

Relationship Banking and Information Technology: The Role of Artificial Intelligence and FinTech¹

Marko Jakšič² and Matej Marinč³

March 29th, 2018

Abstract

Banks have no time for complacency. They need to reevaluate their competitive advantages in light of profound changes driven by advances in information technology (IT) and competitive pressure from FinTech companies. This article emphasizes that banks should not abolish relationship banking, which nurtures close contact with bank customers. A long-term orientation of relationship banking streamlines incentives and supports the long-term needs of bank customers. However, banks might be lured into transaction banking due to the presence of IT-driven economies of scale and competition from FinTech start-ups and IT companies. In this light, the article evaluates the role of distances, artificial intelligence, and behavioral biases. Implications for stability in banking are explored. We argue that relationship banking can overcome its drawbacks, but it needs to adjust to the new reality in order to survive.

JEL G20, G21, L86, O33

Keywords The Future of Banking, Relationship banking, Information technology, Artificial Intelligence, FinTech

¹ The authors would like to thank to the anonymous referee, the editor Igor Lončarski, Arnoud Boot, Iftekhar Hasan, Robin Lumsdaine, Vasja Rant, and Razvan Vlahu for their valuable comments and suggestions.

² Faculty of Economics, University of Ljubljana, Kardeljeva pl. 17, marko.jaksic@ef.uni-lj.si.

³ Corresponding author. Faculty of Economics, University of Ljubljana, Kardeljeva pl. 17, matej.marinc@ef.uni-lj.si.

1. Introduction

Banks have no time for complacency. They need to reevaluate their competitive advantages in light of profound changes driven by advances in information technology (IT) and competitive pressure from FinTech companies. Societies are on the verge of deep transformation due to IT developments in social networks, communications, artificial intelligence, and big data analytics. Understanding banking in these fluctuating times is a challenge.

We argue that the economics of banking have not changed. Banks' *raison d'être* is and will continue to be mitigation of information asymmetry between investors and borrowers (Diamond, 1984; Greenbaum, Thakor, and Boot, 2016). Banks need to evaluate limited information, which is sometimes difficult to quantify, in order to estimate the creditworthiness of bank clients, whose incentives may be thoroughly misaligned with banks. In an environment filled with information asymmetries, relationship banking—in which banks form close ties with their customers through long-term cooperation (see Boot, 2000, Boot and Marinč, 2008)—should not be dismissed as obsolete. A relationship bank reduces information asymmetries through intense acquisition of soft information—difficult to quantify, store and transmit in impersonal way (Liberti and Petersen, 2017)—proprietary in nature, typically throughout the long-term relationship with its clients. To act on soft information, a relationship bank retains substantial flexibility and discretion, and relies on confidentiality and trust.

However, relationship banking needs to respond to substantial challenges due to IT-driven innovations (highlighted by e.g. Currie and Lagoarde-Segot, 2017). First, the potential drawback of relationship banking refers to its efficiency in comparison to transaction-driven technologies.

IT developments have increased efficiency in transaction banking (e.g., especially in payments, clearing and settlement, internet banking, and transaction lending), changing the role of distances in banking. A plethora of questions relates to the role of human bankers, who are central to relationship banking with respect to artificially intelligent computers that perform transaction banking tasks. Humans are still needed in banking, but bankers need to reconsider their role. Understanding how people think and act becomes increasingly important. Banks need to understand behavioral biases, herding behavior, bounded rationality, and people's emotions. Information spreads quickly across social networks, making society prone to herding, information manipulation, and unfounded panics. In this light, perfect rationality might be an overly simplistic concept.

IT developments have spurred competition in banking further affecting the strategic choice of banks between relationship banking versus transaction banking orientation. How to leverage on relationships is a challenge if scaling up is easy in transaction banking. We suggest that IT technology is becoming ripe for relationships. For example, several FinTech companies successfully scale a relationship banking technology. Competition then works to mitigate the drawback of relationship banking that relates to the "hold-up problem," described by Sharpe (1990) and Rajan (1992), in which relationship banks use proprietary information to their advantage and make borrowers overly dependent on them.

Implications for stability are explored. Risks stemming from IT-driven innovations in banking need to be carefully analyzed to prevent a negative impact on bank stability.

This article is organized as follows. Section 2 defines relationship banking and surveys external forces in the banking environment. Section 3 reviews the changing importance of proximity in

light of IT developments. Section 4 discusses the role of human banker with respect to artificial intelligence supported lending. Section 5 analyzes the insights from FinTech companies for the evolving nature of relationship banking. Section 6 investigates the viability of relationship banking under the heavy IT-driven competitive pressure. Section 7 analyzes the impact of relationship banking and IT developments on stability. Section 8 concludes the article.

2. Relationship banking and external forces in banking

After briefly discussing the main functions of banks in light of IT developments, we define relationship banking and describe the IT-driven societal changes that shape the banking environment.

2.1. Rasion d'être of banking and IT developments

Before defining relationship banking, it is instructive to briefly describe the role of banks as put forward by the contemporary financial intermediation theory and identify the impact of IT developments in banking.

Financial intermediaries facilitate interactions and transactions among providers and users of financial capital (Greenbaum, Thakor, and Boot, 2016). A commercial bank as a prime example of a financial intermediary collects deposits, which are typically withdrawable upon demand, to fund illiquid loans. Illiquidity of loans arises due to the information asymmetry between borrowers and their financiers. In the screening process of loan applicants and in subsequent monitoring, banks obtain proprietary information about their borrowers. Proprietary information yields a distinct competitive advantage and is related to relationship banking.

IT developments have had a transformative effect on the banking industry. IT developments have improved the cost-effectiveness of banks. Beijnen and Bolt (2009), Schmiedel, Malkamäki, and Tarkka (2006), and Li and Marinč (2017) point to the economies of scale in payment processing and clearing and settlement systems. Online and mobile access channels coupled with electronic and mobile payment systems and enhanced transaction lending techniques offer additional cost savings. Jakšič and Marinč (2015) identify improved communication, decision-making, automation, and empowerment of bank customers as core dimensions across which IT developments are reconfiguring banks.

While recent empirical studies point to the existence of scale economies in banking that might be related to IT developments, the identification of how IT affects the banking industry is missing (Boot, 2017). In this light, further attention is needed on how IT developments affect information asymmetries in banking and what the mediating role of close relationships in banking is. Despite IT-driven cost savings, we argue for the continuous importance of relationships in banking while revisiting the role of distance, automatic decision-making in lending, and the FinTech industry.

2.2. Defining relationship banking

Relationship banking refers to the type of interaction among banks and their clients. In relationship banking, banks repeatedly interact with customers across several services, products, and/or access channels to obtain and exploit proprietary information—often non-quantifiable or soft in nature—to form close ties with their customers (Boot, 2000). A stereotypical example of relationship banking is a small bank extending a line of credit to its long-term client, usually a

small firm. In contrast, transaction-oriented banking refers to the services designed for a one-time interaction with a bank client; for example, organizing an IPO for a large company.

Clear-cut separation between relationship banking and transaction banking is difficult. Transaction lending technologies can rely on a combination of soft and hard information. Berger and Udell (2006) and Berger and Black (2011) decompose transaction lending technologies into financial statement lending, small business credit scoring, asset-based lending, factoring, fixed-asset lending, leasing, and judgment-based lending. Each lending technology gives a distinct advantage to a bank, including support for lending to small and medium-sized firms. For example, judgment-based lending—a transaction lending technique—employs soft information based on the judgment of a loan officer relying on experience and training. In the same vein, even though relationship lending is generally associated with soft information, this does not mean that relationship lending automatically excludes any use of quantifiable information.

Relationship banking is broader than relationship lending and encompasses other banking activities in which long-term relationships with bank clients are sought. A bank obtains proprietary information through an analysis of payment data or through long-term deposit-taking activity of a bank customer (such as credit line usage, limit violations, and cash inflows; see Norden and Weber, 2010). Some relationships can even be formed with clients seeking investment banking services, such as the merger and acquisition advisory business (Francis, Hasan, and Sun, 2014).

2.3. *IT-driven societal changes*

Societies are facing substantial economic challenges. IT developments—such as full-time connectivity, social networks, and the internet of things coupled with artificial intelligence—are transforming society (Aral, Dellarocas, and Godes, 2013). A multitude of data and data-driven decision-making processes are erasing some of the information barriers across economic agents challenging the established managerial practices (Constantiou and Kallinikos, 2015). Information about companies is easier to find, evaluate, and transmit. Even though much quantifiable data is available, judging its veracity is important.

Customers are also changing. They want an inexpensive service that is accessible anywhere and at any time, and is tailor-made to their needs. They demand multi-channel experience and gaming. They want decision-making and empowerment. All of these changes have led to higher short-termism. Information is instantaneously transmitted, and customers align their thoughts and actions through new media vehicles. Customers are driven by peer pressure (Bapna and Umyarov, 2015). Short-termism of customers can lead to herding, bank runs, and stock market crashes.

The upshot of these arguments is that the world has become an elusive place. Whereas the basic competitive advantage of banks has remained in mitigating information problems, the economic environment has changed. Economies are strained by financial crises, social changes, and IT developments. In this light, this article analyzes the evolving role of relationship banking.

3. How far can you be for relationship banking?

IT developments have facilitated banking over larger distances due to *i*) easier access to banking services through mobile and online banking platforms and electronic payments, and *ii*) enhanced transaction lending technologies.

First, mobile and online banking allows for continuous availability of bank products and services without geographic limitations (Martins, Oliveira, and Popovič, 2014, Khedmatgozar and Shahnazi, 2017) increasing bank profitability (Ciciretti, Hasan, and Zazzara, 2009; DeYoung, Lang, and Nolle, 2007). Is online and mobile banking disrupting the role of a bank branch network—a core access channel for relationship banking? In the Euro area, the number of branches fell from 186.255 at their peak in 2008 to 149.353 in 2016. In the U.S., the number of branches experienced a more modest decline, from 83,600 at their peak in 2012 to 80,638 in 2016.⁴

Several studies confirm that internet banking acts as a complement to the branch network rather than as its substitute (e.g., Onay and Ozsos, 2013). Xue, Hitt, and Chen (2011) show that customers that adopted internet banking in areas with a high density of branches engaged more intensely in product acquisitions and transaction activities than customers in other areas. Customers that adopted internet banking were also less likely to leave the bank. Campbell and Frei (2010) find that online banking increases the importance of a branch network but reduces the role of less personalized delivery channels (e.g., the ATM network).

⁴ Obtained from the ECB Statistical Data Warehouse (<http://sdw.ecb.europa.eu>) and from the FDIC webpage (<https://www5.fdic.gov/hsob/HSOBRpt.asp>).

Electronic payments have facilitated long-distance banking. Even though electronic payments are in principle a transaction banking technology, payment details provide much valuable proprietary information about the credit quality and needs of bank customers. Hasan, Schmiedel, and Song (2012) show that effective payment technology spurs banks to form close, long-term relationships with their customers. Greater and more diverse employment of various retail payment technologies is positively related to bank profitability.⁵

Banks also consider embracing a deep social media presence. Filip, Jackowicz, and Kozłowski (2016) argue that aggressive Facebook communication benefits small local banks through higher interest income. The interconnection between a social network presence and relationship banking is yet to be further explored by banks and by researchers.

These arguments suggest that internet banking is still complementing relationship-oriented branch network services rather than disrupting it. However, banks need to adjust to the new generation of on-line versatile customers and supplement relationship banking with its on-line version.

Second, physical distances between banks and their borrowers have grown (Petersen and Rajan, 2002). IT developments have led to proliferation and continuous improvements in transaction lending techniques (Frame and White, 2010). DeYoung et al. (2011) corroborate that an increase in distances was driven by IT developments and coincided with developments in credit scoring lending techniques.

⁵ The evidence from the introduction of retail payments in Europe shows that sometimes IT developments need to be supported by regulation. Increasing competition, establishing customer protection policies, and limiting large cash payments is needed (Hasan, Martikainen, and Takalo, 2014).

The amount of information available over the internet is vast. Banks exchange information through credit bureaus and take into account information available through media, credit-rating agencies, and analysts (Bushman, Williams, and Wittenberg-Moerman, 2016). Beck, Ioannidou, and Schäfer (2016) show that foreign banks can use transaction credit scoring models to overcome their information disadvantage and a lack of local information about borrowers. Can relationship lending compete with efficient IT-supported transaction lending techniques?

A large body of literature identifies the importance of a proximity and branch network in relationship lending. Agarwal and Hauswald (2010) find that relationship knowledge is mostly available at short distances. Banks employ spatial price discrimination to obtain additional rents (Degryse and Ongena, 2005). A bank branch network also integrates lending and deposit markets (Gilje, Loutskina, and Strahan, 2016). A branch network allows liquidity to flow from regions where it is in abundance to regions where information-intensive lending needs are the highest.

The geographic proximity is gradually being replaced by proximity in the new social structures created by social networks. In this sense, relationship banking may serve as a complement to cultural, religious, and ethnic proximity. The cultural proximity of loan officers to borrowers reduces information frictions in lending and leads to higher quantity, higher quality, and lower cost of lending. The benefits of cultural proximity add to the benefits of hard and soft information gathered through relationship banking (Fisman, Paravisini, and Vig, 2017).

Being close to customers matters in banking. Lending officers that are geographically and culturally closer to their borrowers make better lending decisions, which help their bank as well as their borrowers. For this to occur, the banker needs to have sufficient flexibility and discretion

to incorporate cultural knowledge into decision-making. A combination of relationship banking and cultural proximity then work to improve bank lending decisions.

4. Do human bankers still have a role to play at the dawn of artificial intelligence?

With the rise of artificial intelligence, the role of humans in banking needs to be reevaluated. Outside of banking, computers have surpassed humans at chess, Go, the quiz show *Jeopardy*, and even poker (see e.g. Silver et al., 2017, Moravčík et al. 2017). Is a human banker still needed, a loan officer that collects soft information through personal interaction with a borrower (Uchida, Udell, and Yamori, 2012), or will computers take over through automatic transaction lending built on the multitude of data available about bank borrowers? Differently put, can computers surpass humans in mitigating information asymmetry problems (e.g., adverse selection and moral hazard problems) in banking?

Despite advances in IT, relationship banking still bears benefits (Marinč, 2013). Credit rationing increases for opaque firms that are matched with transaction-oriented banks compared to those that are matched with relationship-oriented banks (Ferri and Murro, 2015). Lending on soft information yields more bargaining power to borrowers with high managerial skills and character compared to lending on hard information (Grunert and Norden, 2012).

Knowing that humans can easily be replaced by computers in codifiable, routine tasks that follow well-defined procedures (Autor and Dorn, 2013), the question then is how much discretion versus rules loan officers need in lending. Cerqueiro, Degryse, and Ongena (2011) show that discretion is especially used for opaque and small firms, for small and unsecured

loans, and when a firm is located far from a lender. The discretion of loan officers is predominantly used in the pricing of loans rather than in the process of loan origination.

Artificially intelligent computers can evaluate and respond to actions of *homo economicus*, an agent that is completely rational and self-interested (Parkes and Wellman, 2015). However, humans do not always act rationally in a complex situation full of information asymmetry, such as bank lending. Two issues are worth considering. The first is the “human” behavior of a loan officer, and the second is the “human” behavior of a borrower.

First, loan officers are driven by their own motives at work. In their lending decisions, loan officers have been shown to be affected by mood (Cortés, Duchin, and Sosyura, 2016), overconfidence (Ho et al., 2016), and career concerns (Cole, Kanz, and Klapper, 2015). Lenders’ decisions are driven by personal traits of loan applicants such as beauty, race, and age (Ravina, 2012). Loan officers may even manipulate soft information and override hard information to reach their own objectives (Berg, Puri, and Rocholl, 2012; Agarwal and Ben-David, 2014). Flat-based compensation with strong incentives for loan approval encourages loan officers to distort and inflate credit rating assessments (Cole, Kanz, and Klapper, 2015).

The role of IT developments might then be to better align incentives of loan officers with bank goals. Paravisini and Schoar (2015) analyze how bank lending changes after a bank adopts a new credit-scoring technology. They show that credit committees increase their effort on difficult-to-evaluate loan applications. The introduction of credit scoring reduces the default probability of loans and increases loan profitability. They argue that the availability of credit scores diminishes incentive problems inside credit committees.

Similarly, IT-supported communication channels may increase communication intensity across hierarchical layers and geographical distances within a banking organization. Current studies argue for the importance of interpersonal communication (Liberti and Mian, 2009). Lower communication costs between a loan officer and the head of the same bank branch improve credit quality assessment (Qian, Strahan, and Yang, 2015). In light of the pervasive presence of internet and smart mobile devices, improved communication quality within organizations may support reliance on subjective information, also across larger distances.

Second, borrowers also can behave in a *homo economicus* way for their own benefit. They can misreport their financial status. Financially constrained borrowers influenced the appraisal process at their banks to obtain credit and to lower the interest rates they faced (Agarwal, Ben-David, and Yao, 2015). Residential borrowers misreport their personal assets in areas of low financial literacy or social capital and if they are more likely to become delinquent (Garmaise, 2015). Both hard and soft information can be manipulated and is prone to the influence of borrowers.

Relationship and transaction lending can complement each other (Bartoli et al., 2013). In this view, transaction lending techniques should be complemented by soft information gathered in relationship lending. For example, despite the multitude of hard information available, its credibility is becoming more elusive. Borrowers can manipulate hard information. Soft information gathered through relationship banking may limit the scope for manipulation of hard information.

Liberti, Seru, and Vig (2016) analyze the change in the information environment about bank borrowers and its impact on bank lending processes. Following the introduction of a credit

registry that shares information about a subset of bank borrowers, a bank responded by moving substantial tasks to loan officers. Hardening of the information led to reorientation toward more relationship banking (see also Liberti, Sturgess, and Sutherland, 2016). Mocetti, Pagnini, and Sette (2017) find that a bank delegates more authority to a local branch manager if it heavily invests into information and communication technologies. With additional authority the local branch manager invests more intensively in the acquisition of soft information (Liberti, 2017).

Put another way, a deep presence across products is important, and the benefits of bank-borrower relationships can be leveraged up by cross-selling transaction-oriented products (Rocholl and Puri, 2008).

5. Relationship banking, FinTech, and IT firms: Friends or foes?

Banks are facing increased competition from FinTech start-ups and established IT companies such as PayPal, Facebook, Apple, Google, and Amazon that are entering traditional banking businesses. The question is whether banks can learn something novel about relationship banking from their new competitors. Non-bank competitors may embrace the logic of relationship banking and provide novel perspectives.

Several online lending platforms, spurred by advances in cloud computing, big data, and scalable IT infrastructures (Drummer, Feuerriegel, and Neumann, 2017), outsource soft information acquisition to crowds. On peer-to-peer lending platforms—such as Prosper Marketplace, Lending Club, SoFi, and Stilt—consumers can either act as borrowers or lenders and work to evaluate creditworthiness and mitigate information asymmetries on their own. Non-expert individuals that act as lenders evaluate soft and non-standard information on loan purpose and

text descriptions to screen the creditworthiness of their peers. Soft and nonstandard information is especially important for evaluating lower-quality borrowers (Iyer et al., 2016). Borrowers socially and geographically closer to lenders with better appearance of trustworthiness obtain credit more often and with lower interest rates (Duarte, Siegel, and Young, 2012; Burtch, Ghose, and Wattal, 2014).

A wide network of online friendships improves access to funding, lowers interest rates, and is negatively related to ex-post default rates (Lin, Prabhala, and Viswanathan, 2013). An offline friend network is an important stimulator of borrowers' success in peer-to-peer lending (Liu et al., 2015). Offline friends secure initial lending, provide endorsements through bidding, and provoke herding behavior of other lenders.

These arguments suggest that the business model of on-line lending platforms partially relies on soft information acquisition through repeated interactions—core ingredients of relationship banking. What this potentially shows is that soft information also can be garnered and used by others than expert bankers. The core question of relationship banking then becomes how to select the individuals that can extract and judge soft information the most effectively, how to motivate them, and how to scale up their knowledge.

The novelty and hype surrounding new initiatives should not cloud the problems that linger below the surface. Incentives of participants in peer-to-peer lending matter. If incentives are misaligned, sophisticated investors can exploit unsophisticated investors (Hildebrand, Puri, and Rocholl, 2016). Crowdfunding platforms may even exploit people's behavioral biases (Agrawal, Catalini, and Goldfarb, 2014). Rather than being a side effect, herding behavior and hype about

products could then be thoughtfully provoked by the design of crowdfunding platforms in order to boost their operations.

Payments is another typical banking business that FinTech startups such as Stripe, Square, and established IT companies such as PayPal are trying to disrupt. Facebook supports money transfers. Apple Pay, Android Pay, and Google Wallet are building on mobile payments. Rysman and Schuh (2016) classify innovations in consumer payments among mobile payments, faster payments, and digital currencies.

Banks should be careful not to lose the payments business. Not only the fees but also information gathered through payments matters. Information obtained by observing transactions in savings or checking accounts supports screening and subsequent monitoring of borrowers, and helps reduce loan defaults (Puri, Rocholl, and Steffen, 2017).

To conclude, even though IT-driven transaction banking is challenging relationship banking, there still is a role for a thorough understanding of the human behavior of bank borrowers and bank officers. Relationship banking, however, needs to adjust and determine how to use IT developments for its own benefit.

6. IT developments, competition, and relationship banking

We have shown that IT developments have allowed banks to serve more distant clients, increasing competition in banking. FinTech companies have further fueled the competitive pressures in banking. Changed political circumstances may further affect competition. Interventionist government support for banks during the financial crisis has modified the

competitive landscape in banking (Hasan and Marinč, 2016). The question here is whether higher competition will erode relationship banking.

A definite answer on the interconnection between competition and relationship banking is still missing. Petersen and Rajan (1995) note that in an inter-temporal setting banks have little incentive to invest in relationship banking, knowing that competition will erode future relationship banking rents (see also Ogura, 2010). In contrast, Boot and Thakor (2000) show that banks, as a response to more intense competition, resort to relationship banking to preserve rents that are evaporating especially in the transaction banking business. Degryse and Ongena (2007) empirically confirm that bank branches employ more relationship lending if they face more intense local competition.

Presbitero and Zazzaro (2011) argue that the organizational structure of the banking market drives the connection between competition and relationship banking. If large and distant banks dominate credit markets, higher competition works to the detriment of relationship banking. In contrast, if small, local banks are in the majority, higher competition induces banks to cultivate close and extensive ties with their borrowers.

IT developments smoothen communication barriers across borders and directly affect information transmission across multinational banks. The literature shows that large, cross-border, and multilayered banks are worse at gathering and transmitting soft information present in relationship lending across the organizational structure compared to small, local banks (Berger et al., 2005; Stein, 2002). If borders are weakened, distant banks have less difficulty engaging in relationship banking. Rather than along national lines, other borders may arise along cultural, religious, and ethnic lines. Multinational banks that have branches at greater cultural and

geographical distances from their main headquarters avoid extending relationship loans (Mian, 2006).

Lending specialization in relationship banking goes further than collecting idiosyncratic knowledge about certain borrowers. Banks obtain market-specific knowledge about foreign markets and exporters borrow from banks specialized for their export market (Paravisini, Rappoport, and Schnabl, 2015). If IT developments further lower the importance of borders spurring globalization and international trade, bank knowledge about export markets may become even more important.

A related question refers to the effect of competition on the benefits of relationship banking to bank borrowers. Reducing geographic restrictions on bank expansion allows small firms to borrow at lower interest rates with no impact on the amount that small firms borrow (Rice and Strahan, 2010). Cooperative banks spur new firm creation and facilitate access to bank financing for small and medium-sized firms, whereas the presence of large banks improves the efficiency of small and medium-sized firms (Hasan et al., 2015).

To reap the benefits of relationship banking, its drawbacks need to be properly addressed. For example, a relationship bank that obtains market power over the borrowers might engage in substantial rent extraction, holding up the borrower as in Rajan (1992). The typical response to mitigate the hold-up problem is to increase competition in banking. On the basis of meta-analysis, Kysucky and Norden (2016) show that the benefits of relationship banking are more pronounced if bank competition is high.

7. Implications for stability

Now, we evaluate the impact of IT-driven changes in banking on stability. Excessive reliance on IT solutions can result in additional risk taking and even raise system risk in the banking system. Rajan, Seru, and Vig (2015) show that statistical models underpriced default risk before the global financial crisis in a systematic manner, especially for borrowers for which soft information was more valuable. Systemic risk concerns may arise as a result of reliance on computer models that account for risk in the same way and, by doing so, perform the same mistakes.

Financial markets have experienced unprecedented integration due to globalization and advances in information technology (Lucey et al. 2018). Bad news that quickly spreads through media and social networks (see e.g., Ichev and Marinč, 2018) can trigger bank runs and affect stability in banking. In this light, relationships with bank depositors are important. Depositors that have a long-term relationship with a bank are less likely to run (Iyer and Puri, 2012) and support relationship lending better (in light of Song and Thakor, 2007). Relationship banking may then, by relying on diverse, soft information, act as an anchor of stability in the IT-driven society.

Scalable transaction-oriented banking operations spurred by IT developments present an additional challenge for the regulators. IT developments allow for fast expansion that can lead to excessive risk taking in banking (Marinč, 2013). Boot and Ratnovski (2016) focus on the dis-synergies between relationship banking and other more risky banking activities, and whether separation is warranted. Bank operations on a financial market such as trading provide benefits to a relationship bank only when they are limited in size. If trading operations become large, banks cannot commit their resources to relationship banking ex-post, which derails their ability

to build relationships ex-ante. Martynova, Ratnovski, and Vlahu (2018) show that higher bank profitability may fuel expansion in riskier side activities increasing bank risk taking. In this view, IT developments that increase profitability of bank core operations may indirectly support risky bank expansion in side activities.

Innovations in IT might have exacerbated risks coming from financial markets due to misinformation due to complex information networks, higher volatility with transaction velocity, and speculative trading behavior (Ma and McGroarty, 2017). Huang and Ratnovski (2011) argue that wholesale funding can be disruptive and can create excessive liquidation. These studies point to the need to insulate relationship banking from destabilizing forces that come from short-term funding, excessive leverage, or from scalable transaction-oriented bank operations (see also Boot, 2011, 2014).

Regulatory overhaul, including Basel III framework for capital and liquidity regulation and structural regulation that separates core banking functions from the riskier trading activities might work towards additional stability but also imposes additional costs on the traditional banks. In many instances, FinTech companies are operating outside the regulated banking system effectively engaging in the regulatory arbitrage. Buchak et al. (2017) show that FinTech shadow banks have grown substantially not only due to their superior on-line lending technology but even more so because of increasing regulatory burden that put traditional banks at competitive disadvantage. The problem of this is that systemic risk can accumulate in the shadow banking system as experienced in the recent financial crisis (Gorton and Metrick, 2010).

Whereas drastic innovations in FinTech may improve efficiency, the profit motive of FinTech companies may not always be aligned with the need for stability. For example, payment system

stability (and more generally the stability in the financial systems infrastructure) is of paramount importance for the real economy. Innovations in payments may impact systemic stability and systemic concerns necessitate regulatory scrutiny (Pauget, 2016). How to ensure a level playing field without suffocating innovations and new entry by FinTech is therefore a crucial conundrum that the regulators need to solve (see Darolles, 2016, Philippon, 2016).

Technology is also disrupting the notions of data sharing and trust. For example, Bitcoin is built using a block chain technology that allows a decentralized approach towards verifying transactions and wealth holdings. Relationship banking may retain some advantage in the field of trust due to its long-term orientation. How the proprietary data (e.g., on payments, lending, and deposit-taking) are safeguarded and provided to third parties will become increasingly important in the future and relates to the core issue of banking—the build-up of confidentiality and trust.⁶

In the future, one can even envision relationship banks acting as safe-keepers of proprietary information that can be transferred to third parties under the consent and approval of bank customers. A seamless fusion of banking operations with the FinTech solutions is possible through application programming interfaces (APIs) that connect banking and FinTech softwares together. The regulators are following technological advances. In Europe, data sharing has been regulated by the payment system directive PSD2,⁷ which is opening up the payment system to non-bank players. The challenge then refers to combining soft information that relationship

⁶ Fungáčová, Hasan, and Weill (2016) analyze the level and determinants of trust in banking across countries and point to the importance of socioeconomic factors. Trust in banks is higher for women, increases with income, and is affected by an individual's religious, political, and economic values.

⁷ Directive 2015/2366/EU of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No 1093/2010, and repealing Directive 2007/64/EC.

banks gather and integrate it in decision making or potentially even share it with collaborative FinTech providers.

Another concern relates to IT-driven innovations in banking and consumer protection issues. If computers can beat the best humans at various games, can they also extract rents from financially uneducated, poor, or financially excluded borrowers? Inequality may increase due to redlining by computer algorithms built on existing inequalities. The impact of artificial intelligence in lending on inequality is largely unknown (Rainie and Anderson, 2017) and the issue of protecting humans from computers might deserve further scrutiny.⁸

The financing needs of the population are increasing due to increased longevity and larger volatility of income and spending needs of bank customers through their life cycles. Older and younger adults are more susceptible to financial mistakes than middle-aged adults (Agarwal et al., 2009) and more subject to unfair lending practices such as predatory lending, excessive credit card fees, or mortgage terms (Agarwal et al., 2014, 2016). Achieving compliant IT systems is a first step but more needs to be done. Compliance cannot replace ethics (as Batten, Lončarski, and Szilagyi (2018) show in the case of insider trading prevention). How to incorporate ethics into artificial intelligent lending programs is yet to be researched.

The suggestion coming from the risk management literature is that a thoughtful implementation matters for success of new IT systems. Bakker, Boonstra, and Wortmann (2010) identify technical risk factors and organizational risk factors, such as senior management support and

⁸ A famous example is Microsoft's artificially intelligent Twitter bot named Tay. After Tay was exploited by a group of users and spammed with inflammatory messages, it began tweeting racist messages itself. Subsequently, Microsoft has released Zo, a censored version of Tay.

user participation, as crucial risk factors that have an impact on IT project success. They argue that paying attention to risks might mitigate the negative effects of risk on project success.⁹ Interestingly, Monteiro de Carvalho and Rabechini Junior (2015) show that soft skills in risk management are important for project success.

The implications for banking readily follow. The dichotomy between IT-based transaction banking and relationship banking might be rather superficial. Instead, the correct implementation of IT-based solutions, with the focus on soft skills, and the inclusion of soft information matter for successful relationship banking.

8. Conclusions

This article provides a review of how relationship banking is evolving in light of disruptive, IT-driven innovations. We argue that relationship banks might still have an edge when competing with transaction oriented banks, or FinTech companies.

IT developments have made scalable transaction banking more cost-effective. Mobile and online banking coupled with transaction lending techniques allow for continuous access to banking services across large distances. Greater reliance on hard, quantifiable information available online and through credit bureaus facilitates AI-based decision making. Despite the widespread benefits, IT developments in banking also raise potential concerns. Hard information is prone to manipulation and gaming. Transaction lending techniques might not capture correctly the

⁹ Zwikael and Globerson (2006) find a positive but low impact of risk management planning on project performance. Miloš Sprčić et al. (2016) identify a positive impact of enterprise risk management on a firm value in a short run but not in a long run.

incentives of human bankers, bank borrowers and depositors, which might lead to higher marketability, herding, and consequently to increased systemic risk. IT-based systems might also disregard ethical dimensions in lending.

IT developments are not only changing the way banks work but are also reconfiguring societies. Geographical borders are giving way to other types of community structure. Social networks can work to spread rumors, hype, and fads, spur herding behavior, and increase volatility in banking. People do not always act on the basis of hard facts, rationality, and scientific discoveries. The ability to understand the behavior of bank customers may then become a core capability of relationship banking.

We argue that strong relationships still present a competitive advantage in banking. The benefits of a branch network that stem from geographic and cultural proximity to bank clients still exist, and human bankers cannot be fully replaced by artificially intelligent computers in lending just yet. The evidence indicates that greater IT support does not diminish the role of relationship banking but actually increases the acquisition of soft information. We argue that the road ahead for relationship banks is to use IT to build upon relationship banking. Relationship banks need to adopt the technology, adjust to the changing customers' needs, and respond to the regulatory demands.

Bibliography

- Agarwal, S., and I. Ben-David, (2014). Loan Prospecting and the Loss of Soft Information. Forthcoming in *Journal of Financial Economics*, <https://ssrn.com/abstract=2403669>
- Agarwal, S., I. Ben-David, and V. Yao (2015). Collateral Valuation and Borrower Financial Constraints: Evidence from the Residential Real Estate Market. *Management Science*, 61(9), 2220–2240.
- Agarwal, S., I. Ben-David, and V. W. Yao (2016). Systematic Mistakes in the Mortgage Market and Lack of Financial Sophistication. Forthcoming in *Journal of Financial Economics*. March 1. Charles A. Dice Working Paper No. 2016-09.
- Agarwal, S., S. Chomsisengphet, N. Mahoney, and J. Stroebel (2014). Regulating Consumer Financial Products: Evidence from Credit Cards. *Quarterly Journal of Economics*, 130, 111–164.
- Agarwal, S., J. C. Driscoll, X. Gabaix, and D. Laibson (2009). The Age of Reason: Financial Decisions over the Life Cycle and Implications for Regulation. *Brookings Papers on Economic Activity*, Economic Studies Program, The Brookings Institution, 40(2), 51–117.
- Agarwal, S., and R. Hauswald (2010). Distance and Private Information in Lending. *Review of Financial Studies*, 23(7), 2757–2788.
- Aral, S., C. Dellarocas, D. Godes (2013). Introduction to the Special Issue—Social Media and Business Transformation: A Framework for Research. *Information Systems Research*, 24, 3–13.
- Autor, D. H., and D. Dorn (2013). The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market. *American Economic Review*, 103(5), 1553–1597.
- Bapna, R., and A. Umyarov (2015). Do Your Online Friends Make You Pay? A Randomized Field Experiment on Peer Influence in Online Social Networks. *Management Science*, 61(8), 1902–1920.
- Bartoli, F., G. Ferri, P. Murro, and Z. Rotondi (2013). SME Financing and the Choice of Lending Technology in Italy: Complementarity or Substitutability? *Journal of Banking & Finance*, 37(12), 5476–5485.
- Batten, J. A., I. Lončarski, and P. G. Szilagyi (2018). When Kamay Met Hill: Organisational Ethics in Practice. *Journal of Business Ethics*, 147(4), 779–792.
- Beck, T., H. Degryse, R. De Haas, and N. van Horen (2015). When Arm’s Length Is Too Far. Relationship Banking over the Credit Cycle. SRC Discussion Paper, No 33. Systematic Risk Centre, The London School of Economics and Political Science, London, UK.
- Beck, T., V. Ioannidou, and L. Schäfer (2016). Foreigners vs. Natives: Bank Lending Technologies and Loan Pricing. Forthcoming in *Management Science*.
- Beijnen, C., and W. Bolt (2009). Size Matters: Economies of Scale in European Payments Processing. *Journal of Banking & Finance*, 33(2), 203–210.

- Berger, A. N., and Black, L. K. (2011). Bank Size, Lending Technologies, and Small Business Finance. *Journal of Banking & Finance*, 35(3), 724–735.
- Berger, A. N., N. H. Miller, M. A. Petersen, R. G. Rajan, and J. C. Stein (2005). Does Function Follow Organizational Form? Evidence from the Lending Practices of Large and Small Banks. *Journal of Financial Economics*, 76, 237–269.
- Berger, A. N., and G. F. Udell (2006). A More Complete Conceptual Framework for SME Finance. *Journal of Banking & Finance*, 30, 2945–2966.
- Boot, A. W. A. (2000). Relationship Banking: What Do We Know? *Journal of Financial Intermediation*, 9, 7–25.
- Boot, A.W.A. (2011). Banking at the Cross-Roads: How to Deal with Marketability and Complexity? *Review of Development Finance*, 1(3–4), p. 167–183.
- Boot, A.W.A. (2014). Financial Sector in Flux. *Journal of Money, Credit and Banking*, 46(1), 129–135.
- Boot, A. W. A. (2017). The Future of Banking: From Scale & Scope Economies to Fintech, *European Economy - Banks, Regulation and The Real Sector*, Vol. 2, 77–95.
- Boot, A. W. A., and M. Marinč (2008). The Evolving Landscape of Banking. *Industrial and corporate change*, 17(6), 1173–1203.
- Boot, A.W.A., and L. Ratnovski (2016). Banking and Trading, *Review of Finance*, 20(6), 2219–2246.
- Boot, A. W. A., and A. V. Thakor (2000). Can Relationship Banking Survive Competition? *Journal of Finance*, 55(2), 679–713.
- Buchak, G., G. Matvos, T. Piskorski, A. Seru (2017). Fintech, Regulatory Arbitrage, and the Rise of Shadow Banks. NBER Working Paper No. 23288. March 2017.
- Burch, G., A. Ghose, and S. Wattal (2014). Cultural Differences and Geography as Determinants of Online Prosocial Lending. *MIS Quarterly*, 38(3), 773–794.
- Campbell, D., and F. Frei (2010). Cost Structure, Customer Profitability, and Retention Implications of Self-Service Distribution Channels: Evidence from Customer Behavior in an Online Banking Channel. *Management Science*, 56(1), 4–24.
- Canales, R., and R. Nanda (2012). A Darker Side to Decentralized Banks: Market Power and Credit Rationing in SME Lending. *Journal of Financial Economics*, 105(2), 353–366.
- Cerqueiro, G., H. Degryse, and S. Ongena (2011). Rules versus Discretion in Loan Rate Setting. *Journal of Financial Intermediation*, 20(4), 503–529.
- Ciciretti, R., I. Hasan, and C. Zazzara (2009). Do Internet Activities Add Value? Evidence from the Traditional Banks. *Journal of Financial Services Research*, Vol. 35(1), p. 81–98.
- Cole, S., M. Kanz, and L. Klapper (2015). Incentivizing Calculated Risk-Taking: Evidence from an Experiment with Commercial Bank Loan Officers. *Journal of Finance*, 70, 537–575.

- Constantiou, I. D., and J. Kallinikos (2015). New Games, New Rules: Big Data and the Changing Context of Strategy. *Journal of Information Technology*, 30(1), 44–57.
- Cortés, K., R. Duchin, and D. Sosyura (2016). Clouded Judgment: The Role of Sentiment in Credit Origination. *Journal of Financial Economics*, 121(2), 392–413.
- Currie, W. L., and T. Lagoarde-Segot (2017). Financialization and Information Technology: Themes, Issues and Critical Debates – Part I. *Journal of Information Technology*, 32(3), 211–217.
- de Bakker, K., A. Boonstra, and H. Wortmann (2010). Does Risk Management Contribute to IT Project Success? A Meta-analysis of Empirical Evidence. *International Journal of Project Management*, 28(5), 493–503.
- Darolles, S. (2016). The Rise of Fintechs and Their Regulation. *Financial Stability Review* (20), 85–92.
- Degryse, H., and S. Ongena (2005). Distance, Lending Relationships, and Competition. *Journal of Finance*, 60(1), 231–266.
- Degryse, H., and S. Ongena (2007). The Impact of Competition on Bank Orientation. *Journal of Financial Intermediation*, 16(3), 399–424.
- DeYoung, R., D. Glennon, and P. Nigro (2011). The Information Revolution and Small Business Lending: The Missing Evidence. *Journal of Financial Services Research*, 39(1), 19–33.
- Diamond, D. (1984). Financial Intermediation and Delegated Monitoring. *Review of Economic Studies*, 51, 393–414.
- Dinç, S. I. (2005). Politicians and Banks: Political Influences on Government-Owned Banks in Emerging Markets. *Journal of Financial Economics*, 77(2), 453–479.
- Drummer, D., S. Feuerriegel, and D. Neumann (2017). Crossing the Next Frontier: The Role of ICT in Driving the Financialization of Credit. *Journal of Information Technology*, 32, 218–233.
- Duarte, J., S. Siegel, and L. Young (2012). Trust and Credit: The Role of Appearance in Peer-to-Peer Lending. *Review of Financial Studies*, 25(8), 2455–2484.
- Ferri, G., and P. Murro (2015). Do Firm–Bank ‘Odd Couples’ Exacerbate Credit Rationing? *Journal of Financial Intermediation*, 24(2), 231–251.
- Filip, D., and K. Jackowicz, and Ł. Kozłowski (2016). The Influence of Social Media and Internet Presence on Small, Local Banks’ Market Power: New Evidence from an Emerging Economy. March 12. Available at SSRN: <https://ssrn.com/abstract=2746897>.
- Fisman, R., D. Paravisini, and V. Vig (2017). Cultural Proximity and Loan Outcomes. *American Economic Review*, 107(2), 457–492.
- Frame, W.S., and L.J. White (2010). Technological Change, Financial Innovation, and Diffusion in Banking. In *The Oxford Handbook of Banking*, ed. by A. Berger, P. Molyneux, and J. Wilson. p. 486–507.

- Francis, B. B., I. Hasan, and X. Sun (2014), Does Relationship Matter? The Choice of Financial Advisors. *Journal of Economics and Business*, 73, 22–47.
- Fungáčová, Z., I. Hasan, and L. Weill (2016). Trust in Banks, Working Papers of LaRGE Research Center, <http://EconPapers.repec.org/RePEc:lar:wpaper:2016-09>.
- Garmaise, M. J. (2015). Borrower Misreporting and Loan Performance. *Journal of Finance*, 70, 449–484.
- Gilje, E. P., E. Loutskina, and P. E. Strahan (2016). Exporting Liquidity: Branch Banking and Financial Integration. *Journal of Finance*, 71, 1159–1184.
- Gorton, G., and A. Metrick (2010). Regulating the Shadow Banking System. *Brookings Papers on Economic Activity*, 261–297.
- Greenbaum, S. I., A. V. Thakor, and A. W. A. Boot (2016). *Contemporary Financial Intermediation*, 3rd Edition, Academic Press, Elsevier, Amsterdam.
- Grunert, J., and L. Norden (2012). Bargaining Power and Information in SME Lending. *Small Business Economics*, 39(2), 401–417.
- Hasan, I., K. Jackowicz, O. Kowalewski, and L. Kozłowski (2015). Do Local Banking Market Structures Matter for SME Financing and Performance? New Evidence from an Emerging Economy. Working paper, December 1. Available at SSRN: <https://ssrn.com/abstract=2727941>
- Hasan, I., and M. Marinč (2016). Should Competition Policy in Banking Be Amended during Crises? Lessons from the EU. *European Journal of Law and Economics*, 42(2), 295–324.
- Hildebrand, T., M. Puri, and J. Rocholl (2016). Adverse Incentives in Crowdfunding. *Management Science*, <http://dx.doi.org/10.1287/mnsc.2015.2339>.
- Ho, P.-H., C.-W. Huang, C.-Y. Lin, and J.-F. Yen (2016). CEO Overconfidence and Financial Crisis: Evidence from Bank Lending and Leverage. *Journal of Financial Economics*, 120(1), 194–209.
- Huang, R., and L. Ratnovski (2011). The Dark Side of Bank Wholesale Funding. *Journal of Financial Intermediation*, 20(2), 248–263.
- Ichev, R., and M. Marinč (2018). Stock Prices and Geographic Proximity of Information : Evidence from the Ebola Outbreak. *International Review of Financial Analysis*, 56, 153–166.
- Iyer, R., A. I. Khwaja, E. F. P. Luttmer, and K. Shue (2016). Screening Peers Softly: Inferring the Quality of Small Borrowers. *Management Science*, 62(6), 1554–1577.
- Iyer, R., and M. Puri (2012). Understanding Bank Runs: The Importance of Depositor-Bank Relationships and Networks. *American Economic Review*, 102(4), 1414–1445.
- Jakšič, M., and M. Marinč (2015). The Future of Banking: The Role of Information Technology. *Bančni vestnik : revija za denarništvo in bančništvo*, 64(11), 68–73.
- Khedmatgozar, H.R., and A. Shahnazi (2017). *Electronic Commerce Research*. <https://doi.org/10.1007/s10660-017-9253-z>

- Kysucky, V., and L. Norden (2016). The Benefits of Relationship Lending in a Cross-Country Context: A Meta-Analysis. *Management Science*, 62(1), 90–110.
- Li, S., and M. Marinč (2018). Economies of Scale and Scope in Financial Market Infrastructures. *Journal of International Financial Markets, Institutions and Money*, 53, 17–49.
- Liberti, J. M. (2017). Initiative, Incentives, and Soft Information. Forthcoming in *Management Science*. doi.org/10.1287/mnsc.2016.2690
- Liberti, J. M., and A. R. Mian (2009). Estimating the Effect of Hierarchies on Information Use. *Review of Financial Studies*, 22(10), 4057–4090.
- Liberti, J. M., and M. A. Petersen (2017). Information: Hard and Soft, Working paper. March.
- Liberti, J. M., A. Seru, and V. Vig (2016). Information, Credit, and Organization. June, 2016. Available at SSRN: <https://ssrn.com/abstract=2798608>.
- Liberti, J. M., J. Sturgess, and A. Sutherland (2016). Information Sharing and Lender Specialization: Evidence from the U.S. Commercial Lending Market. November 2016.
- Lin, M., N., R. Prabhala, and S. Viswanathan (2013). Judging Borrowers by the Company They Keep: Friendship Networks and Information Asymmetry in Online Peer-to-Peer Lending. *Management Science*, 59(1), 17–35.
- Liu, D., D. Brass, Y. Lu, and D. Chen (2015). Friendships in Online Peer-to-Peer Lending: Pipes, Prisms and Relational Herding. *MIS Quarterly*, 39(3), 729–742.
- Lucey, B. M., S. A. Vigne, L. Ballester, L. Barbopoulos, J. Brzeszczynski, O. Carchano, N. Dimic, V. Fernandez, F. Gogolin, A. González-Urteaga, J. W. Goodell, P. Helbing, R. Ichev, F. Kearney, E. Laing, C. J. Larkin, A. Lindblad, I. Lončarski, K. Cuong Ly, M. Marinč, R. J. McGee, F. McGroarty, C. Neville, M. O’Hagan-Luff, V. Piljak, A. Sevic, X. Sheng, D. Stafylas, A. Urquhart, R. Versteeg, A. N. Vu, S. Wolfe, L. Yarovaya, A. Zaghini (2018). Future directions in international financial integration research - A crowdsourced perspective. *International Review of Financial Analysis*, 55, 35–49.
- Ma, T., and F. McGroarty (2017). Social Machines: How Recent Technological Advances Have Aided Financialisation. *Journal of Information Technology*, 32(3), 234–250.
- Marinč, M. (2013). Banks and Information Technology: Marketability vs. Relationships. *Electronic commerce research*, 13(1), 71–101,
- Martins, C., T. Oliveira, and A. Popovič (2014). Understanding the Internet Banking Adoption: A Unified Theory of Acceptance and Use of Technology and Perceived Risk Application. *International Journal of Information Management*, 34(1), 1–13.
- Martynova, N., L. Ratnovski, and R. Vlahu (2018). Bank Profitability and Risk. Taking. February 2018. https://www.dnb.nl/en/binaries/20180220_MRV_tcm47-335181.pdf
- Mian, A. (2006). Distance Constraints: The Limits of Foreign Lending in Poor Economies. *Journal of Finance*, 61(3), 1465–1505.

- Miloš Sprčić, D., M. Mešin Žagar, Ž. Šević, and M. Marc (2016). Does Enterprise Risk Management Influence Market Value – A Long-term Perspective.. *Risk Management*, 18(2–3), 65–88.
- Mocetti, S., M. Pagnini, and E. Sette (2017). *Journal of Financial Services Research*, 51, 313–338.
- Monteiro de Carvalho, M., and R. Rabechini Junior (2015). Impact of Risk Management on Project Performance: the Importance of Soft Skills. *International Journal of Production Research*, 53(2), 321–340.
- Moravčík, M., M. Schmid, N. Burch, V. Lisý, D. Morrill, N. Bard, T. Davis, K. Waugh, M. Johanson, M. Bowlin (2017). DeepStack: Expert-level artificial intelligence in heads-up no-limit poker. *Science* 356, 508–513.
- Nakashima, K., and K. Takahashi (2017). The Real Effects of Bank-Driven Termination of Relationships: Evidence from Loan-Level Matched Data. Working paper, August 22. <http://dx.doi.org/10.2139/ssrn.2619356>
- Norden, L., and M. Weber (2010). Credit Line Usage, Checking Account Activity, and Default Risk of Bank Borrowers. *Review of Financial Studies*, 23(10), 3665–3699.
- Ogura, Y. (2010). Interbank Competition and Information Production: Evidence from the Interest Rate Difference. *Journal of Financial Intermediation*, 19(2), 279–304.
- Pauget, G. (2016). Systemic Risk in Payments. *Financial Stability Review*, 20, 37–44.
- Paravisini, D., V. Rappoport, and P. Schnabl (2015). Specialization in Bank Lending: Evidence from Exporting Firms, NBER Working Papers 21800, National Bureau of Economic Research.
- Paravisini, D., and A. Schoar (2015). The Incentive Effect of Scores: Randomized Evidence from Credit Committees. Revised July 2015. NBER Working Paper No. w19303.
- Parkes, D. C., and M. P. Wellman (2015). Economic Reasoning and Artificial Intelligence. *Science*, 349(6245), 267–272.
- Petersen, M. A., and R. G. Rajan (2002). Does Distance Still Matter? The Information Revolution in Small Business Lending. *Journal of Finance*, 57(6), 2533–2570.
- Philippon, T., (2016). The FinTech Opportunity. NBER Working Paper No. 22476, August.
- Presbitero, A. F., and A. Zazzaro (2011). Competition and Relationship Lending: Friends or Foes? *Journal of Financial Intermediation*, 20(3), 387–413.
- Puri, M., and J. Rocholl (2008). On the Importance of Retail Banking Relationships, *Journal of Financial Economics*, 89(2), 253–267.
- Puri, M., J. Rocholl, and S. Steffen (2017). What Do a Million Observations Have to Say about Loan Defaults? Opening the Black Box of Relationships. January 30. <https://ssrn.com/abstract=1572673>.

- Qian, J., P. E. Strahan, and Z. Yang (2015). The Impact of Incentives and Communication Costs on Information Production and Use: Evidence from Bank Lending. *Journal of Finance*, 70, 1457–1493.
- Rainie, L., and J. Anderson (2017). Code-Dependent: Pros and Cons of the Algorithm Age. PewResearchCenter, February 8, 2017, <http://www.pewinternet.org/2017/02/08/code-dependent-pros-and-cons-of-the-algorithm-age/>
- Rajan, R. G. (1992). Insiders and Outsiders: The Choice between Informed Investors and Arm's Length Debt. *Journal of Finance*, 47, 1367–1400.
- Repullo, R., and J. Suarez (2012). The Procyclical Effects of Bank Capital Regulation. *Review of Financial Studies*, 26(2), 452–490.
- Rajan, U., A. Seru, and V. Vig (2015). The Failure of Models that Predict Failure: Distance, Incentives, and Defaults. *Journal of Financial Economics*, 115(2), 237–260.
- Ravina, E. (2012). Love & Loans: The Effect of Beauty and Personal Characteristics in Credit Markets. November 22. <http://dx.doi.org/10.2139/ssrn.1107307>
- Rice, T., and P. E. Strahan (2010). Does Credit Competition Affect Small-Firm Finance? *Journal of Finance*, 65, 861–889.
- Rysman, M., and S. Schuh (2016). New Innovations in Payments. NBER Working Paper 22358.
- Schmiedel, H., M. Malkamäki, and J. Tarkka (2006). Economies of Scale and Technological Development in Securities Depository and Settlement Systems. *Journal of Banking & Finance*, 30(6), 1783–1806.
- Sharpe, S.A. (1990). Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships. *Journal of Finance*, 45, 1069–87.
- Silver, D., J. Schrittwieser, K. Simonyan, I. Antonoglou, A. Huang, A. Guez, T. Hubert, L. Baker, M. Lai, A. Bolton, Y. Chen, T. Lillicrap, F. Hui, L. Sifre, G. van den Driessche, T. Graepel, D. Hassabis (2017). Mastering the game of Go without human knowledge. *Nature* 550, 354–359.
- Song, F., A. and V. Thakor (2007). Relationship Banking, Fragility, and the Asset-Liability Matching Problem. *Review of Financial Studies*, 20(6), 2129–2177.
- Stein, J. C. (2002). Information Production and Capital Allocation: Decentralized versus Hierarchical Firms. *Journal of Finance*, 57, 1891–1921.
- Uchida, H., G. F. Udell, and N. Yamori (2012). Loan Officers and Relationship Lending to SMEs. *Journal of Financial Intermediation*, 21(1), 97–122.
- Xue, M., L. M. Hitt, and P. Chen (2011). Determinants and Outcomes of Internet Banking Adoption. *Management Science*, 57(2), 291–307.
- Zwikael, O., and S. Globerson (2006). From Critical Success Factors to Critical Success Processes. *International Journal of Production Research*, 44, 3433–3449.