided by banks (e.g., online lending). However, others exclude banks from their definition of fintech, as I will do in this paper. This heterogeneity in the definitions of fintech makes it virtually impossible to identify exactly how big fintech really is. However, one useful growth measure to use is venture capital (VC) investment in fintech companies. Data quoted in an International Organization of Securities Commissions’ (IOSCO) report indicate cumulative investments of over \$100 billion in more than 8800 fintech companies as of November 2016.<sup>10</sup> On an annual basis, global fintech investments increased at a steady pace between 2014 and 2017 from \$19.9 billion to \$39.4 billion. In the first half of 2018, the global fintech sector raised \$41.7 billion, which surpassed the amount for all of 2017.<sup>11</sup>

There are also many interesting stylized facts about fintech. Using

in which larger percentages of the population are banked and where banking earns higher rents (due to lower interbank competition). This is intuitive. Banking rents tend to be high in countries in which banks are used a lot, which provide an inducement for fintech investments to get a share of the rents.

2.2. Key fintech products and services

The Basel Committee on Banking Supervision (BCBS) has provided a categorization of fintech innovations currently in evidence, which I have modified and shown in Table 1 below.<sup>12</sup> This corresponds to the four categories mentioned in Section 1.

The way to interpret this table is to think of the four columns as four distinct types of financial services that are being affected—and will be even more affected in the future—by fintech. The numerous rows below these four columns labeled “Market Support Services” are different aspects of information technology that enable fintech to change the financial services landscape. BCBS also conducted a survey of its members that yielded the percentages of fintech providers of different products and services. In the context of the four categories of fintech services listed in Table 1, it found that the highest number of fintech service providers are in payments, clearing and settlement services, followed by credit, deposit and capital-raising services.

**Table 1**  
Fintech services by sector.  
Source: Adapted from BCBS and Bank for International Settlements (2018a).

Sectoral innovations				
Credit, deposit, and capital-raising services	Payments, clearing and settlement services		Investment management services	Insurance
Crowdfunding	Retail	Wholesale	High-frequency trading	Link to mobile devices
Lending marketplaces	Mobile wallets	B2B point of sale	Copy trading	Big data
Mobile banks	Peer-to-peer transfers	FX wholesale	E-trading	Improved risk pricing
Credit scoring	Digital currencies	Digital exchange platforms	Robo-advice	New contracts
Market support services	Portal and data aggregators			
	Ecosystems (infrastructure, open source, APIs)			
	Data applications (big data analysis, machine learning, predictive modeling)			
	Distributed ledger technology (blockchain, smart contracts)			
	Security (customer identification and authentication)			
	Cloud computing			
	Internet of things / mobile technology			
	Artificial intelligence (bots, automation in finance, algorithms)			

European data, Mansilla-Fernandez (2017) documents the following stylized facts about fintech based on correlations in the data.

*Stylized Fact 1:* Investments in fintech companies are higher in more financially-developed countries.

*Stylized Fact 2:* Use of electronic payments is higher in countries where a higher fraction of the population holds an account with a financial institution.

*Stylized Fact 3:* Investments in fintech companies are higher in countries with less competitive (more concentrated) banking systems.

*Stylized Fact 4:* Investments in fintech companies are higher in countries with higher lending interest rates and lower deposit interest rates

Collectively, these stylized facts tell us that the opportunities for fintech seem to be greatest in the most financially-developed countries

2.3. Credit, deposits and capital raising services: P2P lending and other fintech lenders

P2P lending—sometimes referred to as “marketplace lending”—is the loaning of money to individuals and businesses through online services that directly match lenders with borrowers without using an intermediating bank. As Milne and Parboteeah (2016) report, P2P lending has gained traction in both the U.S. and Europe since the financial crisis. A PriceWaterhouseCoopers (2015) monograph noted that the origination volumes of P2P lending platforms has grown very rapidly since 2007 in the US, UK and China. A recent estimate of global P2P lending is that P2P lending will grow from a little over \$50 billion in 2016 to almost \$300 billion by 2022.<sup>13</sup>

<sup>12</sup> See Bank for International Settlements (2018a).

<sup>13</sup> Source: Statista Digital Market Outlook 2017. This estimate understates global growth because it includes on the US, UK and China.

<sup>10</sup> See IOSCO (2017).

<sup>11</sup> See Fin-Tech Global, July 11, 2018.

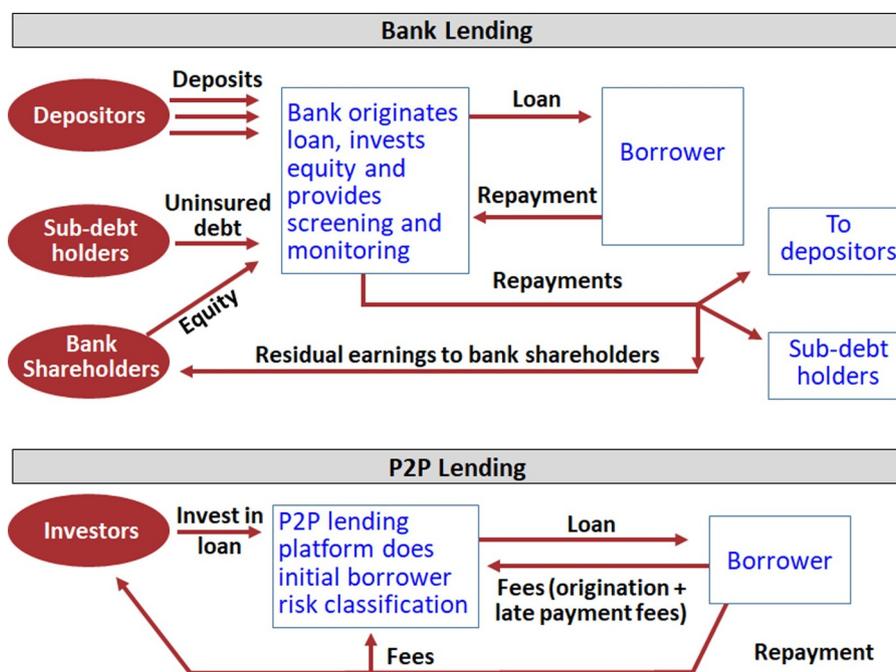


Fig. 2. P2P versus bank lending.

The P2P lending process works as follows. The borrower submits an application for a loan. The P2P platform does a preliminary credit analysis and assigns a “loan grade”, which is a risk classification. Then investors (potential lenders) bid on the listing with loan amounts and interest rates. The platform then combines qualified lenders’ bids into a single loan. The P2P platform itself does not invest in the loan, so there is no tranching of claims as in the case of a bank loan that is financed with debt (deposits and subordinated debt) and equity (capital invested by the bank). In this sense, all the money provided by investors, who finance the loan, can be thought of as investor equity.<sup>14</sup> Thus, when people say that P2P lending is *non-intermediated* finance, what they mean is that there is no bank between investors and borrowers that commits its own capital to provide qualitative asset transformation.<sup>15</sup> The P2P platform’s compensation comes in the form of loan origination fees (1–6%) and late payment fees paid by borrowers in addition to a percentage of all borrower repayments (typically 1%) that goes as a service fee to the platform. Moreover, because the P2P platform owner collects a fraction of loan repayments, the owner’s objective function is similar to that of a (minority) shareholder who has operating control.<sup>16</sup> See Fig. 2 above.

Much of the growth in P2P lending has occurred in the aftermath of the 2007–2009 financial crisis, Aggregate P2P lending volume is still very small compared with bank lending, but is growing rapidly. Global P2P lending was only \$26.16 billion in 2015,<sup>17</sup> but it will be in the range of \$150 billion–\$490 billion by 2020, according to a Morgan Stanley estimate. Even then, the projected lending volume will be dwarfed by U.S. commercial bank lending volume which stood at \$13.116 trillion as of December, 2018.<sup>18</sup>

Table 2  
Breakdown of P2P lending.  
Source: Statista.com and Welltrado (2018).

Type of loan	Percentage of P2P total (%)
Consumer loans	36
Business loans	26.1
Invoice trading	19.4
Mortgage loans	18.5

Some of the well-known P2P lending platforms in the U.S. are LendingClub Corporation (LC), Prosper Marketplace, Upstart, CircleBack Lending, Funding Circle (co-founded in the US and the UK), and Peerform. The top P2P platforms in Europe include Minto, Grupeer, IUVO Group, Housers, Bitbond, Zopa, and Auxmoney. China’s P2P lending market is the largest in the world, with more than 4,000 platforms making about \$20 billion per year in loans.

On the consumer lending side, U.S. P2P lenders often market their loans as being cheaper than credit cards.<sup>19</sup> Most P2P lending is unsecured.<sup>20</sup> In the U.S., P2P lending is subject to SEC regulation and must also be compliant with state laws, but the regulatory burden on these platforms is much lighter than that on banks.

In terms of a breakdown of P2P lending in the U.S., see the Table 2 below.

The use of fintech in lending is *not* limited to P2P platforms. There are also shadow banks—financial intermediaries that provide maturity transformation services like depository institutions but do not fund themselves with deposits—that use fintech, but are neither P2P platforms nor banks. These shadow banks provide essentially the same lending services as commercial banks, but do not finance with deposits. They make extensive use of information technology in the lending process like P2P platforms, but do not seek to just match borrowers with (peer) lenders in a non-intermediated fashion. Rather, they invest their own equity and thus have balance sheets somewhat similar to banks, except that deposit financing is replaced by uninsured debt

<sup>14</sup> Many of the investors who take these equity claims in loans made by P2P platforms have high leverage on their own balance sheets.

<sup>15</sup> See Bhattacharya and Thakor (1993) and Greenbaum et al. (2019) for a discussion of qualitative asset transformation (QAT).

<sup>16</sup> That is, the collection of a fraction of the total loan repayment makes the platform owner’s claim similar to that of the investors in the platform, and the platform owner makes all the operating decisions.

<sup>17</sup> Of this, about \$15 billion was in the US.

<sup>18</sup> Of course, this also includes loans by banks to other banks. Lending to households and corporations is under \$10 trillion, but it still dwarfs P2P lending.

<sup>19</sup> See Tom (2017).

<sup>20</sup> See Consumers International (2017).

financing and funding raised through securitization. An example is OnDeck Capital, which uses technology to provide loans to small businesses, and states that it offers borrowers many advantages over banks, including much faster loan approval and unsecured loans. It not only makes spot loans but also sells lines of credit. It made \$2.5 billion in loans in 2018 and financed them with equity, debt financing (mostly from institutional lenders, including banks), and proceeds from securitization. Thus, the emerging credit market landscape does not segment neatly into just commercial banks and P2P lenders, but also has a variety of shadow bank lenders that are active users of fintech and combine elements of commercial banks and P2P lenders.

#### 2.4. Payments, clearing and settlement services: cryptocurrencies

The biggest disruptive potential of fintech in payments services is with cryptocurrencies. Perhaps the most well-known cryptocurrency or digital currency is Bitcoin, which was launched in 2009. It allows person-to-person transactions independently of the banking system.<sup>21</sup> Bitcoin is a virtual currency, i.e., it is a digital computer code that is stored in an electronic wallet in cyberspace. While some view Bitcoin as a currency, others view it as a financial investment.

Bitcoin and other cryptocurrencies are not merely money that exists in cyberspace. Rather, these digital currencies rely on a decentralized form of control, with ownership, security and verification based on a cryptography-based digital ledger that replaces banks. Transactions are stored digitally on a public ledger known as the Blockchain.<sup>22</sup> This removes the need for a trusted financial intermediary like a bank to verify transactions. The decentralized form of control also makes it seemingly unnecessary for control to be exercised by governments.<sup>23</sup> See Catalini and Gans (2016) and Cong (2019) for discussions of the economics of the Blockchain.

The advent of Bitcoin was followed by the inception of “altcoins” or “alternative coins”. These are also cryptocurrencies, and are alternatives to Bitcoin. They use a similar peer-to-peer system for validating transactions (mining) and adding them to a Blockchain. Differences are mainly in proof-of-work algorithms. Prominent altcoins are Ethereum, Litecoin, Bitcoin Cash, Dogecoin, Monero, and Dash.<sup>24</sup>

How big are cryptocurrencies? The market capitalization of all cryptocurrencies as of February 2018 was about \$417 billion. The highest market cap achieved until then was \$800 billion in January 2018; these currencies have highly volatile market values. Bitcoin still has the largest share of this market, but it has declined over time.<sup>25</sup>

Cryptocurrencies have also provided a way for those seeking funding for projects to raise financing through a mechanism called an Initial Coin Offering (ICO). An ICO is basically a cryptocurrency version of crowdfunding. It enables cryptocurrency developers<sup>26</sup> to raise funding for the development by selling tokens to investors, who therefore essentially become part of the project themselves. These tokens can then be traded on an exchange. Benedetti and Kostovetsky (2018) document that the buy-and-hold returns to investors in ICOs have been very high, indicating either underpricing of ICOs or a very high perception of risk on the part of investors. Many ICOs are thus

platform tokens that are not meant to be general payment substitutes for fiat money (see Cong, Li and Wang (2019)). So in that sense, there are many different types of cryptocurrencies: (a) general payment digital money, (b) platform tokens, (c) corporate coupons, and (d) digitized securities (with cash flows).

#### 2.5. Investment management services

Fintech will also significantly alter the way we trade and the way we manage money, including the provision of financial advice. High-frequency trading and e-trading, both of which are aspects of fintech, will evolve with fintech. Foreign exchange trading will also be affected by fintech, especially copy trading. The term “copy trading” is used typically in forex trading and it refers to the phenomenon of copying the trades of successful traders. Many successful traders provide access to their trades, either for a fee or for free. Finally, robo-advising<sup>27</sup> will continue to grow as well with advances in fintech. There is already some research evidence on robo-advising. D'Acunto et al. (2019) provide evidence that adopters of robo-advising are similar demographically to non-adopters, but are more active and have greater assets under management. Investors adopting robo-advising experience diversification benefits, getting better returns with lower volatility. All investors increase attention based on online account logins, and adopters are documented to reduce prominent behavioral biases, including disposition, trend-chasing, and rank effect biases.

#### 2.6. Insurance

“InsurTech” is the branch of fintech that is dedicated to the insurance sector.<sup>28</sup> The basic economics driving fintech in insurance is that connected devices (phones, watches, computers, etc.) in homes, cars and worn as personal gear gather huge amounts of personal information about individuals. This leads to “big data” that insurance companies can use to calculate risk more precisely and in a more dynamic way than they do at present.

Consumers can choose to utilize sensors and trackers provided by insurance companies which then generate data that insurance companies can use not only in pricing the initial policy, but also in designing adjustments that reward certain types of low-risk behaviors. The end results are more finely-calibrated risk assessment and pricing, with less pooling across customers with heterogeneous but *ex ante* indistinguishable risk profiles. Automobile and health insurance are two important segments for Insurtech.

Insurtech is still small, but is growing fast. The global Insurtech market revenue in 2018 was \$532.7 million.<sup>29</sup> Private equity firms and venture capitalists are actively investing in Insurtech. Other prominent investors are Softbank, Google Ventures, Salesforce and Amazon.

As this segment of fintech grows, we should expect to see changes at both the intensive and the extensive margins. At the intensive margin, traditional insurance contracts will be modified to reduce cross-subsidization of high-risk agents by low-risk agents. At the extensive margin, we may see new kinds of risks being insured with new kinds of insurance contracts, e.g., contracts that insure against even small changes in the market values of non-traded or illiquid assets. In general, new insurance contracts will partition the state space more finely and insure smaller and smaller risks with ever-increasing precision.

<sup>21</sup> For a nice account of Bitcoin, see Wolla (2018). See also Thakor (2019).

<sup>22</sup> Blockchain is a *distributed* ledger, which means that the ledger is spread among all peers in the network, with each peer holding the ledger.

<sup>23</sup> See Ibinex.com (2018).

<sup>24</sup> See Ibinex.com (2018) for descriptions of these.

<sup>25</sup> For example, Bitcoin's market share in April 2013 was over 94%, and had declined to about 40% by June 2018.

<sup>26</sup> Cryptocurrency developers are those who are writing, developing and debugging code to come up with the next generation of Blockchain-based applications that permit the introduction of new cryptocurrencies with properties that include larger volumes, faster speeds, and lower power consumption of the mining networks than existing cryptocurrencies. The “project” is the set of activities involved in developing and launching the cryptocurrency.

<sup>27</sup> Robo advisors provide digital financial advice based on mathematical rules or algorithms with minimal human intervention.

<sup>28</sup> See, for example, Consumers International (2017).

<sup>29</sup> See Research and Markets (2018).

### 3. Question 1: how do we modify financial intermediation theories to accommodate banks, shadow banks and non-intermediated solutions?

This is a big question. So far, the literature on fintech has simply bootstrapped fintech platforms to models of financial intermediary existence,<sup>30</sup> or discussed the implications of financial intermediary existence models for fintech.<sup>31</sup> Some papers have argued that fintech can bring cost economies to banking that have been elusive for a long time.<sup>32</sup> Others, like Vives (2017), have proposed that fintech has welfare-enhancing disruptive capability that needs to be harnessed through regulations that adapt to ensure that the promised benefits of fintech accrue without jeopardizing financial stability.

These discussions and conjectures notwithstanding, perhaps it is time to make a theoretical push in two directions: (i) develop an integrated theory of financial intermediation that reflects both the economic functions of financial intermediaries embedded in existing theories, and captures what fintech firms do; and (ii) once such a theory is in hand, begin to rethink our theories of financial system architecture to include banks, markets and fintech firms.<sup>33</sup>

I believe that to do (i) above, it will be useful to begin with a careful listing of the similarities and differences between traditional financial intermediation and fintech. To fix ideas and tackle a manageable problem, let us focus on bank lending versus P2P lending. Although a few papers—mostly empirical—have been written on this topic, there is quite a bit of confusion on even basic facts. For example, I have seen some assert that a P2P lender is nothing more than a computer program that provides an investor-borrower matching algorithm, so it is not really a profit-maximizing firm that faces incentive problems, and for this reason it simply cannot be compared with a bank. This view is wrong—P2P lenders are profit-maximizing entities, and they make subjective decisions that are often opaque and require the trust of users (see Merton, 2018). But this highlights the need for an integrated theory of intermediated and non-intermediated lending in which the basic institutional facts are laid out and used. So, given below is a table that summarizes the financial intermediation services provided by banks (along with some of the papers that model these services) and the services provided by P2P platforms. This table also includes the frictions and incentive problems faced by banks and P2P platforms.<sup>34</sup> This is not to suggest that all frictions have been exhaustively captured below or that a theory of banks and P2P lenders will necessarily need to include all the frictions and services given in this table to generate insights. Nonetheless, it is hoped that this taxonomy proves to be useful in making modeling choices.

Two questions need to be addressed with respect to this table: (i) what sort of incentive conflicts should we expect to see in P2P lending platforms, and how should these be modeled? and (ii) how big are the cost differences between banks and P2P platforms?

On the incentive conflicts in P2P platforms, it is useful to refer to Fig. 2 as well as Table 3. Because the platform provides investors a loan risk classification based on some pre-lending screening, there is the incentive problem of inadequate screening by the platform. Unlike a bank, the platform has no skin-in-the-game in the form of equity capital

invested in the loan.<sup>35</sup> So the way the platform is compensated should attempt to overcome this incentive problem. Having the platform collect a portion of the borrower's repayment provides some incentive for the platform to make good loans since this mimics the payoff to equity. However, the presence of origination fees provides incentives to grow aggressively and engage in overlending.<sup>36</sup>

Have we seen any examples of this in practice that would illustrate these incentive problems and help fix ideas?

The answer is yes. Consider the example of LendingClub. It was accused of mislabeling the loans it sold to its investors, and this was apparently a violation of the company's own internal rules. It led to the departure of its founder and CEO in 2016. It raised questions about the firm's integrity. A stock analyst following the company said:<sup>37</sup>

"If the company is willing to sell mislabeled goods to one of the largest and most sophisticated clients, why should Joe investor assume he'll be treated any better. Small investors need to be sure they are receiving the loans they signed up for."

These kinds of episodes raise questions about the quality of pre-lending screening done by the P2P platform.<sup>38</sup> These episodes also raise concerns about overlending, and trust.

Recently, Thakor and Merton (2019) have developed a theory of bank and non-bank lending in which banks have an endogenous advantage over non-bank lenders (including P2P lending platforms) when it comes to being trusted to make good loans. Their theory suggests that, while incentive problems in banks may be more numerous and complex than in P2P platforms, banks possess an advantage in developing investor trust due to their unique access to low-cost deposit funding. Begley and Srinivasan (2019) provide empirical evidence that this trust advantage of banks matters to borrowers.

The other issue is the magnitude of the cost difference between the business model of banks and the business model of P2P lenders. There is consensus that banks have higher operating costs than P2P lenders because they have to pay for their deposit-gathering branch network,<sup>39</sup> ATMs and the cost of being more heavily regulated. Welltrado (2018) estimates that operating costs as a percentage of outstanding loans are 2.70% at Lending Club versus almost 7% at banks.

Eventually, a theory of bank and P2P lending will turn on the tradeoff between the benefit of bank lending and the benefit of P2P lending. The benefit of bank lending lies in the larger array of intermediation services banks provide relative to P2P lending platforms, particularly in relationship banking, and possibly in the ability of banks to be more trusted lenders. The benefit of P2P lenders lies in their lower

<sup>35</sup> Of course, reputational concerns can provide discipline. But the effectiveness of these has been questioned by Thakor and Merton (2019) who develop a model in which depository institutions endogenously have stronger reputational incentives than P2P lenders and other non-banks. Thakor (2014) discusses how equity capital attenuates incentive problems in banks. Thakor (1996) provides a theory and supporting empirical evidence on how changes in capital requirements affect bank lending.

<sup>36</sup> As earlier discussions pointed out, this is similar to Acharya and Naqvi's (2012) observation about how loan-volume-based compensation induces excessive risk taking and overlending by bank loan officers. The problem is more severe during economic booms (see Thakor, 2015, 2016).

<sup>37</sup> See Consumer's International (2017).

<sup>38</sup> For example, Salisbury (2016) reported: "Moody's said investments backed by loans issued by Lending Club's rival Prosper weren't performing as well as expected and might have to be downgraded...Fitch said pockets of recent credit underperformance were prompting marketplace lenders (a large group that includes peer-to-peer companies as well as other lenders) to tweak the computer models they used to evaluate loans—suggesting that the companies may not be as good at vetting borrowers as they had suggested."

<sup>39</sup> Regulation too can contribute to these costs through imprecise measurements that distort the implementation of regulations and the resulting costs. See, for example, Benoit, Hurlin and Perignon (2019) who document this in the context systemic risk scoring for SIFIs.

<sup>30</sup> See, for example, de Roure et al. (2019).

<sup>31</sup> See, for example, Molnár (2018).

<sup>32</sup> For example, Philippon (2014, 2018).

<sup>33</sup> Our existing theories of financial system architecture consider the emergence of and interaction between banks and markets. See, for example, Boot and Thakor (1997) and Song and Thakor (2010). There are also theories of how banks and non-banks arise and interact. For a general equilibrium theory of how banks and non-banks arise endogenously to segment the credit market, see Donaldson et al. (2019).

<sup>34</sup> Unless, we view P2P platform firms as profit-maximizing entities that face incentive conflicts vis-à-vis borrowers, it seems unlikely that we can have a coherent theory of financial intermediation with P2P platforms.

**Table 3**  
Banks and P2P lending platforms.

Banks	P2P lending platforms
<p><i>A. Services provided (as depicted in existing theories).</i></p> <ul style="list-style-type: none"> <li>Improved risk sharing and consumption insurance (Bryant, 1980; Diamond and Dybvig, 1983).</li> <li>Screening (Ramakrishnan and Thakor, 1984; Millon and Thakor, 1985; Coval and Thakor, 2005).</li> <li>Monitoring (Diamond, 1984; Holmstrom and Tirole, 1997; Mehran and Thakor, 2011).</li> <li>Funding liquidity creation (Donaldson et al., 2018).</li> <li>Loan commitments (credit rationing insurance) and other off-balance-sheet puts and guarantees (Boot et al., 1993; Thakor, 2005).</li> </ul> <p><i>B. Capital structure.</i></p> <ul style="list-style-type: none"> <li>High leverage with little bank equity capital.</li> </ul> <p><i>C. Incentive problems.</i></p> <ul style="list-style-type: none"> <li>Insufficient screening.</li> <li>Insufficient monitoring.</li> <li>Insufficient funding liquidity creation.</li> <li>Excessive risk-taking due to high leverage and safety nets.</li> <li>Overlending and excessive growth due to incentives distorted by safety nets and too little capital.</li> <li>Insufficient capital due to safety nets.</li> <li>Incentives to renege on off-balance-sheet commitments.</li> </ul> <p><i>D. Regulation</i></p> <ul style="list-style-type: none"> <li>Deposit insurance and capital regulation.</li> <li>High regulatory costs and restrictions.</li> </ul> <p><i>E. Objective function</i></p> <ul style="list-style-type: none"> <li>Maximize bank equity value.</li> </ul>	<p><i>A. Services provided.</i></p> <ul style="list-style-type: none"> <li>No.</li> <li>Yes.</li> <li>No.</li> <li>No.</li> <li>No.</li> </ul> <p><i>B. Capital structure</i></p> <ul style="list-style-type: none"> <li>All equity-financed: no equity capital invested by lending platform, so investors are equityholders in loans.</li> </ul> <p><i>C. Incentive problems</i></p> <ul style="list-style-type: none"> <li>Yes.</li> <li>No.</li> <li>No.</li> <li>No.</li> <li>Overlending and excessive growth due to profit-maximization motives.</li> <li>No.</li> <li>No.</li> </ul> <p><i>D. Regulation</i></p> <ul style="list-style-type: none"> <li>No.</li> <li>Lower regulatory burden.</li> </ul> <p><i>E. Objective function</i></p> <ul style="list-style-type: none"> <li>Maximize value of P2P platform's owners' claim consisting of origination and other fees plus fraction of borrower repayments.</li> </ul>

operating costs.

Such a theory should not only be consistent with some of the emerging stylized facts about P2P versus bank lending (more on this in the next section), but it should also generate predictions that can be tested in the future to potentially reject the theory. In contrast to financial intermediation theories that predict the optimality of infinitely large intermediaries and have no role for bank capital (e.g., Diamond, 1984 and Ramakrishnan and Thakor, 1984), the new theory should assign a role to bank capital, since this is a key distinguishing feature of banks relative to P2P platforms.

In the earlier theories depicting the borrower's choice between bank and capital market financing (e.g. Boot and Thakor, 1997, 2000 and Song and Thakor, 2010), those seeking relationship loans go to banks and those seeking transaction loans go to the capital market. P2P and other fintech loans are more like transaction loans and hence closer to the capital market end of the spectrum. The implication of this that fintech lenders will be less competitive vis a vis banks in relationship lending is supported by the empirical evidence in Balyuk et al (2019). Keeping in mind that small banks rely more on relationship lending than large banks, they document a negative relationship between fintech small business lending and county small bank market share. As theories are modified in future research to include P2P and other forms of non-bank financing, it will also be useful to include informal financing that sometimes provides an effective resolution of information and enforcement problems (see Allen et al. (2019) for more on this role of informal financing).

#### 4. Question 2: impact of fintech on credit, deposits and capital raising: will P2P lending replace bank lending?

In addressing this question, I begin by reviewing in this section the empirical evidence on P2P lending versus bank lending, and then discuss the implications of P2P lending for relationship lending by banks and systemic risk.

#### 4.1. The empirical evidence

While in its early days, P2P lending was indeed “peer to peer”, most of the investors now are hedge funds and large financial institutions.<sup>40</sup> One of the main research questions that has been posed has to do with the extent to which P2P lending competes with bank lending. Tang (2019), for example, hypothesizes that when there is a negative shock to bank credit supply, whether the P2P borrower pool worsens or improves in quality depends on whether P2P and bank lending are complements or substitutes. The paper uses a change in U.S. accounting rules as a negative shock to bank credit supply, and shows that U.S. P2P lending is a substitute for bank lending in that it serves infra-marginal bank borrowers, but it is a complement for small loans.

A related paper is de Roure et al. (2019) which asks the following research questions:

- Under what circumstances do banks lose loans to P2P platforms?
- What are the risk characteristics of the loans that migrate from banks to P2P platforms?
- Are P2P platforms lending at higher or lower risk-adjusted interest rates than banks?

To address these questions, the paper develops a simple model of bank and P2P lending. Banks have access to rent-generating deposits and invest their own capital in loans. So they are “leveraged lenders”, as explained in the previous section. P2P platforms have no deposits and are all-equity lenders. Due to their leverage, there is risk-shifting moral hazard in banks, which necessitates sufficient equity capital to overcome; there is no such moral hazard in P2P lenders. Moreover, in line with the discussion in the previous section, banks face a higher

<sup>40</sup> Consequently, in the days when it was truly peer-to-peer lending, research focused on the personal attributes (e.g., looks) of those who received loans. See Pope and Snyder (2011), Lin et al. (2013), and Morse (2015). However, now institutional investors like banks, venture capital firms like Sequoia, hedge funds and private equity firms all invest in P2P lending platforms.

operating cost than P2P platforms, due to regulation.

The model generates three main predictions:

- (1) If only *some* banks are subject to an exogenous increase in regulatory costs, and the unaffected banks are not financially strong enough to replace the reduction in credit supply from the affected banks, then banks in the aggregate will lose market share to P2P lenders.
- (2) P2P platforms make riskier loans than banks make.
- (3) The risk-adjusted interest rates on bank loans are lower than on P2P loans.

The authors then confront these predictions of the model with German consumer credit data. P2P lending data are provided by Auxmoney, the largest and oldest P2P lending platform in Germany. Unlike the U.S., P2P lenders in Germany are allowed to serve sub-prime borrowers. To provide causal evidence, the paper uses a quasi-natural experiment, which is the 2011 European Banking Authority (EBA) capital exercise. This resulted in two large banks (Landesbanken) being undercapitalized and faced with the prospect of having to raise substantial capital to be in compliance. In the short run, banks faced with such a prospect typically cut back on lending and shed assets to come into compliance; in the long run, they build up capital via retained earnings.<sup>41</sup> The empirical strategy is to see if the savings banks linked to these two Landesbanken—which were only indirectly affected by the regulatory shock due to their connection with these Landesbanken<sup>42</sup>—decreased their lending relative to savings and cooperative banks that were unaffected, and the extent to which P2P lenders exploited the opportunity to increase their lending.

Using a diff-in-diff specification, the authors find strong empirical support for the three predictions of the theory. They also perform ancillary tests that show that P2P lending made the biggest inroads where consumer awareness of P2P lending (measured by Google searches for P2P lending) prior to the regulatory capital shock was the greatest.

From the Tang (2019) and de Roure et al. (2019) papers, the main takeaways are as follows:<sup>43</sup>

- P2P lenders compete with bank lending, but tend to have a competitive advantage when banks experience some kind of shock that (temporarily) limits their credit supply. This effect is stronger when the banks that are unaffected by the shock are financially weaker (i.e., have lower capital),
- P2P lenders are willing to make riskier loans than banks, but despite their lower operating costs, the loans offered by P2P lenders may not be cheaper.
- P2P lenders may serve both marginal and infra-marginal bank borrowers.
- The regulations that banks are subject to also have an effect on P2P lending.

P2P lending is also characterized by network effects. The more investors a platform can attract, the more borrowers it can attract. This means that P2P platforms can benefit from creating a herding effect

<sup>41</sup> Uluc and Wieladek (2018) document that retained earnings represent an important channel used by banks to adjust to capital requirements.

<sup>42</sup> The savings banks were affected in two ways. First, they had to purchase equity in their Landesbanken to help these Landesbanken to raise their capital levels. This reduced funds available to lend. Second, the purchase of equity increased their risk-weighted capital requirements, further constraining the lending of the savings banks.

<sup>43</sup> While these papers look at the interaction between bank and P2P lending, Buchak et al. (2018b) examine the interaction between depositories and shadow banks in mortgage lending. They document considerable market segmentation in shadow bank penetration, just as other papers have found for P2P lending.

among investors. There is empirical evidence of such herding. See, for example, Lee et al. (2011).

In addition to the factors discussed above, the growth of P2P lending will also depend on how much trust depositors have in banks, and investors have in P2P platforms. This is a strong prediction of the Thakor and Merton (2019) model. Empirical support for this appears in Broström et al. (2018). The paper empirically examines the effect of a loss of trust in banks on the growth of P2P lending, using Prosper.com data. The paper finds that lower trust in banks is associated with a higher likelihood of participation and higher levels of participation of lenders in P2P loans.

#### 4.2. Implications for relationship lending by banks and systemic risk

The rise of P2P lending raises obvious questions about the future of relationship banking. Here, the theory offers some guidance. The Boot and Thakor (2000) model predicts that when banks face higher competition from non-banks, they invest *more* in increasing the value of their relationship loans; Degryse and Ongena (2007) provide supporting empirical evidence. This suggests that if P2P lenders are perceived by banks as serious competitive threats, then banks will invest *more* in relationship lending.

Moreover, collateral plays an important role in relationship lending; see Boot and Thakor (1994). Their model predicts that early in a relationship, the borrower gets a secured loan, and then, conditional on good repayment behavior, the borrower gets an unsecured loan. This kind of use of collateral prevents credit rationing; see, for example, Besanko and Thakor (1987b) who show that lack of collateral can lead to rationing.<sup>44</sup> So a borrower who lacks collateral may not be in a position to build a relationship with a bank.<sup>45</sup> Such a borrower is a prime candidate for taking loan from a P2P lender. This may explain why so much of P2P lending is unsecured.

The other issue is how P2P lending may affect bank stability. The issue of whether increased competition faced by banks hurts or helps financial stability has been widely studied. The usual channel is that more competition leads to lower rents for banks from relationship lending, so it increases the attractiveness of risky investments for banks. The problem is exacerbated by deposit insurance, with banks' incentives to take risk to maximize the value of the deposit insurance put being the strongest when their relationship lending rents are the lowest. See Besanko and Thakor (1993) for a theoretical argument along these lines.

There is an alternative theoretical argument that focuses on the effect of bank competition on *borrowers* and their risk-taking incentives. When banking is more competitive, loans are cheaper for borrowers, and the low borrowing cost reduces the *borrower's* incentive to engage in risk shifting, thereby, decreasing default risk and improving financial stability. See Boyd and De Nicolo (2005) for such an argument.

Ultimately, I suspect that the specific attributes of banks and the degree of concentration of the credit market will determine whether an increase in competition—such as that provided by P2P lenders—will increase or diminish financial stability. If banks are relatively thinly

<sup>44</sup> Collateral is also thought of as resolving a cash flow pledgeability problem, in the sense that it is useful when a significant portion of the borrower's cash flow cannot be credibly pledged to repay the lender. Recently, Donaldson et al. (2018) have offered another reason why collateral is used so much in lending even when the borrower has ample pledgeable cash flows. Their explanation is that unsecured debt suffers from a non-exclusivity problem—the claims of unsecured creditors can be easily diluted by subsequent borrowing, particularly secured borrowing. To prevent such dilution, the initial lender will insist on collateral.

<sup>45</sup> Recent empirical evidence indicates that there is something special about *bank* collateral and that a reallocation of collateral access from banks to non-bank creditors can reduce the investments of borrowers. See Cerqueiro et al. (2019).

capitalized and have asset portfolios that are already risky, then the predictions from [Besanko and Thakor \(1993\)](#) are more likely to hold, whereas if the banks are well capitalized, then the predictions from [Boyd and De Nicrolo \(2005\)](#) are more likely to hold.<sup>46</sup> [Goetz \(2018\)](#) addresses this question empirically. Using a novel way to capture changes in bank competition by examining how the exogenous state-specific process of U.S. banking deregulation gradually lowered entry barriers into urban banking markets, he finds that an increase in banking competition improved banking stability by increasing bank profitability and asset quality. This indicates that competition forces banks to be more efficient, perhaps reducing their propensity to over-lead and engage in evergreening.

Overall, therefore, there does not seem to be any compelling cause for alarm with respect to potentially harmful effects of the growth of P2P lending on financial market stability. The one caveat, of course, is that P2P lending remains free of scandals and events that can erode trust and cause investors to flee these platforms; see [Thakor and Merton \(2019\)](#) for more on this. Their analysis implies that fintech is likely to succeed mostly in financial services that involve calculations, processing and record-keeping, in which there is a lot of transparency, and performance can be easily tested and verified. However, fintech often requires a model as well as data for the model. Both model selection and data quality require opaque judgments that are difficult to verify and thus, their success depends on trust by the users. Hence, absent trust, the reach of fintech will be limited.<sup>47</sup>

So let us return to the question that this section has been devoted to answering: will P2P lending replace bank lending? The answer, based on all the research we have seen thus far, is yes and no. For some forms of lending, where the risks and associated regulatory costs are high, we will continue to see a migration of lending from banks to P2P lenders. This effect will be stronger in countries in which fewer people use the banking system. However, deposit insurance and the demand for safe assets will continue to give banks a funding cost and trust advantage over other forms of lending, and banks will continue to dominate in those areas. Moreover, where collateral is useful—in order to attenuate moral hazard and private information problems—banks will continue to have an advantage over P2P platforms.<sup>48</sup>

In the end, despite some loans migrating to marketplace lenders, it is unlikely that the growth of P2P lending platforms will pose a significant competitive threat to banks' lending operations. What is more likely is that as marketplace lending gains more traction, banks will build their own platforms or acquire existing platforms to have another form of lending within the bank and/or develop partnerships with P2P platforms. Wells Fargo and Goldman Sachs are already in the process of building their online lending platforms. Lending Club and Prosper are partnering with Utah-based WebBank so that WebBank will originate loans and then sell them to Lending Club and Prosper, and OnDeck is partnering with JP Morgan Chase to underwrite some of its small business loans.

### 5. Question 3: payments, clearing and settlement: the role of cryptocurrencies and fiat money

In this section, I examine how fintech will affect the payments system.

<sup>46</sup> The extent to which banks contribute to global systemic risk will also depend on bank capital. [Bostandzic and Weiß \(2018\)](#) provide interesting empirical evidence that banks contribute more to global systemic risk when they have lower capital.

<sup>47</sup> See [Merton \(2018\)](#) for more on this.

<sup>48</sup> [Besanko and Thakor \(1987a, b\)](#) develop models to show how collateral can help resolve pre-contract private information problems. [Boot et al. \(1991\)](#) and [Chan and Thakor \(1987\)](#) develop models with both private information and moral hazard and show the role collateral plays. [Boot et al. \(1991\)](#) also provide empirical evidence for their predictions. [Berger et al. \(2016\)](#) provide evidence in support of both *ex ante* and *ex post* (moral hazard) theories of collateral.

#### 5.1. Digital wallets with fiat money

Perhaps the area in which fintech has had the greatest impact so far is in payments. Consumers have experienced innovations in this area like “digital wallets” (e.g., PayPal). These innovations enable consumers to complete online transactions without disclosing credit card details.<sup>49</sup> Smartphones have facilitated the adoption of digital wallets in online environments.<sup>50</sup>

Digital wallets “tokenize” digital payments, thereby, allowing smartphones to replace physical wallets. In the future, digital wallets can transform the payments system that exists today by bringing together: peer-to-peer payments, tickets, boarding passes, keys to cars, homes and hotel rooms, and even personal identity verifications like driver's licenses and passports.

What impact will digital wallets have on banks? The answer depends on what kind of economy we are talking about. I believe the short-run impact will be bigger in developing countries where the percentage of the population that uses the banking system is relatively small. For example, consider Kenya's M-Pesa. It allows users to deposit money into an account linked to a cell phone, to send payments to sellers of goods and services, and to withdraw deposits for regular money. Thus, for all intents and purposes, it provides many of the essential services that banks provide, without having to rely on bank deposits.

M-Pesa was launched in Kenya in 2007 by mobile network partners Vodafone and Safaricom. M-Pesa now services millions of customers worldwide and its services have expanded beyond payments systems to include lending, rental payments to landlords, and international remittances.<sup>51</sup>

The growth of M-Pesa from the payments side and the growth of P2P lending from the loan side means that non-bank solutions are being brought to bear on both the asset and liability sides of the bank's balance sheet. Numerous papers have argued that the rents banks earn on deposits have had a major impact on their exposure to maturity transformation risk,<sup>52</sup> as well as the potential trustworthiness of banks *vis-à-vis* their non-bank competitors.<sup>53</sup> If competition from digital wallets and P2P lending platforms crushes the margins banks earn on deposit-financed lending, then it raises potentially serious questions about the elevation of risks for banks and financial stability. However, as long as deposit insurance is in place and investors demand safe assets, banks will continue to have a funding-cost advantage. Indeed, even their brick-and mortar network may provide banks an advantage in gaining consumer lending business if they remodel branches to look like say Starbucks cafes where people like to hang out; Capital One's recent branch remodeling along these line is an example.

#### 5.2. Cryptocurrencies

While digital wallets rely on eventual payment in fiat currency, cryptocurrencies provide a possible alternative to fiat currency. Traditionally, money has been created in two prominent ways. One is currency produced by the national government. For example, through the United States Mint and the Bureau of Engraving and Printing, the U.S. Treasury produces coins and bills that are distributed by the Federal Reserve System through the banking system.<sup>54</sup> The other is

<sup>49</sup> This addresses security issues faced by consumers who may be reluctant to provide their credit card details to vendors they do not trust.

<sup>50</sup> See [Consumers International \(2017\)](#).

<sup>51</sup> See [Consumers International \(2017\)](#).

<sup>52</sup> See [Drechsler et al. \(2018\)](#). They show that banks' monopoly over deposits allows them to engage in maturity transformation without being exposed to the attendant risk.

<sup>53</sup> [Thakor and Merton \(2019\)](#) develop a theory in which banks are more trustworthy due to their depository rents.

<sup>54</sup> See [Wolla \(2018\)](#).

private money created by banks that generate a deposit account for the borrower in the process of making a loan. That is, as in the funding liquidity creation theory of Donaldson et al. (2018), when a bank makes a loan, it is not necessarily taking fiat money out of its vault and giving it to the borrower. Rather, it may lend money it does not have in vault by simply creating a deposit account to which the borrower has access.<sup>55</sup> In this way, banks create private money that augments the stock of money directly created by the Treasury.

Money serves three functions: medium of exchange, store of value, and unit of account. Do cryptocurrencies like Bitcoin serve these functions? Bitcoin does serve as a medium of exchange, but at present it is for a limited number of goods and represents a tiny fraction of overall payments. Moreover, while Bitcoin was initially created as a peer-to-peer payment system, many Bitcoin transactions that occur between consumers and companies involve “middlemen” who convert Bitcoin into real currency.<sup>56</sup> This involves cost as well as time. Another shortcoming of Bitcoin is that it is *not* a stable source of value. By contrast, fiat money is intended to serve as a stable source of value. For example, with a 2% inflation target, the U.S. dollar loses 2% purchasing power per year. However, the fluctuations in the value of Bitcoin have been much bigger.<sup>57</sup> See Fig. 3.

Adding to these difficulties have been hacking attacks, theft and other security problems.<sup>58</sup> Owners of Bitcoins have to hold them in a digital wallet, with no “deposit insurance”. Finally, Bitcoin does not currently serve as a useful unit of account since its price fluctuates a lot and it trades at different prices on different exchanges. Thus, even though Bitcoin is a virtual currency, it appears that it may be more appropriate—at least for now—to think of Bitcoin as an investment possibility than a currency. Indeed, as Merton (2018) points out, only *legal-tender* fiat currencies have intrinsic value,<sup>59</sup> and only *government-controlled* digital currencies are likely to be legal tender.<sup>60</sup>

Nonetheless, the traction cryptocurrencies have gained thus far has led to considerable speculation about *central bank digital currencies*, i.e., government-controlled digital currencies. The idea is that fiat money itself would become digital. While the idea of a central bank digital currency can be traced all the way back to Tobin (1985), it is fair to say that a serious discussion of this issue has begun in earnest only recently. The Bank for International Settlements (2018b) has recently issued an excellent in-depth report on the subject. Its key findings are as follows:

- Wholesale central bank digital currency, combined with the use of distributed ledger technology, may enhance settlement efficiency for transactions, involving securities and derivatives, but central banks will want more experience and experimentation before believing that adoption is safe.
- Central bank digital currency may be the answer to the rapid disappearance of cash in some jurisdictions, but there needs to be an examination of the usefulness of this in light of efficient digital private retail payment products (e.g., digital wallets).

<sup>55</sup> Donaldson et al. (2018) refer to this as the creation of “fake receipts” and show that it enables banks to permit the economy to invest more than its entire initial endowment in real projects.

<sup>56</sup> Cryptocurrencies like Bitcoin have been used for drug trafficking and other illegal activities. However, law enforcement agencies are able to detect criminal activity when an attempt is made to convert Bitcoin into physical currency. See Foley et al. (2019) who document that 46% of Bitcoin activity is illegal. This is one of the concerns of central bankers when it comes to digital currencies.

<sup>57</sup> See, for example, Wolla (2018). See also the discussion of Bitcoin in Blundell-Wignall (2014).

<sup>58</sup> In 2014, hackers attacked Bitcoin exchange Mt. Gox and stole 850,000 Bitcoins, valued at the time at \$14 billion.

<sup>59</sup> Because they can be used to settle government obligations of taxes and fees (\$4.8 trillion annually in the US).

<sup>60</sup> Governments can always ban the holding of any legal-tender currency surrogate.

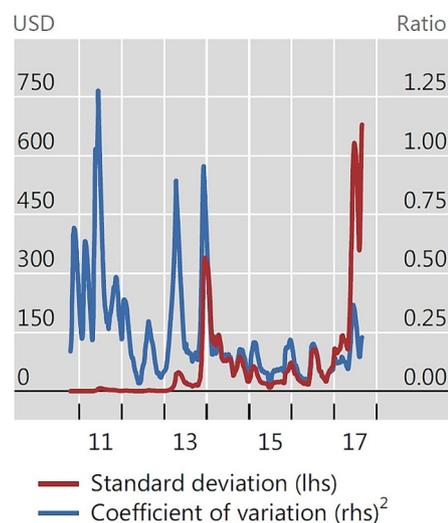


Fig. 3. Bitcoin price volatility. Ratio of standard deviation to mean.

Bech and Garratt (2017), Central Bank of Kenya; CoinDance; CoinDesk; [www.blockchain.info](http://www.blockchain.info).

- Money laundering and terrorism are two issues that would need to be dealt with in any discussion of central bank digital currency.
- A central bank digital currency would not fundamentally alter the mechanics of monetary policy, but may require the central bank to broaden the base of assets it can hold as collateral.<sup>61</sup>

### 5.3. Implications for payments system

There is an interesting distinction between cryptocurrencies and central bank digital currencies that is worth discussing. At least some of the current resistance to central bank digital currencies is based on the notion that these might be cryptocurrencies with a truly decentralized and permission-less asset that allows users to remain anonymous. Many in central banks have serious reservations about this. The reasons are obvious—the risk of hacking, the possibility of the currency being used for drug trafficking and other illegal activities, etc. Thus, for this reason and the other reasons discussed earlier, I view it as unlikely that central banks will replace the existing system of fiat currency with cryptocurrencies anytime soon. Of course, innovations in payment systems are occurring at an ever-increasing pace, so it will be interesting to see how innovators who come up with new forms of payments coordinate with central banks to facilitate the seamless integration of these innovations in the economy.<sup>62</sup>

Having said this, the case for a central bank digital currency that is not a true cryptocurrency is much stronger. To see why, consider the argument presented by Berentseen and Schar (2018) that is summarized below.

Money has three key attributes: (i) *Representation*, which means it can be represented in virtual or physical form; (ii) *Transaction handling*, which means it can be transacted in centralized or decentralized payment systems; and (iii) *Creation*, which means it can be created by a monopoly (such as a central bank or a government) or under competition. In Table 4 below (based in part on the discussion in Berentseen

<sup>61</sup> There are others who believe that a central bank digital currency could ease the conduct of monetary policy by permitting negative interest rates more readily. See, for example, Bordo and Levin (2017).

<sup>62</sup> A recent example of this is Facebook’s plan to introduce its own cryptocurrency, Libra, in 2020 to enable customers to make payments via Facebook’s apps and Whatsapp. Global central banks and legislators in the US have expressed their concerns about this, and US Federal Reserve Chairman Jerome Powell stated recently that the Federal Reserve has been in communication with Facebook about this.

**Table 4**  
Attributes of money and different types of money.

Types of money	Attributes representation	Handling	Creation
Cash (coins or bills)	Represented by a physical object whose value is inseparable from the object and independent of the owner.	Independence of value from owner permits liquidity and free circulation without need for records. Can be transacted in centralized or decentralized payment system.	Central bank or Treasury is a monopoly creator.
Commodity money (e.g., gold)	Represented by physical object whose value is independent of owner.	Can be freely circulated without record-keeping and can be transacted in centralized or decentralized payment system.	Can be competitively created (via a competitive extraction industry).
Bank deposits	No physical representation: "fake receipts" are virtual money that exist only as a record in an accounting system.	Requires record-keeping by a trusted intermediary and transaction in a centralized pay system.	Competitive since banks compete for deposits.
Central bank digital currency	No physical representation: virtual currency.	Currently transactions with this would need to be conducted in a centralized payment system (Bitcoin could permit this to be done in a decentralized network.)	Issued monopolistically by central bank.

and Schar, 2018), I categorize different types of money based on these attributes.

Before discussing the merits of central bank digital currencies, it is worth recalling the advantages of cash (fiat money) as a medium of exchange:

- User of cash can remain anonymous, (i.e., access to the cash payment system does not require permission).
- Does not involve a credit relationship. Any "debt" is immediately settled with the payment of cash, so there is no counterparty risk.
- It is the only liquid asset for saving outside the private financial system.

One of the appealing features of a central bank digital currency is that it would satisfy the demand for a liquid asset that has no counterparty risk, but without the hassle—cash is inefficient and significantly more expensive than electronic payments—security risks (i.e., theft) and crime (tax evasion, money laundering) associated with cash. Moreover, a central bank digital currency also permits a more flexible monetary policy in that negative interest rates are possible (see Bordo and Levin (2017)). With cash, negative interest rates are difficult because a saver would then prefer to stuff money in a mattress rather than in a bank. This is not a problem with a central bank digital currency.<sup>63</sup>

The mechanics of how this would work are as follows. The central bank would allow households and firms to open accounts with them and make payments with central bank digital money instead of commercial bank deposits. Banks may still be able to create private money via fake receipts by creating deposits in the process of lending, but these will be deposits of central bank digital currency on which they would compete to pay higher interest rates than what the central bank pays on these accounts.<sup>64</sup>

Given below are some specific benefits of central bank digital currency:

- **Better discipline on commercial banks.** Due to the availability of deposit accounts directly with the central bank,<sup>65</sup> households and firms will demand higher interest rates on deposits from banks and also greater safety in the form of higher capital and better risk management.<sup>66</sup>

<sup>63</sup> With central bank digital currency, all fiat currency would be digital. There may be non-digital private money that pays a higher interest rate. Nonetheless, because it is not fiat money, it would not be equivalent to central bank digital currency.

<sup>64</sup> The central bank's interest rate would be the lowest in the economy.

<sup>65</sup> For an extensive discussion of the pros and cons of centralizing all deposits with the central bank, see Thakor (2019).

<sup>66</sup> In such a world, the central bank would have no reason to offer deposit insurance for deposits not made with the central bank.

- **Easier monetary policy** in which the interest paid by the central bank on household deposits becomes the main tool of monetary policy.
- **Lower administrative costs.** The current system can be used to make the transition to the new system by requiring commercial banks to open deposit accounts with the central bank for their customers.

The key, of course, is to make sure that the new system does not deprive commercial banks of the ability to create private money through their lending activities, as this has numerous economic benefits.<sup>67</sup>

#### 6. Question 4: smart contracts and the financial market

Blockchain technology has permitted the emergence of "smart contracts". These are contracts that are based on decentralized consensus as well as tamper-proof algorithmic executions.<sup>68</sup> This enlarges the space of feasible contracts, which means it offers researchers with a continent of normative contracting innovations to explore in future work. How might we improve on existing contracts? In addressing this question, we can provide both normative contributions to our stock of research knowledge and also valuable contributions to practice.

The essence of smart contracts is that they can enable agents who have no trust in each other to collaborate without having to go through a neutral central authority. That is, a smart contract replaces the need for a trusted intermediary like a bank to bring the contracting parties together. Thus, at its core it is a "machine solution" to creating trust.<sup>69</sup> The OECD describes this phenomenon as follows:

"The technology of trust-less transfer is very interesting and it is quite possible (or even likely) that it will become a disruptive technology for many financial intermediaries in the future. The idea of eliminating a trusted third party in finance is revolutionary—the world of finance has never faced such a technological innovation that questions the need for intermediaries and the huge share of earnings in the economy that they appropriate for this role."

The potential for smart contracts to improve efficiency and lower contracting and verification costs is substantial. This is because smart contracts remove the need for reconciliation between parties and speed up the settlement of trades.<sup>70</sup>

<sup>67</sup> See Donaldson et al. (2018). Thakor (2019) discusses why preserving this is important. It is possible that if every central bank had its own digital currency, cryptocurrencies like Bitcoin will have diminished appeal, but it is unlikely that they would disappear since the attractiveness of non-fiat cryptocurrencies is not limited to their digital nature.

<sup>68</sup> See Cong and He (2019) for a discussion of the economics of smart contracts.

<sup>69</sup> See Consumers International (2017).

<sup>70</sup> However, as Cong and He (2019) point out, the process of generating decentralized consensus involves information distribution, which necessarily

To see how radically smart contracts may change existing contracts, think of a car insurance contract.<sup>71</sup> With a smart contract, the car insurance can be embedded in *the car itself* and that data generated by the driver's use of the car can be fed continuously to the insurance contract, so it adjusts the terms of the contract based on this data.<sup>72</sup>

In low-income countries, the impact of smart contracts has already begun to be felt. For example, [Consumers International \(2017\)](#) describes BitPesa, a remittance service operating in Nigeria, Kenya, Uganda, Tanzania, Senegal and Democratic Republic of the Congo.<sup>73</sup>

“Blockchain is used by BitPesa as an open source digital ledger, which keeps a constantly updated record of all transactions, making the platform transparent and secure... For example, in a BitPesa transaction, BitPesa is able to receive a local currency directly which it then sends in Bitcoin to a digital broker who then deposits it as local currency in the receiving country.”

At first blush, smart contracts appear to represent a big looming threat to banks and other financial intermediaries.<sup>74</sup> If their role as a trusted third party in contracting is trivialized, it takes away a large chunk of their profitability. However, my expectation is that banks will adapt in order to be purveyors of smart contracts. They will exploit the increased contracting opportunities offered by smart contracts to modify existing contracts and create new ones. This is similar to how banks responded to the “threat” posed by securitization to the traditional, “bundled” deposit-funding model of banking.

Moreover, as [Merton \(2018\)](#) has pointed out, even smart contracts represent an opaque mechanism that is embedded in a contract. Opacity maybe acceptable to customers when they trust the counterparty, so they do not have to worry about what is in the smart contract code and the possible motivations of the code writer, and how this might alter the contractual relationship. Absent this trust, the opacity related to what data the smart contract is gathering and how the data are being used will cause customers to be reluctant to embrace them. Another impediment may be privacy concerns.

## 7. Conclusion

This paper has reviewed the emerging literature on fintech, with a focus on the interaction between fintech and banking. In the process, numerous issues have been examined with respect to P2P lending, cryptocurrencies and smart contracts. These issues have been explored in the context of four central questions. First, how should our theories of financial intermediation be altered to accommodate traditional intermediation, shadow banks and fintech? Here, I have offered some thoughts on the shape and form such a theory will need to take, and I have emphasized the role that trust will play in distinguishing banks from their new competitors.

Second, how will credit markets, deposits and capital raising be affected by fintech? This question has to do with how P2P lenders will compete with banks in lending. The story here is of considerable market segmentation in the penetration of P2P lenders. Specifically, the conclusion is that P2P lenders will not replace banks anytime soon, but they will take some market share away from banks when banks are capital-constrained and for borrowers who do not have collateral to

(footnote continued)

alters the information environment. This means that, while smart contracts can reduce information asymmetries and deliver higher consumer surplus, they may also encourage collusion due to the irreducible distribution of information, especially in consensus generation.

<sup>71</sup> Example taken from [Consumers International \(2017\)](#).

<sup>72</sup> This development is already underway, as insurance companies provide usage-based insurance. Smart contracts will enable the pricing of such insurance to be much more precise.

<sup>73</sup> See [Consumers International \(2017\)](#).

<sup>74</sup> See [Thakor \(2019\)](#) for a discussion of these issues.

offer for secured loans. This conclusion is somewhat tentative since research on this topic is at an early stage. In the end, if marketplace lenders make significant inroads, it is likely that banks will either launch their own platforms, acquire platforms and/or partner with P2P platforms to prevent significant erosion of lending volume. With deposit insurance, banks' unique access to deposits will continue to sustain an advantage for banks.

Third, how will fintech affect payments systems? Here, I believe, lies the biggest disruptive potential of fintech. We have already seen that the emergence of new money market instruments has significant implications for monetary policy (see, for example, [Carlson and Wheelock, 2018](#)). There is little doubt that digital currencies will eventually replace cash, but the open questions are when and in what form will central banks embrace such currencies as part of the payment system?

Fourth, how will smart contracts affect the financial system? My conclusion here is perhaps the most tentative because the research on this question is non-existent to sparse, depending on how liberal one wants to be in interpreting the existing research. It is quite likely that smart contracts will fundamentally alter financial contracting, with changes induced at both the intensive and extensive margins. The more open questions are: what shape will specific financial contracts take in the future and how will securities trading, banks, insurance companies, and other financial intermediaries be affected?

Finally, will fintech platforms continue to remain unlevered or will they eventually rely on the high-leverage strategies of banks? A quick glance at the data shows that these platforms have recently not delivered the returns to investors that banks have. For example, in the last quarter of 2018, JP Morgan Chase had an ROE of 14.07%, whereas Lending Club had an ROE of -6.2%. A broader comparison shows a qualitatively similar result. This may tempt P2P platforms to start using leverage in the future.<sup>75</sup> Whatever theories we build of banks versus P2P platforms should consider these potential developments to highlight the costs and benefits of leverage for these platforms.

## Acknowledgment

I gratefully acknowledge the very valuable input of Will Cong and the JFI editors, but I alone am responsible for errors.

## References

- Acharya, V., Naqvi, H., 2012. The seeds of a crisis: a theory of bank liquidity and risk-taking over the business cycle. *J. Financ. Econ.* 106 (2), 349–366 November.
- Acharya, V., Naqvi, H., 2019. On reaching for yield and the coexistence of bubbles and negative bubbles. *J. Financ. Intermed.* 38, 1–10 April.
- Allen, F., Qian, M., Jing, X., 2019. Understanding informal financing. *J. Financ. Intermed.* 39, 19–34 July.
- Arner, D., Barberis, J., Buckley, R., 2016. The Evolution of Fintech: A New Post-Crisis Paradigm? University of Hong Kong Faculty of Law Research Paper no. 2015/047, September.
- Balyuk, T., Berger, A.N., Hackney, J., 2019. What is fueling the FinTech lending revolution? Local banking market structure and FinTech Market Penetration. working paper, University of South Carolina, July.
- Bank for International Settlements, 2018. Sound Practices: Implications of Fintech Developments for Banks and Bank Supervisors. Basel Committee on Banking Supervision February.
- Bank of International Settlements, 2018. Central Bank Digital Currencies. Committee on Payments and Market Infrastructures March.
- Bech, M., Garratt, R., 2017. Central bank cryptocurrencies. *BIS Q. Rev.* 55–70 September.
- Begley, T., Srinivasan, K., 2019. Small Bank Lending Amidst the Ascent of Fintech and Shadow Banking: A Sideshow? WP, Washington University in St. Louis, May.
- Benedetti, H., Kostovetsky, L., 2018. Digital Tulips? Returns to Investors in Initial Coin Offerings. WP Boston College June.
- Benoit, S., Hurlin, C., Perignon, C., 2019. Pitfalls in systemic-risk scoring. *J. Financ. Intermed.* 38, 19–49 April.
- Berentzen, A., Schar, F., 2018. The Case for Central Bank Electronic Money and the Non-Case for Central Bank Cryptocurrencies 100 Federal Reserve Bank of St. Louis. <https://research.stlouisfed.org/publications/review/2018/02/13>.
- Berger, A.N., 2003. The economic effects of technological progress: evidence from the

<sup>75</sup> It may also induce them to search for yield, thereby further feeding asset price bubbles formed by the yield-searching behavior of banks (see, for example, [Acharya and Naqvi, 2019](#)).

- banking industry. *J. Money Credit Bank.* 35 (2), 141–176 April.
- Berger, A.N., Frame, S., Ioannidou, V., 2016. Reexamining the empirical relation between loan risk and collateral: the roles of collateral liquidity and types. *J. Financ. Intermed.* 26 (c), 28–46.
- Besanko, D., Thakor, A.V., 1987a. Competitive equilibrium in the credit market under asymmetric information. *J. Econ. Theory* 42 (1), 167–182 June.
- Besanko, D., Thakor, A., 1987b. Collateral and rationing: sorting equilibria in monopolistic and competitive credit markets. *Int. Econ. Rev.* 28 (3), 671–689 October.
- Besanko, D., Thakor, A.V., 1993. Relationship banking, deposit insurance and bank portfolio choice. In: Vives, X., Mayer, C. (Eds.), *Capital Markets and Financial Intermediation*. Cambridge University Press, pp. 292–318.
- Bhattacharya, S., Thakor, A.V., 1993. Contemporary banking theory. *J. Financ. Intermed.* 3 (1), 2–50 October.
- Blundell-Wignall, A., 2014. The Bitcoin Question: Currency Versus Trust-Less Transfer Technology. OECD Working Papers on Finance, Insurance and Private Pensions no. 37.
- Boot, A., Greenbaum, S.I., Thakor, A.V., 1993. Reputation and discretion in financial contracting. *Am. Econ. Rev.* 8, 1165–1183 December 3-5.
- Boot, A., Thakor, A.V., 2000. Can relationship banking survive competition? *J. Financ.* 55 (2), 679–714 April.
- Boot, A., Thakor, A.V., 1997. Financial system architecture. *Rev. Financ. Stud.* 10 (3), 693–733 Fall.
- Boot, A., Thakor, A.V., 1994. Moral hazard and secured lending in an infinitely repeated credit market game. *Int. Econ. Rev.* 35 (3), 899–920 November.
- Boot, A., Thakor, A.V., Udell, G., 1991. Secured lending and default risk: equilibrium analysis, policy implications and empirical results. *Econ. J.* 101 (406), 458–472.
- Bordo, M., Levin, A., 2017. Central Bank Digital Currency and the Future of Monetary Policy. NBER Working Paper No. 23711.
- Bostandzic, D., Weiß, G.N.F., 2018. Why do some banks contribute more to global systemic risk? *J. Financ. Intermed.* 35, 57–69 Part A, July.
- Boyd, J., Nicoló, G.D., 2005. The theory of bank risk taking and competition revisited. *J. Financ.* 60 (3), 1329–1343.
- Broström, A., Mohammadi, A., Saiedi, E., 2018. Distrust in Banks and Fintech Participation: The Case of Peer-to-Peer Lending. Swedish House of Finance Research Paper No. 18 July.
- Bryant, J., 1980. A model of reserves, bank runs and deposit insurance. *J. Bank. Financ.* 4, 335–344.
- Buchak, G., Matvos, G., Piskorski, T., Seru, A., 2018a. Fintech, regulatory arbitrage and the rise of shadow banks. *J. Financ. Econ.* 130 (3), 453–483 August.
- Buchak, G., Matvos, G., Piskorski, T., Seru, A., 2018b. The Limits of Shadow Banks. University of Chicago Working Paper October.
- Carlson, M., Wheelock, D.C., 2018. Near-money premium, monetary policy and the integration of money markets: lessons from deregulation. *J. Financ. Intermed.* 33, 16–32 January.
- Catalini, C., Gans, J., 2016. Some Simple Economies of the Blockchain. MIT Sloan Research Paper no. 5191-16, April.
- Cerqueiro, G., Ongena, S., Roszbach, K., 2019. Collateral damage? Priority structure, credit supply and firm performance. *J. Financ. Intermed.* in press (available online June 18, 2019).
- Chan, Y.-S., Thakor, A.V., 1987. Collateral and competitive equilibria with private information and moral hazard. *J. Financ.* 42 (2), 345–363 June.
- Chen, M.A., Wu, Q., Yang, B., May 2019. How valuable is fintech innovation? *Rev. Financ. Stud.* 32 (5), 2062–2106.
- Cong, W.L., 2019. A brief introduction to blockchain economics, working paper. Cornell University, May.
- Cong, W.L., He, Z., 2019. Blockchain disruption and smart contracts. *Rev. Financ. Stud.* 32, 1754–1797.
- Cong, W.L., Li, Y., Wang, N., 2019. Tokenomics: Dynamic adoption and valuation, working paper. Chicago Booth, May.
- Consumers International, 2017. Banking on the Future: An Exploration of Fintech and the Consumer Interest. Consumers International Monograph Coming Together for Change July.
- Coval, J., Thakor, A.V., 2005. Financial intermediation as a beliefs bridge between optimists and pessimists. *J. Financ. Econ.* 75 (3), 535–570 March.
- D'Acunto, F., Prabhala, N., Rossi, A., 2019. The promises and pitfalls of robo-advising. *Rev. Financ. Stud.* 32 (5), 1983–2020 May.
- de Roure, C., Pelizzon, L., Thakor, A.V., 2019. P2P Lenders Versus Banks: Cream Skimming Or Bottom Fishing? Goethe University Working paper January.
- Degryse, H., Ongena, S., 2007. The impact of competition on bank orientation. *J. Financ. Intermed.* 16 (3), 399–424.
- Diamond, D., 1984. Financial intermediation and delegated monitoring. *Rev. Econ. Stud.* 51 (3), 393–414 July.
- Diamond, D., Dybvig, P., 1983. Bank runs, deposit insurance and liquidity. *J. Polit. Econ.* 91 (3), 401–419 June.
- Donaldson, J., Gromb, D., Piacentino, G., 2018. The paradox of pledgeability. *J. Financ. Econ.* 123 (1), 163–188.
- Donaldson, J., Piacentino, G., Thakor, A.V., 2018. Warehouse banking. *J. Financ. Econ.* 129 (2), 250–267.
- Donaldson, J., Piacentino, G., Thakor, A., 2019. Intermediation Variety Working Paper, June.
- Drechsler, I., Savov, A., Schnabl, P., 2018. Banking on Deposits: Maturity Transformation Without Interest Rate Risk. NYU Working Paper May Available at SSRN: <https://ssrn.com/abstract=2938236> or <http://dx.doi.org/10.2139/ssrn.2938236>.
- Favaretti, G., Calzolari, G., Pozzolo, A., 2017. Fintech and banks: friends or foes? *Eur. Econ. Banks Regul. Real Sect.* 2017 (2), 9–30 December.
- Foley, S., Karlsen, J., Putninš, T., 2019. “Sex, drugs and Bitcoin: how much illegal activity is financed through cryptocurrencies?” *Rev. Financ. Stud.* 32 (5), 1798–1853. Available at <https://doi.org/10.1093/rfs/hhz015>.
- Frame, S., Larry Wall, W., White, L., 2019. Technological change and financial innovation in banking: some implications for fintech. In: Berger, A.N., Mullineaux, P., Wilson, J.O.S. (Eds.), *Oxford Handbook of Banking*, third ed. Oxford University Press.
- Fuster, A., Plosser, M., Schnabl, P., Vickery, J., 2019. The role of technology in mortgage lending. *Rev. Financ. Stud.* 32 (5), 1854–1899 May.
- Goetz, M.R., 2018. Competition and bank stability. *J. Financ. Intermed.* 35, 57–69 Part A, July.
- Greenbaum, S., Thakor, A., Boot, A., 2019. Contemporary Financial Intermediation, fourth ed. Elsevier July.
- Holmstrom, B., Tirole, J., 1997. Financial intermediation, loanable funds and the real sector. *Q. J. Econ.* 112 (3), 663–691 Aug.
- Ibinex.com, *Global Cryptocurrency Market Report*, ” Monograph, September 2018, [https://media.ibinex.com/docs/global-cryptocurrency-market-report\\_2018.pdf](https://media.ibinex.com/docs/global-cryptocurrency-market-report_2018.pdf).
- IOSCO, *Research Report on Financial Technologies*, February 2017.
- Lee, E., Lee, B., Chae, M., 2011. Herding behavior in online P2P lending: an empirical investigation. In: Proceedings of the 2011 PACIS. Association for Information Systems Electronic Library.
- Lin, M., Prabhala, N.R., Viswanathan, S., 2013. Judging borrowers by the company they keep: friendship networks and information asymmetry in online peer-to-peer lending. *Manag. Sci.* 59 (1), 17–35.
- Mansilla-Fernandez, J.M., 2017. Numbers. *Eur. Econ. Banks Regul. Real Sect.* 3 (2), 31–40.
- Mehran, H., Thakor, A., 2011. Bank capital and value in the cross-section. *Rev. Financ. Stud.* 24 (4), 1019–1067 April.
- Merton, R.C., 2018. Solving global challenges using finance science: past and future. In: Proceedings of the China International Conference in Finance. Tianjin, China. July 11.
- Merton, R., Thakor, R., 2019. Customers and investors: a framework for understanding the evolution of financial institutions. *J. Financ. Intermed.* 39, 4–18 July.
- Millon, M., Thakor, A.V., 1985. Moral hazard and information sharing: a model of information gathering agencies. *J. Financ.* 40 (5), 1403–1422.
- Milne, A., Parboteeah, P., 2016. The Business Models and Economics of Peer-to-Peer Lending. ECR1 Research Report April.
- Molnár, J., 2018. ‘What does financial intermediation theory tell us about fintech?’ *Bp. Manag. Rev.* 49 (5), 38–46 XLIX.EVF.
- Morse, A., 2015. Peer-to-peer crowdfunding: information and the potential for disruption in consumer lending. *Annu. Rev. Financ. Econ.* 7 (1), 463–482.
- Philippon, T., 2014. Has the finance industry become less efficient? On the theory and measurement of financial intermediation. *Am. Econ. Rev.* 105 (4), 1408–1438.
- Philippon, T., 2018. The Fin Tech Opportunity. NYU Working Paper March.
- Pilkington, M., 2016. Blockchain technologies: principles and applications. In: Olleras, X., Zhegu, M. (Eds.), *Research Handbook on Digital Transformation*. Edward Elgar.
- Pope, D.G., Snyder, J.R., 2011. What's in a picture? Evidence of discrimination from Prosper.com. *J. Hum. Resour.* 46 (1), 53–92.
- PricewaterhouseCoopers, 2015. Peer Pressure: How Peer-to-Peer Lending Platforms are Transforming the Consumer Lending Industry. *Technical Report*.
- Ramakrishnan, R.T.S., Thakor, A.V., 1984. Information reliability and a theory of financial intermediation. *Rev. Econ. Stud.* 51 (3), 415–432 July.
- Research and Markets, 2018. Global InsurTech Market Report 2018–2023 – Application of AI and Analytics Technologies in Better Identifying the Potential on Online Insurers. Dublin, December 5, PRNewswire.
- Salisbury, I., 2016. Lending Club's CEO Has Left and Its Stock Has Plunged. Should Lender Bail Out? 13 Time June.
- Scheuffel, P., 2016. Taming the beast: a scientific definition of fintech. *J. Innov. Manag.* 4 (4), 32–54 December.
- Song, F., Thakor, A.V., 2010. Financial system architecture and the co-evolution of banks and markets. *Econ. J.* 120 (547), 1021–1055 September.
- Tang, H., 2019. Tang. Peer-to-peer lenders versus banks: substitutes or complements? forthcoming. *Rev. Financ. Stud.*
- Thakor, A.V., 1996. Capital requirements, monetary policy and aggregate bank lending: Theory and empirical evidence. *J. Finance* 51 (1), 279–324 March.
- Thakor, A.V., 1999. Information technology and financial services consolidation. *J. Bank. Financ.* 23 (2–4), 697–700 February.
- Thakor, A.V., 2005. Do loan commitments cause overlending? *J. Money Credit Bank* 37 (6), 1067–1100 December.
- Thakor, A.V., 2012. Incentives to innovate and financial crises. *J. Financ. Econ.* 103 (1), 130–148 January.
- Thakor, A.V., 2014. Bank capital and financial stability: an economic tradeoff or a Faustian bargain? *Annu. Rev. Financ. Econ.* 6, 185–223 December.
- Thakor, A.V., 2015. Lending booms, smart bankers and financial crises. *Am. Econ. Rev.* 105 (5), 305–309 May.
- Thakor, A.V., 2016. The highs and the lows: a theory of credit risk assessments through the credit cycle. *J. Financ. Intermed.* 25 (1), 1–29.
- Thakor, A.V., 2019. The Purpose of Banking: Transforming Banking for Stability and Growth. Oxford University Press July.
- Thakor, R., Merton, R.C., 2019. Trust in lending. In: Proceedings of the 2019 AFA Meeting. Atlanta. January.
- Tobin, J., 1985. Financial Innovation and Deregulation in Perspective. Cowles Foundation Papers no. 635.
- Tom, P., 2017. P2P Lending Market in Numbers. The GetLine Network September 29.
- Uluc, A., Wieladek, T., 2018. Capital requirements, monetary policy and risk shifting in the mortgage market. *J. Financ. Intermed.* 35, 3–16 Part B, July.
- Vives, X., 2017. The impact of fintech on banking. *Eur. Econ. Banks Regul. Real Sect.* 2017 (2), 97–106 December 23.
- Welltrado, 2018. Global Blockchain-Backed Loans Marketplace ICO. White Paper March.
- Wolla, S., 2018. Bitcoin: Money or Financial Investment? St. Louis Fed Publications March. <https://research.stlouisfed.org/publications>.