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Banks and Information Technology: Marketability vs. Relationships[‡]

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Abstract

This paper evaluates the impact of information technology (IT) on the operations of banks and the structure of the banking industry, including implications for stability. On the one hand, banks can focus on relationship banking and use IT developments to tailor services to individual needs and build enhanced, albeit modified, relationships with customers. On the other hand, IT better allows banks to exploit scale and scope economies, most evident in transaction banking. Another manifestation of IT is via financial innovations that have enhanced marketability. Stability enters the picture because increased marketability facilitates opportunistic behavior. Together with enhanced herding behavior and changes in industry structure, this could undermine stability and augment systemic risk, calling for a regulatory overhaul.

Keywords: Banking, Information Technology, Relationship Banking, Stability, Systemic Risk

JEL CLASSIFICATION: G21, G28, L86, O33

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1. Introduction

Information technology (IT) has fundamentally reshaped the banking industry. This paper evaluates the impact of IT on the behavior of banks and on the structure of the banking industry, including implications for stability.

On the one hand, banks can use IT to support and enhance relationships with their customers through cross-selling of customized products and innovative services and by making the business process flexible and customer-driven. IT-enhanced relationship banking activities may then work to increase stability.

On the other hand, banks can exploit scale and scope economies that derive from standardized IT-supported processes, mainly present in transaction banking. IT has enhanced the ability of banks to process and transmit quantifiable data. Via proliferation of financial innovations this has augmented marketability. Securitization is an example of such marketability. Increased marketability has made banks more footloose—that is, less able to stick to strategies that require long-term commitment. IT-driven tradability and "changeability" may erode staying power and induce more opportunistic decision-making. This may have been detrimental to relationship banking. That is, banks may have lost incentives to engage in monitoring and screening activities that fit the longer horizon associated with relationship banking activities.

IT development facilitates consolidation process in banking. IT may also push banks to choose between transaction banking and relationship banking. Although it is difficult to foresee the structure of the industry, one could predict a bimodal structure in which large universal banks driven by economies of scale and scope would coexist and compete with small customer-focused banks.

IT-driven marketability and structural changes may reinforce each other and culminate in increased systemic risk. That is, risk-taking by individual banks may become highly correlated and this may increase the probability that banks fail simultaneously. IT-driven marketability may spur herding. Under the pressure of the same market forces, banks would imitate each other by following hypes and fads, which would make them even more interlinked. For example, banks have simultaneously employed quantitative default models to predict the default probabilities of complex securities. These models systematically underestimated the probability of default, thereby creating large systemic exposure of the banking industry and contributing to the depth of the 2007–2009 financial crisis.

To evaluate the impact of IT in banking, this paper builds on three strands of literature. First, management and economics literature focuses on the IT-driven changes in firm organization and structure and how such changes contribute to firm profitability (see Brynjolfsson and Saunders, 2010). This paper focuses on

risk-taking. It argues that IT may spur marketability in banking, which in turn may facilitate opportunistic behavior. Second, information systems literature may sometimes underestimate the industry effect in individual-, group-, or organization-level studies (Chiasson and Davidson, 2005; see also Orlikowski and Iacono, 2001, and Melville, Kraemer, and Gurbaxani, 2004). This paper focuses on the banking industry, in which the issue of stability is of paramount importance (see Boot and Marinč, 2008). IT may drive organizational and industry changes that worsen stability in banking with a negative externality for the entire economy. This points to the spillover effect of IT across the borders of an individual organization and even across the borders of the entire industry. Third, within banking literature the paper builds on the general description of IT in banking, available in Berger (2003), Frame and White (2010), and VanHoose (2009), and proposes policy implications.

The conclusion of the paper is that a strong legal and regulatory environment may help banks focus on their customers and use IT developments for this purpose. Banking regulators need to respond to IT-driven marketability in order to safeguard the stability of the banking system. Increasing capital requirements and strengthening corporate governance in banking is important. Additional structural changes may also be needed.

This paper is organized as follows. Section 2 discusses how IT applications affect transaction banking and relationship banking activities. Section 3 analyzes how IT changes the structure of the banking industry, including the comparative advantages of large vs. small banks. Section 4 focuses on the question of whether the proliferation of IT-driven transaction banking has derailed stability. It is argued that IT-driven marketability coupled with structural changes could make banks footloose with potential repercussions for stability and systemic risk. In Section 5 we argue that relationship banking activities are more desirable from the perspective of financial stability and we discuss a legal and institutional framework that would promote relationship banking. Section 6 concludes the paper.

2. IT applications in banking

IT has fundamentally changed the core activities that banks perform. First, we distinguish between relationship banking and transaction banking activities. Second, we argue that decision making in banking has become more automatic and based on hard quantifiable information, boosting especially transaction banking. Third, new distribution channels may have further encouraged the move towards transaction banking. Fourth, relationship banking may have kept a competitive edge through the IT-driven product proliferation and customization.

2.1. *Relationship banking vs. transaction banking*

Traditional commercial banks hold illiquid and nonmarketable loans and fund by collecting liquid deposits. Banks' raison d'être lies in absorbing the risks on the asset side which protects depositors, leads to the increased supply of funding, and facilitates lending to informationally opaque borrowers. The illiquidity of bank loans is driven by proprietary information gathered through the process of originating, pricing, and monitoring of loans. According to Boot (2000), the core competitive advantage of banks stems from the relationship banking activities, defined as bank activities that rely on often proprietary, customer-specific information, obtained through multiple interactions with the same customer over time and/or across products. Such information is predominantly soft in nature (i.e., difficult to quantify) and therefore proprietary to the bank, reusable, and costly to produce.

Whereas lending to small businesses primarily on the basis of soft information can be seen as the most typical relationship banking activity, it is far from being the only one. Relationship banking occurs also on the bank funding side. Establishing close relationships with customers is important in gathering core deposits through the bank branch network and in offering customized payment products or cash management services. In contrast to relationship banking, transaction banking refers to activities with a one-time focus on a single customer. Such activities are scalable and can be easily replicated for transactions with a multitude of customers. Typical transaction banking activities are pursued by bulge-bracket investment banks and refer to principle investing activities, short-term market-making, and wholesale loan origination and funding. These activities brought especially investment banking closer to the transaction nature of financial markets.

It is fair to say that the line between relationship banking and transaction banking is blurred. For example, an investment bank through its brokerage function matches buyers and sellers of securities. This may be seen as a typical transaction banking activity. Yet, underwriting may carry a relationship component because investment banks still absorb credit/placement risk and, to reduce such risk, they gather proprietary information through multiple interactions with the client.

2.2. *Digitized processes: The rise of transaction banking*

IT development has revolutionized business processes within a bank. IT advances place a focus on hard, quantifiable information. IT allows quantitative data to be better exploited, more easily transmitted, and more core to decision-making. What we show next is that this development has helped especially transaction banking activities.

In the back office, IT has spurred decision making based on hard quantifiable information about bank clients, particularly important in transaction banking. IT has provided access to integrated data across the entire bank. IT software and infrastructure are combined to link bank products and services to customers, back-office functions, and business units. Banks are increasingly using credit-scoring models to automatically process and approve loans. For example, banks use credit-scoring models when approving mortgages, credit cards, and automobile credits to retail customers. Even lending to small and medium-sized enterprises has become increasingly digitized. Transaction lending techniques, such as financial statement lending, asset-based lending, fixed-asset lending, leasing, factoring, and small business credit scoring use quantifiable information to automatically process loans. Transaction lending gives a competitive edge to distant banks even though they may lack close personal contact with borrowers (Berger and Udell, 2006).

Small business credit scoring is particularly IT-intensive because it gathers and processes data from multiple sources. Small business credit scoring typically combines consumer data from the owner, small business data gathered by the financial institution, and data obtained through consumer and commercial credit bureaus.[2] The empirical evidence shows that small business credit scoring increases the availability of credit, the maturity and risk of credit, and the distance between the bank and the borrower (Berger, Frame, and Miller, 2005; Berger et al., 2005a; Berger and Frame, 2007; Frame, Padhi, and Woosley, 2004; DeYoung, Glennon, and Nigro, 2008).

The rise of transaction banking was facilitated by the IT-driven changes in communication standards. Banks have established highly secure communication standards such as SWIFTNet and EBICS to exchange a variety of information (e.g., account statements, securities holdings, and debit and credit payment orders) between themselves and other financial institutions. Automatic messaging systems (e.g., Loan/SERV) are becoming a standard in a syndicated loan market and facilitate communication between several banks when lending to a single large borrower. Banks also increasingly exchange information about their retail and corporate borrowers through public credit registers and private information exchanges. IT developments such as the internet, IT tools (such as web browsers, aggregators, customer opinions, and web wrappers—programs that extract machine-readable data from the Web) and IT architectures for information-sharing have augmented the quantity of information that banks possess (Pan and Viña, 2004). Increased communication and greater information availability have improved the quality of bank operations. For example, the evidence shows that the existence of information exchanges (e.g.,

[2] In 1998, only 62% of large U.S. banks (that responded to the survey) employed small business credit scoring techniques when lending to small businesses (Frame, Srinivasan, and Woosley, 2001). Today, it is used by the majority of large banks and an increasing proportion of small banks (Berger, Cowan, and Frame, 2011).

credit bureaus such as Dun & Bradstreet and Experian) improves the lending decisions of banks, reduces loan interest rates, and decreases loan defaults (Pagano and Japelli, 1993; Kallberg and Udell, 2003).

IT has also reshaped risk management in banking. Banks need to build internal processes that identify, measure, and mitigate risk. Risk-management systems provide automatic registration of risky events, allow for centralized risk oversight over the entire bank, provide decision support for risk mitigation, and have a framework for automatic reporting to regulators (Bamberger, 2010). Models for risk measurement and management, such as value-at-risk and stress testing, have become increasingly complex due to advances in quantitative finance (e.g., computation power and data availability; Fender and Gibson, 2001; Jorion, 2006, p. 431) and the development of intelligence techniques such as neural networks (Ioannidis, Pasiouras, and Zopounidis, 2010). Such IT-supported centralization of risk management may have again benefited transaction banking activities more because in relationship banking risks need to be evaluated locally and scalability is limited due to soft information.

Investment banks also engage in transaction banking activities related to the financial market, such as principle investing activities (e.g., engagement in private equity investing) and proprietary trading in primary and secondary markets, they act as market makers, and are involved in wholesale loan origination and funding.[3] For trading activities, banks increasingly engage in algorithmic trading. That is, they trade automatically based on complex and often opaque algorithms. Banks are estimated to account for approximately half of the algorithmic trading on foreign exchange markets (Chaboud et al., 2009). Algorithmic trading, in this case called high-frequency trading, often occurs through high-speed/frequency software engines able to process new information and initiate trading orders faster than human traders. High-frequency trading accounts for over two-thirds of U.S. equity market turnover by volume (Haldane, 2011) and is found to decrease market volatility (Hendershott, Jones, and Menkveld, 2011) and to improve liquidity and market efficiency (Barker and Pomeranets, 2011). Hence, IT is also important for banks when interacting with financial markets.

The most evident and empirically quantifiable are the real effects of IT developments in payment systems and clearing and settlements. Several studies identify substantial IT-based cost reduction and economies of scale in processing electronic payments (Hancock, Humphrey, and Wilcox, 1999; Beijnen and Bolt,

[3] Large investment banks in particular also offer services such as custody of securities, clearing, securities lending, cash management, and reporting, which require substantial IT support (Channon, 1998; Schmiedel, Malkamäki, and Tarkka, 2006; Duffie, 2010). Risk management that makes extensive use of IT is crucial in underwriting, over-the-counter derivatives, and off-balance-sheet financing.

2009) and in clearing and settlement systems (Schmiedel, Malkamäki, and Tarkka, 2006).[4] Paper payments such as cash and checks are increasingly being replaced by electronic payments such as debit and credit cards, direct debits, credit transfers, and e-money purchases or by mobile payments (e.g., M-banking, M-wallet, direct mobile billing, mobile money transfer, and contactless card systems). In the U.S., checks accounted for 46.4% of the total number of transactions in 2003, but only for 24.3% in 2009, whereas the use of debit cards increased from 20.2% to 36.9% (computed from BIS, 2011, p. 396). Humphrey et al. (2006) find that replacing the costly paper-based payment method with an electronic-based payment system and replacing branch offices with ATMs resulted in cost savings of 0.38% of the EU nations' GDP per year. Whereas electronic payment processing and engagement in clearing and settlements can be characterized as scalable transaction banking, customer-focused innovations in electronic payments may have some characteristics of relationship banking.

2.3. *Distribution: Further push for transaction banking*

Banks are increasingly reaching their customers through online and mobile distribution channels. Through the internet, banks provide information about their products and services, but also directly offer products and services to their customers (e.g., internet deposits, money market accounts, loan and mortgage applications, electronic payment transactions, online trading facility, mutual funds, and insurance services). In a 2011 worldwide survey, KPMG (2011) finds that more than half of respondents claimed that they had used mobile banking in the past six months, compared to only 19% in 2008. In the U.S., 61% of respondents claimed that they used online banking in 2011 compared with 44% in 2004 (Pew Internet & American Life Project, 2011; Dahlberg et al., 2008 review mobile banking and mobile payments). The evidence from Spanish and Italian banking shows that the introduction of internet banking increases bank profitability (see Hernando and Nieto, 2007 and Ciciretti, Hasan, and Zazzara, 2009). DeYoung, Lang, and Nolle (2007) report that U.S. community banks charged extra fees for services related to deposit accounts upon introducing the internet channel. Greater revenues more than compensated for the increase in wage expenses that these banks incurred.

The question is whether new distribution channels spur transaction banking activities. The introduction of internet banking changes depositors' behavior by facilitating a shift from relationship-oriented core deposits established through bank branches (e.g., checking accounts) towards more non-relationship finance (e.g., money market deposit accounts and brokered deposits; DeYoung, Lang, and Nolle, 2007).

[4] IT-induced economies of scale reach across national borders. In the future, technological improvements and standardization (e.g., the SEPA initiative in the EU; see Bolt and Schmiedel, 2009) may further reduce the burden of various technical requirements, fiscal rules, and legal frameworks, and consequently decrease fragmentation in the payment-processing and clearing-and-settlement industry.

The internet delivery channel reduces the availability of soft information that a bank would otherwise obtain through the person-to-person relationship at bank branches (Agarwal and Hauswald, 2008). Relationship lending techniques that extensively use soft information, such as small-business lending, are less suitable for use over the internet than transaction lending techniques that rely on quantifiable hard information such as credit card loans, auto loans, and mortgages. Banks that adopted internet banking realized an increase in credit card lending, invested more in off-balance-sheet activities, had more diversified loan portfolios, and were marginally more risky (DeYoung, Lang, and Nolle, 2007; Ciciretti, Hasan, and Zazzara, 2009).

However, more recent evidence shows that internet banking modifies the importance of other access channels and acts as a *complement* to a branch network. Campbell and Frei (2010) show that online banking induces replacement of marginally more costly self-service delivery channels (such as ATMs), augmentation of costly service delivery channels (branches and call centers). The introduction of online banking increases the market share, customer retention, and cost of services. Mobile banking can increase access to finance in developing countries for a previously unbankable population (Kapoor, Ravi, and Morduch, 2007). Novel distribution channels have made banks flexible institutions that can easily respond to the needs of customers. The internet access channel allows for swift (and relatively cheap) changes in business products and immediate distribution to customers. In the case of a bank branch network, potential changes require a substantial period of time and investment.

2.4. *A road for relationship banking: Proliferation, customization, and soft information*

Banking has become a broad business with a multitude of different products and services that can be tailored to the specific needs of bank customers. Bank customers use IT applications that spur demand for product variety and customization, present especially in relationship banking. Information availability through browsers and customer opinions may boost demand for niche products (Anderson, 2006). IT also enables banks to customize products. IT reduces the time of setting up a new production process and allows for its replication (Bartel, Ichniowski, and Shaw, 2007). Innovative, made-to-order production increases customization of products.

The variety of bank products has increased in the front office. The transaction lending techniques such as leasing, factoring, asset-based lending, fixed-asset lending, and lending based on small business credit scoring have joined relationship loans (Berger and Udell, 2006). Transaction-based brokered deposits and money market deposits are now offered alongside relationship-based bank core deposits. Banks also cross-sell a wide array of services and products including payments, savings, and advisory services (de la Torre et al., 2010). Productivity enhancements due to IT have made possible microfinance loans and facilitated a

variety of micropayment products. Banks can tailor their products and services to their clients' needs and characteristics. An instructive example is mortgage lending. IT capabilities for data collection and mining allow mortgage lenders to sell complex and customized financial products to consumers and employ the information advantage with respect to the risk of consumers and the products offered (Willis, 2006).

The abundance of new transaction-based products does not necessarily imply that relationships are hurt. Rather, hard information obtained through transaction-based products can be complemented by soft information, gathered through the continuous interaction with the same client. For example, soft information in small business lending may include the branch officer's personal assessment of collateral value, firm prospects, and management quality (see Agarwal and Hauswald, 2010). If IT applications are tailored to core banking operations and become bank- or even subsidiary-specific, relationships may intensify. For example, in contrast to consumer loans, small business loans may preserve a relationship banking dimension even though banks process them with transaction-lending techniques that use hard quantifiable information. The rationale may be that historic data about the performance of small business loans are rarely available and are bank-specific. Banks combine transaction-lending techniques with relationship lending and moral hazard issues still pertain to the process of loan origination and servicing (see also Berger and Frame, 2007). Thus, the high information content of small business loans persists. The role of IT determines how relationships are affected. If IT facilitates dissemination of verifiable information, as is the case in consumer loans, relationship banking is hurt. However, if IT leads to tailor-made processing of information for the incumbent bank, as may be the case for loans to small and medium enterprises, relationships may intensify (see Hauswald and Marquez, 2003).

What can be concluded about the impact of IT on internal characteristics of banks? Evidence indicates that it is not the investment in IT that matters per se (in line with Carr, 2003). For example, Martín-Oliver and Salas-Fumás (2008) analyze how the stock of IT capital affects bank productivity. They find that growth in IT capital contributed to one-third of output growth of Spanish commercial and savings banks. However, IT capital did not improve demand for bank services (i.e., it was not a value-enhancing input). They hypothesize that IT capital may have contributed to the production of bank services but has not increased customers' willingness to pay for these services.

IT needs to be adopted together with the entire range of coordinated changes in organizational activities (Milgrom and Roberts, 1990). In particular, IT investment needs to be accompanied by workplace reorganizations towards more decentralized organizations, human capital investment, and the introduction of new products and services (Bresnahan, Brynjolfsson, and Hitt, 2002). IT developments may help mediate information problems within banks. IT facilitates better communication, coordination, collaboration, and information availability within and across corporate borders (Brynjolfsson and Hitt,

2000). Interaction between employees and customers can flow directly through e-mails or indirectly through blogs and customer opinions. Communication can be structured through constantly evolving corporate intranets, extranets, text messaging, corporate web sites, information portals, and social networks (McAfee, 2006, Davenport, 2005, Sarker et al. 2011). Virtual teams transcend geographical distances (although time zones and cultural differences still affect communication; Lee-Kelley and Sankey, 2008, see also Majchrzak et al., 2004). IT also facilitates organizational practices such as multitasking, teamwork, and rotation policy that may mitigate communication problems between bank employees (see Hertzberg, Liberti, and Paravisini, 2010). In relationship banking IT-driven communication and changed organizational structure work to enhance the transmittance of soft information and mitigate the associated information problems between bank employees. This stands in sharp contrast to transaction banking, where communication is highly standardized, scalable and used to transmit verified and quantified information.

Martín-Oliver and Salas-Fumás (2011) find that per each euro that a representative Spanish bank spends on IT-related assets, five additional euros are spent in complementary intangible assets. IT investment (coupled with training) builds up human capital into an intangible asset that contributes to the economic value of a bank. Beccalli (2007) shows that IT investment related to consulting services, implementation services, training and education, and support services improves bank performance (measured by financial profitability ratios ROA and ROE or cost and profit X-efficiency), but not direct IT investment in hardware and software (see also Casolaro and Gobbi, 2007). Beccalli (2007) surmises that IT investment in hardware and software can only be transformed into higher profitability if coupled with investment in external IT services that improve customer services. If we stretch this argument further, IT investment may then only be valuable if used to improve bank-customer relationships.

To conclude, the use of IT improves business processes both in transaction banking and relationship banking. The efficiency improvements are arguably larger for transaction banking activities and demand lower effort of implementation. This explains why IT development has contributed to transaction banking growing faster than relationship banking. However, (especially relationship-oriented) banks should not give in to the transaction nature of banking. They should use IT developments to build long-term relationships with their customers in a new way and, by doing this, also increase their long-term performance.

3. The structure of the banking industry

IT affects the structure of the banking industry in three dimensions. First, geographic consolidation and diversification is facilitated by IT-driven economies of scale and scope. Second, economies of scale and scope in transaction banking help large banks, whereas small banks focus on relationship banking.

3.1. *Consolidation and diversification*

In the past decades, the banking industry has experienced dramatic consolidation. The number of the U.S. commercial banks declined from 14,496 in 1984 to 6,291 by the end of 2011.[5] In the Euro area, the number of credit institutions dropped from 8,265 in early 1999 to 6,210 by the end of 2011.[6] IT has been seen as a major driver of the consolidation process (Berger, Demsetz, and Strahan, 1999). IT development 1) enhances scale and scope economies in banking, 2) increases the geographical reach of banks, and 3) makes mergers more attractive.

First, recent evidence points to increasing returns to scale (Wheelock and Wilson, 2009; Feng and Serletis, 2010; Hughes and Mester, 2011) and scope (Elsas, Hackethal, and Holzhäuser, 2010, Dontis-Charitos, Molyneux, and Staikouras, 2011) in banking that may be driven by IT developments. IT-driven scale economies are present in back-office operations and mostly relate to scalability of transaction banking activities. Scale economies derive also from running a sizeable distribution network. For example, internet banking allows banks to reach more distant customers at practically zero marginal cost but at high initial investment. Large banks have both a greater capacity to make a large investment in IT and a larger customer base. DeYoung (2005) shows that internet-only banks, even though less profitable than brick-and-mortar banks, were able to realize substantial economies of scale. IT development may also increase the importance of global branding (Wright, 2002) and trust (Brynjolfsson and Smith, 2000), giving an additional advantage to large banks. Large banks also gain a quality advantage over smaller competitors by having a denser branch network, by engaging in more advertising, and having more employees at the branch level (Dick, 2007). Hanafizadeh and Khedmatgozar (2012) argue that increased customers' awareness of the advantages that internet banking brings mitigates the customers' perception about the potential adverse effects of internet banking. Berger et al. (2007) find that IT-induced technological progress increased the profitability of large, multimarket banks more than small community banks. The effect occurred through both greater revenues and lower costs.

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[5] See FDIC, Historical Statistics on Banking, Table CB01, http://www2.fdic.gov/hsob/HSOBRpt.asp
[6] See ECB, List of Monetary Financial Institutions, Euro area (changing composition), http://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=187.MFI.M.U2.102.T.1

The evidence (not limited to banking) identifies a positive relationship between diversification and IT (Hitt, 1999). IT increases the performance of organizations that follow multi-focused business strategies more than the ones that have a single focus (Tallon, 2007). Interestingly, the positive relation between IT and diversification is strong only for diversification in related activities and for moderate geographic diversification (Ravichandran et al., 2009). The rationale may be the following. The costs of communication and coordination among business units are more pronounced for diversified organizations than for specialized organizations. Therefore the benefits of IT in lowering communication costs are the highest for diversified organizations and when organizations' activities are related. In the unrelated activities, the need for communication and coordination is replaced by financial controls and IT is needed less (Liu and Ravichandran, 2008).

IT developments have lowered information problems within large banks. Lower communication costs facilitate the ability to control branch managers from the parent bank. Through online banking, customers may be approached directly from the parent bank. In addition, IT-enhanced methods for risk management and improvements in credit-scoring and data-mining techniques may (partially) shift the decision-making from a branch manager to the parent bank. Felici and Pagnini (2008) show that IT allowed banks to easily open branches in more distant markets.

Paravisini and Schoar (2012) provide empirical evidence on the effect of IT on agency problems within banks. They show that IT mitigates information asymmetry problems between the agent (loan committee) and the principal (higher level manager). In particular, introduction of credit scores in a bank makes information about bank borrowers available to the higher level manager. This lowers the agency problem of loan committee members (i.e., they can no longer take advantage of their private information) and increases their effort and output on difficult-to-evaluate applications. Berger and DeYoung (2006) find that parent banks control affiliate banks better, contributing to decreased agency costs of distance. They surmise that technological progress has spurred the geographical expansion of the banking industry.

Second, IT has increased the geographic reach of banks. Degryse, Laeven, and Ongena (2009) theoretically and empirically analyze how bank organization and lending technology affect the bank's branch reach. They show that the geographical reach increases and spatial pricing stiffens if rival banks have better lending technology and are more hierarchically organized. They argue that higher hierarchy is associated with a move towards transaction lending techniques that allow for hardened competition.

Petersen and Rajan (2002) show that the physical distance between banks and their borrowers have grown and their communication has become less personal, consistent with the explanation that IT has enhanced the quality of hard, transmittable information. Interestingly, an increase in the distance was the highest for

nonbank lenders and for lenders that did not provide a checking account (potentially indicating more transaction driven lending) and the lowest for banks and for lenders that provided a checking account (potentially indicating more relationship driven lending). DeYoung et al. (2011) empirically confirm that IT developments were responsible for at least half of the increase in the borrower-lender distance. In particular, the increase in the distance has accelerated rapidly after 1993, coinciding with the adoption of small business credit scoring lending techniques. The increase was much more pronounced for loans of large banks that used credit scoring techniques. In brief, distances have increased especially in transaction banking activities but less so in relationship banking activities.

Third, consolidation in banking may rather than by IT-related scale/scope economies be driven by some other forces, for example by the lust for market power. Koetter, Kolari, and Spierdijk (2012) identify increasing market power rents in the U.S. banking. In response to additional market power, banks built up product inefficiencies but not cost inefficiencies. Evidence from bank mergers helps disentangle market power vs. efficiency gains by looking at the impact of a merger on bank customers. Following a merger, bank borrowers obtain lower loan interest rates (Sapienza, 2002; Erel, 2009). The beneficial effect of lower interest rates is larger if efficiency gains in the merger are higher and if the increased market power is modest. Sapienza (2002) identifies a negative effect of a merger on the size of lending to small firms. Recently, however, the negative effect might be mitigated by the newly developed hard lending techniques (Erel, 2009; Berger, Rosen, and Udell, 2007). In the deposit market, Focarelli and Panetta (2003) show that deposit interest rates decline after a merger due to the increased market power but that the merger related efficiency gains dominate in the long run and drive up deposit interest rates. The short-run and long-run movement of deposit interest rate is more pronounced for large deposits than for small deposits indicating higher competition for large deposits. DeLong (2001) analyzes focused versus diversifying bank mergers between 1988 and 1995 in the U.S. She shows that activity- and/or geography-focused mergers have a positive announcement effect on share prices, whereas activity-diversifying mergers have no announcement effect. This points to the value of focus in bank mergers.

The direct evidence that IT induces consolidation in banking is scarce. Tafti (2011) measures the integration adjustments due to mergers (i.e., relocation of corporate branches, restructuring of business processes and organizational hierarchies) within the U.S. commercial banking industry. Whereas IT investments do not directly lead to long-term efficiency and profitability of a merged bank, they reduce the disruptive effects that large integration adjustments can have on merger performance. This indicates that IT investments do not directly lead to higher merger benefits but they smoothen the merger process.

3.2. *Large banks vs. small players: Scale and scope economies vs. relationship banking*

Large banks adopted IT technologies much sooner and to a greater extent than small banks. Large banks gained an advantage in transaction lending technologies that rely on easily quantifiable, hard information, whereas small banks more often employ relationship lending, which uses soft information about local markets and soft person-to-person information about local borrowers. Large banks may rely less on "soft" lending techniques than small banks because transmission of soft (i.e., unquantifiable) information through hierarchical and geographical distances within a bank is difficult (Stein, 2002; Liberti and Mian, 2009).

Parallel with Morrison and Wilhelm's (2008) demise of the investment banking partnership, the increased importance of IT (high initial investment needed and greater codification of employee skills) may make small community banks inefficient and they may lose ground in competition with huge IT-intensive banks. Small banks may need to redefine their models in this light. Small banks may be forced to further deepen relationships with their customers and to increasingly focus on niche markets in a particular market segment, geographic region, part of the supply chain, or specific product.

However, not everything is grim for small(er) banks. Empirical evidence points to the existence of a diversification discount in which diversification in multiple activities destroys firm value (Leaven and Levine, 2007; Schmid and Walter, 2009). Large financial conglomerates may have entrenched themselves and greater focus may be desirable in the future. As Ben Bernanke stated: "The largest banks typically rely heavily on statistical models to assess borrowers' capital, collateral, and capacity to repay, and those approaches can add value, but banks whose headquarters and key decision-makers are hundreds or thousands of miles away inevitably lack the in-depth local knowledge that community banks use to assess character and conditions when making credit decisions. . . . The IBM computer program Watson may play a mean game of Jeopardy, but I would not trust it to judge the creditworthiness of a fledgling local business or to build longstanding personal relationships with customers and borrowers."[7] Despite this opinion, Citigroup has employed Watson to redesign products and services in retail banking operations.

A potential dichotomy between large and small banks exists. Large banks may exploit economies of scale and scope by quantifying the informational content of processes and relying on transaction banking activities. This may come at the cost of weaker relationships with their clients. Small banks, however, may focus on soft-information-based relationship banking and use IT applications to deepen the relationship

[7] Ben S. Bernanke, Community Banking in a Period of Recovery and Change, Speech on 23 March 2011, at the Independent Community Bankers of America National Convention, San Diego, California.

with their clients.[8] Although large banks can get involved in relationship banking through their relatively autonomous branch networks and local loan officers (Agarwal and Hauswald, 2010), the evidence confirms that they rather focus on transaction lending (Berger et al., 2005b). That is, loan officers at large banks produce less soft information than at small banks (Uchida, Udell, and Yamori, 2012).

Presbitero and Zazzaro (2011) provide some evidence that large transaction-oriented banks differently respond to competitive pressure than small, customer-focused players. Large banks have a comparative advantage in scalable transaction banking activities. Under competitive pressure they further focus on transaction banking activities which is detrimental for relationship ties with their customers. In contrast, small, customer-focused banks respond to increased competition by further deepening their relationship focus. Increased competition, intensified by IT developments (see e.g. Degryse, Laeven, and Ongena, 2009), may therefore push large banks further to transaction banking and small banks further to relationship banking.

Rather than by growing, small banks can tap scale/scope economies by outsourcing their non-core, transaction banking activities. IT-enhanced interfaces may facilitate cooperation between banks and outsourcing, and even lead to partial decomposition of the value chain in the case of back-office business processes such as check clearing and payment processing, risk management and measurement systems, and IT systems. IT reduces the cost of communication with outside partners. Building on the insights from Brews and Tucci (2004) on internetworking, small banks can increase their focus and specialization, lower inter-firm hierarchy, and increase external partnering. Tas and Sunder (2004) positively assess offshore outsourcing of business processes in banking (e.g., overseas call centers for customer support) only if supporting tools and application software (e.g., virtual team rooms and active project plans) are of sufficiently high quality.

The question then is whether large banks that focus on hard information and primarily on transaction banking activities would coexist with small banks that obtain comparative advantage in soft information acquisition through relationship banking activities. Park and Pennacchi (2008) provide a theoretical framework to analyze competition between large multimarket banks and small banks. In their model, large multimarket banks employ uniform pricing across their markets and can tap on wholesale funding markets whereas small banks primarily fund from local deposits but can adopt their interest rates to the local market. Competition from the large multimarket bank can have disparate consequences for bank

[8] In relationship banking, economies of scale and scope may be more difficult to find. Analyzing mainly retail-oriented Spanish commercial and savings banks, Martín-Oliver and Salas-Fumás (2008) cannot reject the hypothesis that services from IT capital (and labor) exhibit constant returns to scale at the bank level.

customers of different types: competition for small business lending increases but competition for deposits reduces if the conditions on the wholesale funding market are more attractive than local deposit rates. Berger, Rosen, and Udell (2007) confirm that the presence of a large bank in a local banking market is associated with lower rates on small business loans indicating higher competition for small business loans. The conclusion may then be that it is crucial for small banks to adapt fast and search for their opportunities in the local niche markets.

The division between the transaction lending techniques (based on hard information and most suitable for large banks) and relationship lending techniques (based on soft information and appropriate mostly for small banks) might be too simple (Berger and Black, 2011). Each lending technique may contain a relationship and transaction component. Large banks may gain size-related comparative advantage whereas small banks may better evaluate the relationship component. Large and small banks need to evaluate this trade-off when choosing their core activities. For example, Berger and Black (2011) show that the comparative advantage of large banks is more pronounced in leasing than in other fixed-asset lending technologies. Small banks hold a comparative advantage in soft relationship lending.

Altogether, IT pushes banks either to exploit scale and scope economies (particularly in transaction banking) or to focus on relationship banking. Although it is difficult to foresee the structure of the industry, one could predict a bimodal structure in which large universal banks driven by economies of scale and scope would coexist and compete with small customer-focused players.

4. Risks in transaction banking and (in)stability

In transaction banking risk processing is centralized and the main risks are systemic. The whole asset class is often exposed to similar risks. IT has an impact on risk in transaction banking in three ways. First, it increases flexibility in banking but also enables a huge expansion of transaction banking activities making them a concern for the stability of the financial system. Second, it increases the marketability of assets, which means that many assets commove with the markets. Finally, it allows financial assets and financial institutions to become more complex and hence difficult to supervise.

4.1. *Flexibility and high growth*

Digitized business processes become more easily modified. This drives flexibility in transaction lending techniques, risk management, information transmission, and even distribution. Bank managers argue that multichannel access to products and services and outsourcing of IT personnel, IT systems, and IT processes (as well as continuously evolving regulation) contribute to more agile banks (van Oosterhout, Waarts, and van Hillegersberg, 2006). The mere adoption of IT creates a huge change in organizations and

business processes. Corporate IT systems equip organizations with additional flexibility and agility to transform business processes and products as a response to unexpected changes in the corporate environment (Sambamurthy, Bharadwaj, and Grover, 2003).[9] Several corporate IT systems (e.g., ERP and SOA) include templates for the business process design called best practices (Scheer and Habermann, 2000). Consequently, an organization can swiftly modify its current business practices together with implementation of a corporate IT system.[10] Enhanced communication, teamwork, and cooperation within the organization and across the organization's borders provide a fruitful framework for constant modifications in business products and processes. Because business processes are digitized, innovations in business processes and products can easily be replicated across the entire organization (McAfee and Brynjolfsson, 2008).[11]

In IT-intensive industries competition has heated up and has become more of a "win all or lose everything" situation (McAfee and Brynjolfsson, 2008). IT development has increased turnover of small organizations and concentration of the industry in large organizations. Saunders (2009) attributes this result to the observation that large organizations use business process replication to gain economies of scale, whereas small organizations operate in niche markets. Hitt, Keats, and DeMarie (1998) argue that strategic flexibility is valuable in order to survive in an increasingly competitive business environment. Organizations may not have much choice but to be prepared to enter and exit new markets immediately when opportunities and threats crystallize. Evidence from the mortgage industry is aligned with the view that IT makes banking a fast-evolving win-or-lose industry with increased risk. Livshits, MacGee, and Tertilt (2010) show that consumer bankruptcy increased in the U.S. due to two IT-related effects: lower transaction costs of lending and lower costs of bankruptcy.

The issue of risk and stability is of paramount concern in banking due to the negative externalities of a bank failure. The broad economic importance of bank stability justifies the existence of extensive implicit and explicit guarantees in banking (e.g., deposit insurance and government guarantees). This gives rise to a moral hazard problem. Banks undertake excessive risk to obtain high profits knowing that the potential losses will be absorbed by the deposit insurer or the government. Banks may use IT applications to take on excessive risk at short notice as the following examples of Landsbanki and Northern Rock show.

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[9] For example, service-oriented architecture (SOA) allows for service-based software components that are attached to independent functional units (Baskerville et al., 2010). These functional units may be located inside or even across corporate borders and may also provide a basis for designing flexible IT structures in traditionally rigid industries such as banking (Homann, Rill, and Wimmer, 2004).

[10] The fit between business processes and IT is important (Trkman, 2010).

[11] However, IT systems already implemented may also act as inhibitors of change. Legacy IT systems usually use closed-form architectures, which are inflexible and force the bank to rely on a single IT vendor. This may impede the introduction of new financial products or removal of redundant work processes (Mazursky, 1989).

A highly competitive environment allows banks to pursue fast but risky expansion strategies in scalable transaction banking activities. The Icelandic bank Landsbanki grew extraordinarily in the UK and the Netherlands by offering Icesave online savings accounts with high interest rates. In five months it gathered €1.7 billion in approximately 130,000 accounts in the Netherlands (de Moor, du Perron, and Krop, 2009, pp. 54, 56). Its collapse created a diplomatic dispute between Iceland and the Netherlands and the UK. Similarly, Northern Rock expanded aggressively and grew more than six-fold in terms of total assets in the ten-year period before its collapse.[12] One of the drivers behind Northern Rock's expansion was increased marketability. The reliance on quantifiable information allowed the distribution of mortgages through an online mortgage approval system and their subsequent securitization. Rather than relying on branches, Northern Rock employed an IT-based originate-and-distribute model. Nationwide distribution was enabled by the network of intermediaries (e.g., large organizations of introducers and groups of smaller intermediaries) that relied on an online mortgage approval system. In 2006, 89% of all mortgage lending was performed through intermediaries and 90% of all intermediary business was conducted online.[13] To finance this extraordinary growth, Northern Rock substantially increased its leverage, which made it sensitive to wholesale securitization markets and may have been one of the main culprits in its demise (Shin, 2009).

The combination of the increasingly non-relationship nature of bank lending coupled with non-relationship market-based deposits may increase bank fragility (Song and Thakor, 2007). Arnold and van Ewijk (2011) confirm that pure-play internet banks feature low costs and easy scalability, which enables fast growth but may generate overexposure in risky markets.[14]

Stiroh and Rumble (2006) document that a shift towards the transaction banking activities (i.e., fee generating, trading and non-interest activities) results in exposure towards volatile non-internet activities, inducing a lower risk-adjusted profits. Crespi, Vallascas, and Hagendorff (2011) find that Italian banks which focused on lending and deposit taking activities outperformed during the 2007-2009 financial crisis. The performance of well-diversified banks was the most compromised during the financial crisis. Acharya, Hasan, and Saunders (2006) show that an expansion of a bank into new industries may hamper bank monitoring and result in an increased risk of its loan portfolio. The negative effect of diversification occurs especially for high-risk banks, where additional stability is needed the most.

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[12] See Northern Rock Annual Report 1998, p. 31, and Northern Rock Annual Report 2006, p. 59.
[13] Northern Rock Annual Report 2006, p. 34.
[14] Afuah and Tucci (2003) argue that the internet may hasten Schumpeterian creative destruction in mediating technology industries (e.g., commercial banking), where the primary purpose of firms is to link interdependent clients. Creative destruction in banking may lead to the reduction of transaction and production costs but may have repercussions for stability.

In short, the costs of bank failures give rise to implicit and explicit guarantees in banking. Banks may abuse IT-enhanced flexibility and quickly expand their transaction banking activities, creating a concern for systemic stability.

4.2. *Marketability, opportunistic behavior, and herding*

Excessive reliance on quantitative data may lead to "footloose corporations" through greater marketability (Boot and Marinč, 2012). In particular, reliance on quantitative information made bank assets easily tradable. Banks did not keep loans on their balance sheets, but followed an "originate-to-distribute" model: they first bundled loans (e.g., mortgages) together and then sliced them according to the desired risk profile of investors on the capital markets. For example, IT developments and reliance on quantitative information spurred securitization of consumer loans (e.g., credit card, auto, and mortgage loans) and large business commercial papers.

The evidence from the 2007–2009 financial crisis confirms the negative impact of marketability on stability (Mian and Sufi, 2009; Keys et al., 2010). For example, mortgage lenders could easily collect loan applications through the internet, grant loans using credit-scoring techniques, and sell them off on capital markets. What happened subsequently was more problematic. The risk of mortgage-backed products was hidden in the misaligned incentives of mortgage originators. Because mortgage lenders did not cover the entire loss of default, they were eager to collect higher origination fees at the expense of deteriorating lending standards. Banks that securitized a large part of their portfolios faced an increased moral hazard problem, which resulted in lax screening standards and lazy monitoring (Gorton and Pennacchi, 1988; Berndt and Gupta, 2009).

Increased marketability may also result in lost relationships, strengthened competition, and higher risk taking. In particular, the dissemination of information through consumer credit bureaus together with better (and standardized) information processing led to greater marketability of consumer loans and to lower information capture. Banks lost their competitive advantage that previously built on proprietary information collected in the process of monitoring and screening their borrowers. Banks were exposed to fierce competition from rival banks and financial markets. Lower expected future profits may go hand in hand with increased risk-taking (Keeley, 1990; Martinez-Miera and Repullo, 2010). A bank without a strong franchise value fears its own demise little and may undertake risky activities. Consequently, IT advances that derail the competitive advantage of banks (vis-à-vis competing banks and financial markets) may result in repercussions for stability. Boot (2011) argues that banks were lured into transaction banking, which reinforced the financial breakdown.

IT-driven marketability also puts banks under pressure from financial markets, which may force bank(er)s to herd. Herding may be driven by information spillovers (Acharya and Yorulmazer, 2008) or by reputational concerns (Scharfstein and Stein, 1990). Following the hypes and fads that marketability spurs makes banks dependent on investor sentiment. This may increase volatility and reduce bank stability (Shleifer and Vishny, 2010). Herding is particularly worrisome in banking because it increases correlations between risk exposures of banks and elevates systemic risk. For example, Gerding (2009) attributed major responsibility for the recent financial crisis to the sophisticated risk-management strategies widely employed by financial institutions (see also Haldane, 2009). Banks herded in development of the default risk models that relied substantially on historical data about loan delinquencies. However, they failed to consider the weakened incentives of mortgage originators to screen their loan applicants and therefore underestimated default probabilities (Rajan, Seru, and Vig, 2010).

IT also allows herding, if it occurs, to take place more rapidly. For example, automatic decision-making together with sharing information through information registries or extracting machine-readable data from the Web may have hastened herding because banks would make decisions based on the same information. An example is algorithmic trading. Chaboud et al. (2009) show that algorithmic trades are more correlated than low-frequency ones, which may indicate lower diversity of algorithmic trading strategies. Accordingly, high-frequency trading (HFT) may potentially increase herding**.** The events in the "flash crash" confirm the problematic nature of automated IT systems. On 6 May 2010, the U.S. equity and futures markets fell by more than 5% and then quickly recovered. Several stocks were traded at 1 cent per share, and several others for $100,000 per share, an event attributed to the combination of the large order from automatic execution program and algorithmic trading systems (CFTC and SEC, 2010). Beck (2010) argues that during the peak of the 2007–2009 financial crisis banks were simply forced to disconnect their trading computers. The environment changed so much that relying on historical data was useless. In addition, the additional complexity was huge and computer models needed to be substantially reconfigured, which required time (see also Smith, 2010).[15]

IT developments may also facilitate herding of depositors. Iyer and Puri (2012) show that panic may spread through social networks. In particular, a depositor more likely withdraws funds if other depositors from his social network withdraw funds as well.

[15] The systemic risk may also stem from market infrastructure overload if trading systems or clearing and settlement systems are exposed to high-volume and high-speed HFT strategies (Barker and Pomeranets, 2011).

The above examples have indicated that IT-driven marketability in a highly competitive environment allows banks to change their strategies fast. This puts pressure on prudent behavior of banks and may result in herding.

4.3. *Complexity and systemic risk*

IT-driven changes in an individual bank and in the industry structure may reinforce each other and culminate in increased systemic risk. Systemic risk in banking is driven first by excessive complexity and second by being too-big-to-fail/too-interconnected-to-fail.

First, banks may use IT in calibrating complex risk-measurement and risk-management models and designing complex products.[16] The complexity of loan agreements, which IT support enables, may, in addition to serving various needs and preferences of customers, also trick customers into signing a loan contract without knowing its detailed structure. For example, lending in mortgage markets was based on complex attributes of mortgages such as adjustable interest rates, postponed mortgage principle payment, and substantial prepayment fees, and did not require full documentation of ownership of assets and income (Mayer, Pence, and Sherlund, 2009). Borrowers had a difficult time understanding the mechanics of complex mortgage terms (e.g., for adjustable-rate mortgages, see Bucks and Pence, 2008; Campbell, 2006) or were even under attack by predatory lenders (Engel and McCoy, 2002).

Several market participants were tricked by complex mortgage products and other structured financial products generated through the "originate-to-distribute" model. These include credit-rating agencies, large insurance companies (monoliners), and regulators. Large investment banks were able to reverse-engineer the models that credit-rating agencies used to rate collateralized debt obligations. For example, Standard & Poor's provided a CDO Evaluator Manual on its website (Benmelech and Dlugosz, 2009) and investment banks could use it to obtain the highest possible rating at minimum costs. Usually this also meant the highest inherent risk at the given rating. This shows that decision-making based on quantifiable information can easily be gamed if the cost of manipulating the numbers is low (Petersen, 2004). Banks may take excessive risks and hide them from borrowers, credit-rating agencies, regulators, and other financial market participants.

Second, the changed industry structure in combination with higher marketability may be a source of further systemic risk. Systemic concerns may force the regulator to bail out banks that are too large, too complex, and too interconnected (Brown and Dinç, 2011; Mailath and Mester, 1994). Worrisomely, banks

[16] A caveat should be made. IT is not the only driver for creating and disseminating complex products. Others may include quantitative models and the institutional framework.

anticipate bailout and may intentionally become too-big-to-fail or too-complex-to-fail to ride on bailout guarantees and use IT developments for this purpose.[17] Brewer and Jagtiani (2009) provide empirical evidence that a bank overpays for a merger deal that puts it above the too-big-to-fail threshold. If IT increases economies of scale and scope, growing too-big-to-fail has become even more attractive.

IT-facilitated outsourcing may create systemic risk concerns. For example, banks increasingly rely on the credit assessment of credit-rating agencies. Credit-rating agencies drastically underestimated the default probabilities before the 2007–2009 financial crisis.[18] In this sense, outsourcing credit assessment to credit-rating agencies may have triggered systemic exposure of the entire banking system to the default risk models of a few major credit-rating agencies. This increased the interconnectedness of the banking industry. Decomposition of the value chain may also lead to additional interconnectedness across banking, insurance and mutual fund industries, credit-rating agencies, and IT providers. Such interconnectedness may lead to unexpected spillovers of risks and contagion (Allen and Carletti, 2006). The 2007–2009 financial crisis clearly demonstrated the dangers of such interconnectedness.

Outsourcing of IT security also increases the interconnection between banks. If a large credit card database is stolen then all banks (and customers' trust in their security) may suffer at the same time.[19] In addition, if banks are connected through common IT architecture, the security of the network may depend on the weakest link, the strongest link, or the average link (Anderson and Moore, 2006), depending on how the investment in security systems is organized. Banks may invest in security on their own, the best bank may provide security, or banks may together work on security. More research is needed to evaluate how incentives of banks impact security of the network and what is the role of the regulator.[20]

Especially in transaction banking activities, the process of measurement and management of risks is centralized and prone to systematic error. Rajan, Seru, and Vig (2010) argue that the error of quantitative decision-making based on historical values is the highest when soft information about borrowers is more

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[17] Another reason why banks may want to become big is to exploit market power related benefits (e.g., network effect of payment technologies; Scholnick, et al. 2008).

[18] In November 2007, S&P recalibrated its online LEVELS@default model in such a way that default probabilities of non-documentation loans with low FICO scores increased by 60% (Standard & Poor's, 2007).

[19] Although there has been limited evidence of a systemic IT-induced failure, the increasing use of IT in banking may elevate the probability of such event. Nonetheless, there have been several individual failures: JP Morgan Chase's online banking was down from 13 to 15 September 2010 (http://www.nytimes.com/2010/09/16/business/16chase.html?scp=1&sq=chase%20outage&st=cse).

[20] Fraud detection is increasingly important in online payments as more and more transactions are performed online. For example, PayPal was in the first year of its operations under continuous attack of fraudsters. Building on the literature on internet auction fraud (see Gavish and Tucci, 2006, 2008) banks could reduce the level of fraud by increasing information sharing and by using well designed insurance policies. The need for further regulatory scrutinity exists.

important than hard quantifiable information. Furthermore, such an error is systematic in nature and cannot be simply corrected by including more detailed historical values. If historic data do not reflect the future, such predictions can be systematically wrong. Accounting for human incentives in the algorithmic analysis may then be crucial. Incorporating soft information obtained through deep customer relationships into decision-making may mitigate systemic risk.

In brief, IT developments in transaction banking may increase marketability and change the industry structure towards large financial conglomerates and towards greater interconnectedness. As a result, opportunistic behavior became more attractive with a threat for systemic risk.

5. Back to the roots?

We argue that relationship banking activities are more desirable from the perspective of financial stability. We discuss regulatory and legal measures that would support banks in relationship banking activities.

5.1. *Risks in relationship banking*

The key difference between relationship banking and transaction banking is that risks in relationship banking need to be monitored at the local level. In relationship banking activities banks take risks with a substantial client specific component. The banks' estimation of the risk of each client based on soft information acquired through the relationship is crucial. IT can help banks keep better track of the relationships and thereby improve the monitoring of risks.

Banks are learning how to use IT applications to strengthen relationships with customers. Banks can constantly improve products and services, increase their variety, and adjust them to customer needs. For example, cross-selling is important for strengthening relationships between a bank and its borrowers (de la Torre et al., 2010). Banks can exploit information on credit line usage, limit violations, and checking account activity together with soft information about bank client to better predict borrowers' default probabilities (see Norden and Weber, 2010; Agarwal and Hauswald, 2010). Banks can design retention strategies through churn analysis. Berger, Frame, and Miller (2005) show that the adoption of small business credit scoring results in higher loan risks for banks that adhere to rules but in lower loan risks for banks that adhere to discretion. IT developments can therefore be used to employ various bank services and customize them to the needs of an individual customer and at the same time lower the risk of a bank.

Instructive research was performed by Koetter and Noth (2009, 2012) on German savings banks. Koetter and Noth (2009) show that banks that use IT more intensively are more stable and operate in regions with

fewer corporate insolvencies.[21] Koetter and Noth (2012) further refine these findings. They confirm that banks can employ IT to improve screening and monitoring and thereby escape price competition. In particular, IT use positively contributes to total factor productivity and IT-augmented total factor productivity positively affects bank markups.

Goetz (2011) shows that competition from large banks forces small banks to further rely on soft information and to engage in monitoring, which decreases their risk-taking. That is, small banks escape price competition by focusing further on relationship banking in line with Boot and Thakor (2000). In contrast, large banks expand by relying on hard information but monitor less, which makes them less safe and sound. Brunnermeier, Dong and Palia (2012) show that traditional, relationship banking activities (deposit taking and lending) contribute to systemic risk less than non-traditional, transaction banking activities (investment banking, venture capital, and trading activities). Also, smaller and less highly leveraged banks contribute less to systemic risk.

IT may also affect the stability of deposits. Relationship-oriented core deposits collected at a bank branch seem to be more stable than market-based (e.g. internet or money market) deposits. Iyer and Puri (2012) provide evidence that depositors with longer relationships with the bank are less likely to withdraw funds in a bank run. Shin (2009) shows that in the demise of Northern Rock transaction-based internet, telephone, offshore, and postal accounts were depleted to a greater extent than the core branch deposits.

Cross-selling may also increase the stability of a depositor base. Iyer and Puri (2012) find that depositors that also have loans at the same bank were less likely to run. Cross-selling therefore acts as partial insurance against a bank run. In addition, banks should access their customers through multiple access channels and at different points in time. Xue, Hitt, and Chen (2011) show that customers that adopt online banking are less inclined to switch banks and perform more transactions. Such a relationship is stronger if the branch network is dense. Banks should use internet banking complementary to a strong branch network to promote cross-selling of customized products and services.

The relationship commitment in online banking supports a bank's ability to retain its customers (Vatanasombut et al. 2008). Narayanasamy, Rasiah, and Tan (2011) find that the growth in the on-line

[21] Melville, Gurbaxani, and Kraemer (2007) provide evidence that IT investment is relatively more valuable in competitive and dynamic industries. Analyzing the Greek banking sector, Angelakopoulos and Mihiotis (2011) show that banks start providing e-banking services to their customers with the intention to safeguard their competitive position, to reap the benefits of low cost of e-banking transactions, and to follow technological developments. If the technological shock is expected to push customers to use Internet services, the first mover advantage is important for two reasons. First, early adopters gather new customers. Second, the competition in the traditional markets intensifies (Li, Gupta, and Koch, 2006).

delivery of financial services is associated (among other factors such as revenue and cost dimensions, security, technological architecture) with the need to adopt global technology to local requirements. Such a need is particularly strong for online delivery of financial services to small and medium enterprises.

Another example is payment technology. Hasan, Schmiedel, and Song (2012) argue that banks establish a close, long-term relationship with their customers through effective payment technology. They show that greater and more diverse use of various retail payment technologies is associated with higher bank profitability. In addition, they find that banks in banking systems with more developed payment technologies are more profitable and stable.

Relationship banking is also beneficial for other reasons than financial stability. Relationship banking promotes innovation in bank borrowers. Herrera and Minetti (2007) find that longer credit relationships facilitates innovation in manufacturing firms by providing funding needed for the introduction and acquisition of new technologies. Ergungor (2010) shows that banks specialized in relationship banking provide mortgages to low-income borrowers with insufficiently long credit histories. Relationship banking therefore promotes local financial development, which spurs growth in real economy (Guiso, Sapienza, and Zingales, 2004).[22] Hasan, De Renzis, and Schmiedel (2012) show that initiatives for harmonization and integration of retail payments positively affect real economy. The migration to electronic retail payments (especially to card payments) and retail payment transaction technology itself (the number of ATM and POS terminals) positively affect GDP and trade.[23]

5.2. *Setting up the legal and institutional framework*

Relationship banking activities seem to be more desirable from the public policy perspective than transaction banking activities. The legal and institutional framework needs to spur relationship banking.

The legal and regulatory environment should promote prudent risk-taking, innovation (e.g., through improved enforcement of property rights), and contracting with high-quality employees, which has become increasingly important in the more marketable world of today. Strengthening institutional and regulatory environment encourages the IT-driven shift towards more developed financial system and

[22] This may be in line with Hasan, Koetter, and Wedow (2009) who show that especially bank profit-efficiency (and only modestly also cost efficiency) spurs regional economic growth. A bank's ability to manage costs may therefore be less important for regional growth than its ability to generate profits. If transaction banking activities result in cost reduction but not in increased profit efficiency, their ability to generate regional economic growth may be hampered.
[23] In developing countries mobile money services may increase money transfers and promote banking (Aker and Mbiti, 2010).

higher growth (Levine, 2005). However, if institutional and regulatory environment is weak, IT-driven marketability may lead to financial system instabilities that may damage the real economy.

Relationship lending to small and opaque firms can be increased through strengthening legal and judicial environment. The quality of the institutional and legal environment together with the level of financial development determine how effective IT investment in intangible assets is. Ilyina and Samaniego (2011) analyze the technological characteristics of industries that are the main beneficiaries of financial development. They show that R&D-intense industries are better able to raise external funds and to grow faster in countries with well-functioning financial markets and with high-quality governmental and legal institutions. The enforcement of property rights over intangibles seems to facilitate external funding for R&D-intensive industries. This may translate to the increased level of patenting, contributing to more pronounced economic growth (Hasan and Tucci, 2010).

Reducing corruption and legal and financial problems improves the growth of small firms more than larger firms (Beck, Demirgüç-Kunt, Maksimovic, 2005). The biggest obstacles to small firms growth are found to be bank paperwork and bank related bureaucracies, corruption of bank officials, the amount of bribes paid, and time spent with regulators. IT developments may reduce these obstacles. IT-enhanced flow of information reduces paperwork and increases the control over bank officials. Electronic communication establishes strong relational ties and facilitates the transfer of tacit forms of knowledge needed for product development (Ganesan, Malter, and Rindfleisch, 2005). IT developments such as information sharing through credit bureaus can further help mitigate deficiencies in the legal environment in developing countries (Brown, Jappelli, and Pagano, 2009).

Prudential regulation in banking should further encourage relationship banking and reverse a structural shift towards transaction banking and high systemic risk. Government support to large transaction-oriented banks through implicit bail-out guarantees should be correctly priced. Regulators should focus on the stability of the entire banking system instead of the stability of an individual institution. The enhanced macro-prudential focus in recent regulatory initiatives (e.g., higher capital requirements for systemically important banks) is in line with this.[24] Elevating capital requirements across the board as suggested by the recent Basel III initiative may streamline banks toward prudent risk-taking. Regulators should monitor corporate governance mechanisms including the relationship between risk-taking and pay for performance for core bank employees and, by doing this, promote relationship banking.

[24] Adrian and Brunnermeier (2011) propose macroprudential regulation based on the CoVaR measure of bank interconnectedness. Banks might also use dynamic loan loss provisioning (i.e., by acknowledging losses already incurred *and* anticipated in bank loan portfolios; see the developments under Basel III).

Certain overly risky activities might be separated from banks (see the Volcker rule in the Dodd-Frank Act, which prohibits proprietary trading by banks for their own account). Boot and Ratnovski (2012) argue that scalable transaction-based activities such as trading need to be separated from long-term oriented relationship banking activities. Without at least a partial separation, banks would have incentives to shift their operations to scalable transaction banking putting the relationship activities at risk.

IT may also help regulators. Information-sharing IT architectures could be designed to limit the potentially contagious information-sharing among banks and to exploit the benefits of disclosure. Dang, Gorton, and Holmström (2012) argue that in liquidity provision (i.e., when trading is the primary purpose of a class of securities, e.g., treasuries, repo, asset backed commercial papers, money market funds) it is welfare optimal to have as little information production as possible. The absence of information production facilitates trade but can trigger a systemic crisis if a negative shock to the underlying collateral creates incentives to produce private information. In this setting, more transparency (through for example information sharing) may not be beneficial if transmitted information is imprecise. Hence, information-sharing IT architecture in money markets should be designed to transmit only verifiable and precise information. In contrast, information sharing in activities where private information production is desired (e.g., small business lending) may be beneficial even though the shared information is imprecise.

A discrepancy seems to exist between banks and their regulators. Whereas banks have fully embraced IT developments, regulators may have been lagging behind. IT-supported information-sharing among multiple regulators can further enhance their coordination and cooperation. Closer surveillance of automatic decision-making systems in banking may be needed. Stress-test models should analyze the impact of the individual bank failure in the closely interconnected banking system. Demyanyk and Hasan (2010) review econometrics and operations research methods to predict financial crises. They find that pure statistical techniques perform worse than hybrid intelligence systems that combine statistical techniques with intelligence techniques (e.g., neural networks). The wealth of financial data that the regulators could access should in principle help them design better regulation.

But whether the regulators are able to process information timely to limit systemic risk, may be questionable. For example, the combination of complex financial conglomerates and off-balance-sheet financing through SPVs, and ABCP conduits obscured the risks from the regulator. Acharya and Schnabl (2009) saw regulatory arbitrage as one of the culprits of the 2007–2009 financial crisis. The bounded rationality of the regulators coupled with information asymmetry problems may prevent timely supervision of banks in a highly complex environment (Arora et al., 2011).

6. Conclusions

IT spurs fundamental changes in the structure of individual banks and the banking industry. Banks need to decide where to go. On one hand, they can use IT primarily to reap the benefits of scale and scope (e.g., by scaling standardized bank operations) and exploit marketability driven by financial innovations. Enhanced marketability coupled with scale and scope economies spurs transaction-oriented banking activities potentially at the expense of relationship banking. This creates a lack of commitment and facilitates opportunistic behavior with repercussions for stability.

On the other hand, IT can also be used to cross-sell customized products and innovative services and to redesign business processes towards strengthening relationships with customers. In such a case, IT leads to strengthened, albeit different (i.e., more IT-driven) relationships between a bank and its customers. Stability in banking may then actually increase.

The future structure of the banking industry is blurred. On one hand, large universal banks would focus on IT driven scale and scope economies in transaction banking activities. On the other hand, small, customer-focused banks should use IT developments to further cultivate relationship ties with their customers. The danger is that structural changes reinforced by IT developments in transaction banking, such as growing too-big-to-fail or too-interconnected-to-fail, may aggravate stability in banking. Marketability and structural changes towards higher complexity may increase systemic risk. Relationship banking activities seem to be more desirable from the perspective of financial stability and long-term economic growth.

The regulatory and legal measures should entice banks further towards relationship banking. At the end, the quality of a legal and regulatory environment may define whether the road towards strong relationships (and higher stability) or the road towards transaction banking and pronounced marketability (and more opportunistic behavior) will dominate.

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