Good and bad risk: regulation and loan monitoring

Norvald Instefjord
Reader in Finance, Essex Business School, University of Essex
Hiroyuki Nakata
Senior Lecturer in Finance, School of Management, University of Leicester

Abstract
Separating good and bad borrowers is a key role of banks. To do this, banks need monitoring systems and they need to monitor risky loans. We show that the investment in monitoring systems encourages risk taking, which leads to higher regulatory costs for the bank. This effect is so strong that it not only discourages investment in monitoring systems, but also banks can profitably dismantle their existing systems, because the savings in terms of regulatory compliance costs are greater than what they lose to less efficient loan monitoring. A bank regulator who controls bank risk in an indiscriminate way, therefore, can distort the loan-monitoring activity of banks, which can be harmful to the cost of loans. A more sophisticated approach, where the regulator discriminates between the good risk that arises from loan-monitoring activity and the bad risk that arises in other contexts, can mitigate this effect.

1. Introduction

Monitoring and screening of loans are central functions of banks, which can generate social values. Diamond,[1] for instance, provides a theoretical model of the role of banks as monitors, which is instrumental in minimising the cost of producing the information that is necessary to facilitate efficient lending and borrowing. Bernanke[2] argues that the monitoring function of banks was affected by the 1930s financial crisis and led to inefficiencies in bank lending in the US, which contributed to the 1930s US depression. Thus, it appears that efficient monitoring of borrowers to ensure credit quality is important for a well-functioning financial system, and consequently for a well-functioning real economy.

However, the effects of regulations on banks' incentives for investment in monitoring systems are not straightforward. One aspect that complicates the issue is that loan sales have become substitutes for monitoring activity, as argued, for instance, by Parlour and Plantin.[3] Some are critical of increasing the regulatory burden for banks, particularly during a crisis. For example, the former CEO of Deutsche Bank Josef Ackerman has argued that more stringent capital requirements put upon banks "would restrict [banks'] ability to provide loans to the rest of the economy. This reduces growth and has negative effects for all".[4] In addition, Dermine[5] argues that monitoring activity is adversely affected by heavy-handed regulation. In contrast, Admati and Hellwig[6] argue strongly against lifting the regulatory requirements on banks. That regulation reduces the incentive to take risk (through lending), and therefore, also indirectly, the incentive to monitor loans is, however, relatively uncontroversial. As such, the debate is primarily about whether the risk of lending and the monitoring of loans are affected by regulation in a socially harmful way.

This paper studies the issue by focusing on the link between risk and monitoring. If we take an intuitive starting point, the link appears simple. As long as the banks benefit from the separation of good and bad borrowers, one would think that the monitoring systems have private value to the banks' shareholders because the banks can make more informed decisions about whether to keep the loan or sell the loan. And while the banks use these systems to avoid bad lending – which is not implausible given the fact that regulation typically penalizes credit risk – they have social value to the banks' regulators. Loan monitoring is, therefore, an apparent win-win for the shareholders and society. We argue that this view is too simplistic because it applies to the screening activity of loans ex ante prior to the lending decision being made, but not to the monitoring of loans that have been granted ex-post.

Once we study monitoring of loans that have already been made, the above simplistic logic breaks down. The bulk of this paper elaborates on this point in particular, by focusing on the dynamic nature of monitoring. People would like the bank to monitor loans that are risky. The investment in monitoring technology gives banks the incentive to hold a higher quantity of risky loans under monitoring, which increases the loan risk of banks. This risk leads to higher regulatory compliance costs for the bank, with the regulator needing to impose extra costs to create a disincentive for loan monitoring. The risk associated with the increase in monitoring activity has, however, social value as it facilitates and lowers the cost of loans to risky borrowers, such as young and small enterprises, which may yield higher expected returns. There is, therefore, a regulatory trade-off to be considered.

The empirical findings regarding the effects of bank regulation are mixed. By analyzing the bank performance across different countries during the financial crisis of 2007-08, Beltratti and Stultz[7] show that strong regulation is likely to reduce risk but active regulatory intervention to respond to market changes is likely to reduce performance. There is, therefore, some evidence that regulatory intervention can harm shareholder value. Baker and Wurgler[8] show that increasing the stringency of bank regulation could increase significantly the cost of lending.[9] Barth et al.[10] find that regulation that puts restrictions on bank activity has a negative impact, both in terms of bank performance and stability. They do, however, find that more stringent capital

1 Diamond (1984)
2 Bernanke (1983)
3 Parlour and Plantin (2008)
4 Admati and Hellwig (2013)
5 Dermine (2013)
6 Admati and Hellwig (2013)
7 Beltratti and Stultz (2009)
8 Baker and Wurgler (2013)
9 Their findings should however be viewed in the light of similar findings for the stock market as a whole, which suggest a general "low-risk anomaly." Baker et al. (2011) and Baker et al. (2013)
10 Barth et al. (2004)

requirements are associated negatively with nonperforming loans, which suggests that banks with more strict capital requirements cut back on risky lending. Cebenoyan and Strahan[11] find that banks that adopt a more active risk management policy (buy and sell loans more actively) also hold more risky loans, have lower risk, and higher profits than other banks. This study does not, however, give information about whether these banks are subject to less stringent capital requirements, although more active risk management is associated with lower bank capital. Laeven and Levine[12] find that the relationship between capital requirements/bank restrictions and risk-taking is positive when the bank has a strong equity holder, and negative without such a strong equity holder. Furthermore, Klomp and de Haan[13] find that bank regulation has an impact on the risk of high-risk banks, but that this effect is not uniform across the various levels of risk. Therefore, empirically it is very hard to talk about the effect of regulation on bank risk.

Our paper is a version of a more technical paper,[14] to which the reader should turn for technical details and proofs, as the exposition here emphasizes intuition rather than rigor. We proceed as follows: in section 2, we outline the basic framework. The main results are reported in section 3. We discuss the regulatory implications in section 4. Section 5 concludes the paper.

2. Framework

2.1 Ex-post monitoring decision rules

In this section, we describe a framework for ex-post monitoring of loans that have already been granted. The framework is stripped down into its most simplistic form. We assume, therefore, that all loans are perpetual loans whose value depends on the coupon flow of the loan and the losses related to the credit risk of the loan. The coupon flow is c and we assume a constant risk-free rate r and a risk-neutral probability measure, which implies that all asset values are simply expected discounted cash flows. If a loan is of high credit quality, we assume it is risk-free and carries no credit risk. The value is consequently the discounted coupon flow:

$$V(c|\text{good})=\int_0^\infty e^{-rt}c\,dt=\frac{c}{r}$$

If the loan carries credit risk, there are shortfalls in the cash flow of the loan. If the loan is of low credit quality, these losses equal the expected present value k, and the value of the loan is:

$$V(c|\text{bad})=\frac{c}{r}-k$$

Loans are generally perceived as good with some probability π and bad with probability $1-\pi$, so the market value of a loan of quality π is:

$$V(c|\pi)=\frac{c}{r}-(1-\pi)k$$

The expected loss due to credit risk, k, cannot be greater than the risk-free value of the loan, $k\leq\frac{c}{r}$, since the worst-case scenario is that the lender receives no payments from the borrower. The bank, however, is regulated and has a lower ability to bear credit risk, which is represented by $k+K$ with $K>0$, where K is set by the regulator. Thus, if the bank seeks to place a loan of quality π in-house, the value of the loan is:

$$VI(c|\pi)=V(c|\pi)-K(1-\pi)=\frac{c}{r}-(k+K)(1-\pi).$$

The decision the bank has to make is: (a) to sell the loan to the investors, (b) to keep monitoring the loan or (c) to stop monitoring and to keep the loan in-house. Thus, the bank keeps monitoring the loan until it decides either to sell the loan or keep it in-house, and such decisions will be made on the basis of the information the bank acquires through ex-post monitoring.

When the bank sells a loan to the investors, it incurs a signaling cost g, so the net value that can be recovered by the bank of a loan of quality π sold to the market is $V(c|\pi)-g$. Note that if the signaling cost g were zero, the bank would sell all loans to the investors. Also, if the risk-bearing ability were the same for the bank as for the investors, i.e., K=0, the bank would keep all loans in-house since loan sales are costly. Thus, there is a trade-off – the bank seeks to balance the gains from trade against the cost of the loan sale transaction. For high-risk loans, the gains from trade will typically dominate the signaling cost, whereas for low-risk loans, the reverse will be true. We study the risk management decision for the bank as a function of its access to monitoring technology.

11 Cebenoyan and Strahan (2004)
12 Laeven and Levine (2009)
13 Klomp and de Haan (2012)
14 Instefjord and Nakata (2015)

A bank with screening technology makes an initial credit scoring of loans to generate a probability π_0 at the time the loan is considered. The bank has access to ex-post monitoring technology, which gradually reveals the true quality of the loan which is either good or bad, and the monitoring technology yields a posterior belief π_t. Instefjord and Nakata[15] demonstrate that if a noisy Brownian signal about loan quality can be observed, where the diffusion parameter is σ and the drift parameter is μ if the loan is good and zero if it is bad, then it leads to a posterior belief process that follows the stochastic differential equation:

$$d\pi_t = \frac{\mu}{\sigma}\pi_t(1-\pi_t)dB_t$$

The ratio $\frac{\mu}{\sigma}$ is the signal-to-noise ratio of the signal produced by the ex-post monitoring system and B_t is a standard Brownian motion that represents the fact that the signal is one. As the signal-to-noise ratio increases, the posterior beliefs will converge more quickly to a signal of good credit quality, $\pi \to 1$, or to a signal of bad credit quality, $\pi \to 0$. We assume that all new information about the loan is captured by the information signal, which implies that the cash flow from good and bad loans are observationally equivalent during the monitoring period.[16]

Instefjord and Nakata (2015) show that the decision rules of the bank concerning ex-post monitoring are described as follows:

(a) The bank stops monitoring and keeps the loan in-house if $\pi_t \leq \pi^*$

(b) The bank keeps monitoring if $\pi_t [\pi^{**}, \pi^*]$

(c) The bank stops monitoring and sells the loan if $\pi_t \leq \pi^{**}$

The two trigger values π^{**} and π^* are determined by the $\frac{\mu}{\sigma}$ parameters of the monitoring system, the signal-to-noise ratio and the monitoring cost *m*, and if they exist, they are unique.

15 Instefjord and Nakata (2015)

16 This is an assumption that probably seems more unrealistic in theory than in practice, as borrowers typically seek to make their loan repayments as long as they can, because when they start missing their repayments the contractual penalty can be harsh. From the point of view of the lenders, they typically benefit from managing the risk of the loan before the repayments fail to materialise, as afterwards the options available for such management can be limited.

2.2 Risk measure and intermediation surplus

The natural risk measure for a loan of quality π is the discount of a risky loan relative to a risk-free one. Specifically, the risk associated with the loan is simply the discount $\frac{c}{r} - V(\pi) = k(1-\pi)$. For a loan portfolio with loans of quality π uniformly distributed over $[\underline{\pi}, \overline{\pi}]$, the loan portfolio risk is:

$$\int_{\underline{\pi}}^{\overline{\pi}} k(1-\pi)d\pi = k(\overline{\pi} - \underline{\pi})\left(1 - \frac{\overline{\pi} + \underline{\pi}}{2}\right)$$

Since the bank holds loans of type π varying uniformly from π^{**} to 1 by assumption, the risk of the bank's loan portfolio is: $\frac{k}{2}(1-\pi^{**})^2$.

Note that the risk measure $\frac{k}{2}(1-\pi^{**})^2$ is a market-based measure of the need to hold risk capital, since it depends on the discount of the market value of loans relative to a corresponding risk-free loan, i.e., the risk is measured relative to the market's risk-bearing ability *k*. If we made the risk measure on the basis of the internal risk-bearing ability *k*+K, it would depend on the regulator's actions and would mean that a more strict regulation of a bank would itself lead to a higher risk in the bank's loan portfolio without any action on the part of the bank. To prevent this from happening, we make the risk measure a market-based risk measure, broadly in line with the risk assessment models used in practice. An implication of the risk measure is that the regulator requires a higher cost of bearing risk, for instance, more strict capital requirements of the banks in which the barrier for holding risky loans is low (i.e., π^{**} is low).

We consider the following two cases for the determination of the regulatory cost of capital K:

(a) K is fixed regardless of the risk level of the bank's portfolio.

(b) K is chosen so that the risk level of the bank's portfolio meets a target level Ψ.

Note that in the second case, K is set so as to satisfy $\frac{k}{2}[1-\pi^{**}(K)]^2 = \Psi$, and the expression $\pi^{**}(K^*)$ reflects the fact that the bank chooses π^{**} in accord with the bank's decision rules described above, given K^*. Namely, π^{**} is really a function of K^*, and K^* is set so that the risk level is matched with Ψ, which

has a one-to-one relationship with π** given *k*. Thus, setting Ψ is equivalent to setting π**, and we can interpret that the regulator imposes the regulatory cost of risk capital K* on the bank so that the bank will set its lower threshold π** at a level targeted by the regulator. In other words, π** is fixed in this case.

Now, we turn our attention to a measure of the value-added of the bank through its monitoring capability and the keeping of the loans in its own book, which we call the "intermediation surplus." A loan of quality π has a market value of $V(\pi)-g$, conditional on loan quality π and net of signaling costs. The bank can improve on the market value in two ways. The bank can either hold the loan in-house at the value $V_I(\pi)$, or keep the loan under observation in its monitoring system with the aim of delaying the decision to hold or to sell, at the value $V_M(\pi)$. The first option saves the signaling cost *g*, but incurs a higher regulatory cost of risk capital as determined by the regulator's choice of K. The intermediation surplus is, therefore, simply the maximum of these three values minus the market value, i.e.:

$$W(\pi) = \max\{V(\pi)-g, V_M(\pi), V_I(\pi)\}-[V(\pi)-g]$$

$$= \max\{0, V_M(\pi)-[V(\pi)-g], V_I(\pi)-(V(\pi)-g)\}$$

3. Main result

The main result is twofold. First, we demonstrate that an improvement in monitoring technology leads to greater loan values, provided the extra cost of capital K imposed by the regulator is fixed. Second, we demonstrate that a win-win between the bank's shareholders and the regulator from investments in monitoring systems is not feasible when the risk level the bank is allowed to bear is fixed by the regulator. As long as the regulator controls risk, the bank's shareholders will create greater shareholder value from dismantling the bank's monitoring systems. This is owing to a reduction in regulatory compliance costs, than they will lose owing to a reduction in the quality of risk management.

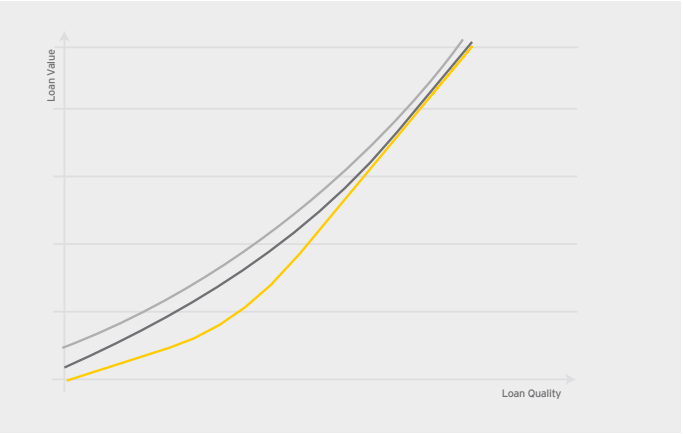

Figure 1: Intermediation surplus for different monitoring technologies with fixed K. The dark grey line is the intermediation surplus with baseline monitoring technology, and the other lines represent the intermediation surplus with higher monitoring cost and higher signal-to-noise ratio, respectively.

The first result is that loan values increase as the monitoring technology improves, provided the regulator does not respond to the increase in bank risk that follows improved monitoring. Improved monitoring has implications for loan values in the monitoring region, but will not change the loan values outside the monitoring region. This is illustrated in figure 1. Figure 1 shows the loan value for the base case where the bank uses a monitoring technology of a certain standard, and two alternative cases where the loan technology is more expensive than in the base case and where the signal-to-noise ratio is lower than in the base case, respectively. Both alternative cases carry lower loan values in the monitoring region as we would expect, the intuition being that the bank stops the monitoring activity sooner when the cost of monitoring increases or the signal-to-noise ratio decreases. As a consequence, the value of the loans in the monitoring region drops. This effect carries over to the average value of bank loans also, as illustrated by figure 2. Figure 2 shows a three-dimensional (3D) plot of average loan values against variations in the monitoring cost and signal-to-noise ratios. The average loan value increases as the monitoring cost is reduced and/or the signal-to-noise ratio is increased. The main implication of this is that the bank has incentives to make the necessary investments in loan-monitoring technology because it translates into higher loan values, which in turn leads to a competitive advantage relative to other banks.

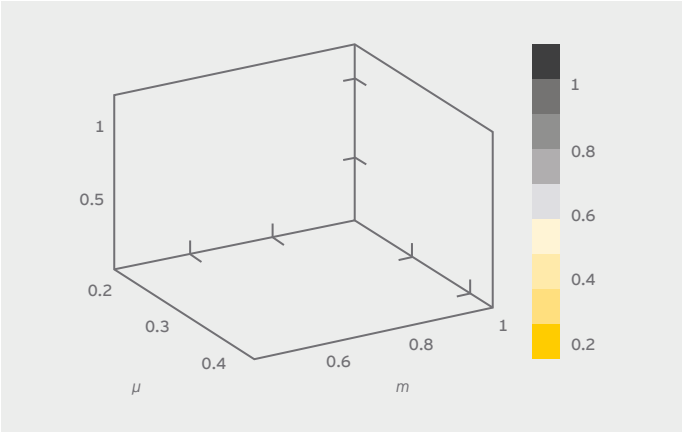

Figure 2: Average intermediation surplus against the signal-to-noise ratio μ for fixed σ (on the x-axis) and the monitoring cost m (on the y-axis). The cost of risk capital K is constant here.

We now turn to the second result. The second result relates to the effect of regulation when the regulator fixes the target risk level the bank can bear. When the bank invests in improvements in the monitoring technology, the bank will expand the monitoring region. Therefore, the bank will take more loan risk in the intermediate period when loans are monitored and awaiting a risk management decision. This extra risk will be detected by the bank regulator and, as a consequence, the bank regulator will impose higher regulatory costs for the bank. The following assumes that the bank imposes regulatory costs to the point that all banks carry the same risk. To illustrate the effect of this, it may be of interest to study the monitoring region as a function of the cost of monitoring and the signal-to-noise ratio of the monitoring signal.

What happens when the regulator responds to the optimal risk-taking by the bank? As argued above, the amount of risk -taking must be the same across banks with different monitoring technologies. This implies that the marginal opportunity cost of selling a loan of the poorest quality under monitoring must be the same for the bank regardless of the bank's monitoring technology. If the bank has access to high-quality monitoring systems (cheap monitoring and/or high signal-to-noise ratio of its monitoring efforts), then the bank will monitor more high-quality loans than low-quality loans. The only way this can be done is for the bank to have a high opportunity cost of placing a loan in-house, which means that the regulator imposes high compliance costs of carrying risk. If the bank only has access to low-quality monitoring systems, then the bank will monitor fewer high-quality loans, and the regulator consequently imposes lower regulatory compliance costs. This has knock-on effects on the loan values of the intermediated loans. Figure 3 shows the loan values that correspond to those in figure 1, with the exception that the regulator adjusts the compliance cost such that the bank takes exactly the same level of risk with more costly monitoring and with higher signal-to-noise ratio in their monitoring, as the bank takes in the base case. We see here that more costly monitoring leads to greater loan values and higher signal-to-noise ratio leads to lower loan values for the bank, which is exactly the opposite of the finding in figure 1.

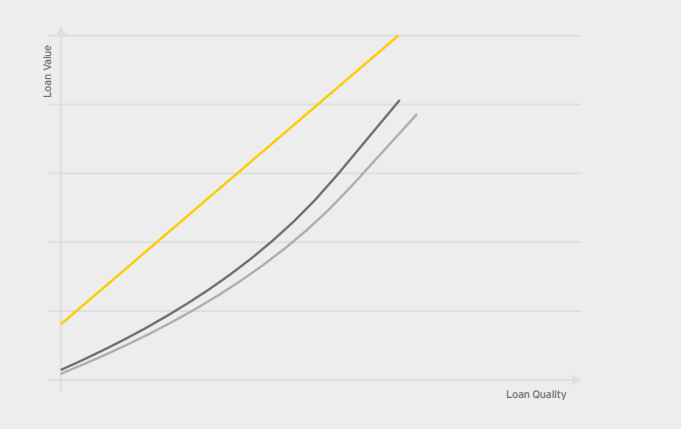

Figure 3: Intermediation surplus for different monitoring technologies with endogenous K. The dark grey line is the intermediation surplus with baseline monitoring technology and the other lines represent the intermediation surplus with higher monitoring cost and higher signal-to-noise ratio, respectively.

The average value of the bank's loan portfolio will also reflect the finding in figure 3. Figure 4 shows the average value in a 3D plot against the monitoring cost *m* and the drift rate μ (for fixed σ), which is a proxy for the signal-to-noise ratio μ/σ, when the regulator imposes strict capital controls to prevent risk-taking. The finding is clear that any improvement in monitoring technology is penalized by the regulator to the extent that the average value of the bank's loan is reduced. By dismantling its monitoring systems, therefore, the bank can compete more aggressively in the loans market.

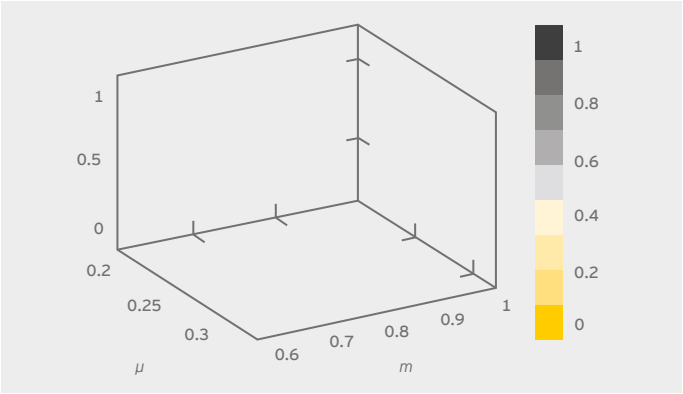

Figure 4: Average intermediation surplus against the signal-to-noise ratio μ for fixed σ (on the x-axis) and the monitoring cost m (on the y-axis). The cost of risk capital K is set in accord with the amount of risk Ψ, i.e., $K=\Psi^{-1}(\Psi)$.

What is the relationship between loan sales and loan monitoring? Our model does shed some light on this issue, but it is complicated by the fact that bank regulation may create incentives for banks to sell loans, simply to reduce their exposure to credit risk. If the compliance cost of regulation remains constant (i.e., the parameter K remains constant), the banks that obtain cheaper ex-post monitoring systems (lower cost *m*) or more effective ex-post monitoring systems (higher signal-to-noise ration μ/σ), the bank becomes less inclined to place loans in-house but also less inclined to sell loans to the secondary market. The bank will, however, spend more time monitoring loans that await a final decision about whether to be held or sold. Therefore, we should expect a negative relationship between loan sales and loan monitoring. This picture changes when the bank is subject to active bank regulation, where higher compliance cost is imposed on the banks that have cheaper or more effective monitoring technology, which allows them to monitor more loans of higher credit risk. In this case, the amount of loan sales is constant, and there is no relationship between monitoring activity and loan sales.

4. Discussion

The main conclusion from our analysis in the previous section is that bank regulation can have harmful effects on bank activities that arise from a regulatory trade-off. The regulator can control the risk that arises from lending, but this will be harmful to the banks' investment in monitoring systems, which leads to inefficiencies in bank lending. Or the regulator can encourage these investments, but this will be harmful to the stability of the banking system. We discuss the existing evidence that sheds light on the effects of bank regulation. Some of these studies are based on cross-country comparisons of regulation. We should make a note of how difficult it is to make precise inference from such studies. Regulation is only one factor that varies across countries. There are many other factors that also vary systematically across different countries. A direct comparison of the effects of regulation is, therefore, very difficult.

A key part of bank regulation is the value put on the investments that banks make in loan-monitoring systems. The Basel[17] Committee's report on credit risk assessment and loan valuation sets out the basic principles for assessing a bank's management of credit risk. This report asserts that:

"... [A] significant cause of bank failures is poor credit quality and credit risk assessment. Failure to identify and recognise deterioration in credit quality in a timely manner can aggravate and prolong the problem. Thus, inadequate credit risk assessment policies and procedures, which may lead to inadequate and untimely recognition and measurement of loan losses, undermine the usefulness of capital requirements and hamper proper assessment and control of banks' credit risk exposure."[18]

It goes on, therefore, to formulate principles, including principle 2 that promotes investment in loan monitoring systems: "A bank should have systems in place to reliably classify loans on the basis of credit risk."[19]

The credit risk that originates in the banks' lending activities should in turn be followed up by a strategy for making provisions for the credit risk that originates through the banks' lending operations: "Principle 5: A bank's aggregate amount of individual and collectively assessed loan loss provisions should be adequate to absorb estimated credit losses in the loan portfolio."[20]

These principles form the core of the link between the investments in loan monitoring systems and the regulatory costs incurred in order to mitigate the risk created by bank

17 BCBS (2006)
18 BCBS (2006, 3)
19 BCBS (2006, 5)
20 BCBS (2006, 8)

lending. This link, which is assumed by our model, is therefore, a fundamental part of the current framework for bank regulation.

Despite the clear line set out by the Basel Committee, the evidence that investments in monitoring systems are a priority for banks is not clear-cut. Berger et al.[21] finds, for instance, that large banks rely more and more on loan screening in the form of credit -scoring systems that are used ex ante when the lending decision is made, and less on monitoring of loans that have already been granted ex-post. There is further casual evidence to support this. Stacy Mitchell[22] argues, for instance, that though small banks are not subjected to the stringency of bank regulation that the larger banks are, both do not rely on credit-scoring systems and also lend disproportionally to smaller businesses. Moreover, in a recent *Financial Times* article, Amir Sufi[23] argues that the ability of the banking sector as a whole to discriminate between good and bad borrowers has been impaired during the financial crisis, and that banks are no longer "savvy information-gathering lenders, but take instead leveraged bets on real estate." There is also empirical evidence that regulatory compliance costs affect loan pricing. Chen et al.[24] finds that the banks that are subject to more stringent regulation charge more for their loans.

The results of our paper imply that the Basel framework may be contributing to the disappearance of relationship banking, where the bank establishes a close relationship with the borrower and picks up signals of changes in the borrower's status, which may be of relevance to the ability to repay the loan. The fact that relationship banking provides early signals of deterioration in loan quality makes it cheaper for the bank to manage the credit risk of the loan, and therefore, the bank is also more inclined to lend in the first place. As such, relationship banking leads in general to a greater accumulation of bank risk. Mester et al.[25] describes a similar monitoring system for individual borrowers on the basis of monitoring of the borrower's checking account activity. It is shown that the practice of monitoring checking accounts is not only common, but also that borrowers who can be monitored in this way obtain cheaper finance, which indicates that the early signal of a deterioration of credit risk leads to improved risk management of the loan. The fundamental problem with this kind of monitoring activity is that it leads to greater willingness to take risk ex ante, and therefore, increased bank risk is a by-product of the monitoring activity. At the same time, the bank is under regulatory scrutiny and must pay compliance costs for taking increased bank risk. The shareholders expect, therefore, that increased monitoring activity will lead to greater compliance costs.

21 Berger et al. (2005)
22 Stacy Mitchell (2010)
23 Amir Sufi (2014)
24 Chen et al. (2000)
25 Mester et al. (2007)

5. Conclusions

We have presented the argument that regulation can harm socially beneficial loan-monitoring activity in banks. Our suggestion is that there is a regulatory trade-off between risk and lending efficiency, but that there are solutions to this trade-off. The first, and obvious, solution is to improve the quality of the credit-scoring technology that will not be affected by the regulatory trade-off. Recently, we have witnessed some interesting innovations in this area linked to the use of big data. This includes the use of social network information to improve the credit assessment of personal borrowers. A recent example cited in the *SmartData Collective* is the use of loan applicants' job history and their connections on LinkedIn in determining whether to grant loans.[26] A problem is that innovations of this type will not improve naturally the credit assessment of corporate borrowers where, in particular, young and small firms can be challenging in terms of credit risk assessment, because there is a lack of history of any kind. A second problem is that once it is known that untraditional data is being used by credit-scoring systems, they may become subject to "sanitization" by the prospective borrower with the aim of maximizing the chances of getting through the credit-scoring process. Either way, credit scoring will have its limits.

The second solution is to adapt bank regulation to the trade-off. This solution builds on bank regulators being more tolerant to bank risk that is generated through ex post monitoring of loans than to bank risk that is generated from other bank activities. This requires a regulatory framework that emphasizes the monitoring technology available to the banks as well as the credit risk that arises through the banks' credit risk. The entire bank risk should be controlled by controlling the risk that arises from non-lending activities. This approach will avoid the downside associated with increased total risk and will also capture the upside associated with less stringent regulation of lending activities.

26 Srinivasan (2015)

A couple of wider points should be mentioned. This paper is primarily about the loan-monitoring activity of borrowers. Banks spend resources on assessing their lending at portfolio level to analyze whether they have the right balance in their lending policy, for instance, to avoid concentration of lending to certain segments of the loan market.

This type of monitoring activity can be subject to criticism that it is likely to increase portfolio risk in the banks' lending operations. Banks that have good systems to analyze and make adjustments to their loan portfolio ex-post will be more willing to accept risk at the portfolio level ex ante. Therefore, by committing not to take such risks, the bank may simply restrict its ability to monitor lending at the portfolio level.

A second point relates to a potential non-monotonic relationship between the stringency of bank regulation and the credit risk of the banks' lending operations. Consider the following, which relies on the link between monitoring activity in the banking system and the real economy. Less stringent bank regulation can lead to greater investment in monitoring systems, which leads to more efficient lending and higher economic growth. This, in turn, reduces the credit risk of the banks' initial lending operations. Therefore, lenient bank regulation can potentially reduce bank risk. Conversely, more stringent bank regulation can prevent banks from investing in monitoring technology, which leads to less efficient lending and lower economic growth. More stringent bank regulation can increase the credit risk of the banks' loan portfolio. Neither point has been rigorously studied to our knowledge. However, we reiterate that our point in this paper is not that banks should be subject to less stringent bank regulation in general, rather that the regulator should rebalance the stringency of bank regulation to take the social value of bank risk into account.

References

Admati, A.R. and M. Hellwig, 2013. The Bankers' New Clothes. Princeton: Princeton UP.

Baker, M. and J. Wurgler, 2013. Would Stricter Capital Requirements Raise the Cost of Capital? Bank Capital Regulation and the Low Risk Anomaly. Available at SSRN: http://ssrn.com/abstract=2233906.

Baker, M., B. Bradley, and R. Taliaferro, 2013. The Low Risk Anomaly: A Decomposition into Micro and Macro Effects, Harvard Business School, Working paper.

Baker, M., B. Bradley, and J. Wurgler, 2011. Benchmarks as Limits to Arbitrage: Understanding Low-Volatility Anomaly, Financial Analysts Journal 67, 40 - 54.

Barth, J.R., G. Caprio Jr., and R. Levine, 2004. Bank Regulation and Supervision: What Works Best? Journal of Financial Intermediation 13, 205 - 248.

Basel Committee on Banking Supervision (BCBS) 2006. "Sound credit risk assessment and valuation for loans," working paper, June. Available at: http://www.bis.org/publ/bcbs126.pdf

Beltratti, A. and R.M. Stultz, 2009. Why Did Some Banks Perform Better during the Credit Crisis? A Cross-Country Study of the Impact of Governance and Regulation, Available at SSRN: http://ssrn.com/abstract=1433502.

Berger, A.N., N.H. Miller, 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 - 29.

Bernanke, B.S., 1983. Nonmonetary effects of the financial crisis in the propagation of the great depression, American Economic Review, 73, 257 - 276.

Cebenoyan, A.S. and P.E. Strahan, 2004. Risk Management, Capital Structure and Lending at Banks, Journal of Banking and Finance 28, 19 - 43.

Chen, A.H., S.C. Mazumdar, and Y. Yan, 2000. Monitoring and bank loan pricing, Pacific-Basin Finance Journal 8, 1 - 24.

Dermine, J., 2013. Bank Regulations after the Global Financial Crisis: Good Intentions and Unintended Evil, European Financial Management 19, 658 - 674.

Diamond, D.W., 1984. Financial Intermediation and Delegated Monitoring, Review of Economic Studies 60, 393 - 414.

Gande, A. and A. Saunders, 2012. Are banks still special when there is a secondary market for loans? Journal of Finance 67, 1649 - 1684.

Instefjord, N. and H. Nakata, 2015. Loan Monitoring and Bank Risk, The Research Institute of Economy, Trade and Industry, RIETI Discussion Paper Series 15-E-121. Available at: http://www.rieti.go.jp/jp/publications/dp/15e121.pdf

Klomp, J. and J. de Haan, 2012. Banking Risk and Regulation: Does One Size Fit All? Journal of Banking and Finance 36, 3197 - 3212.

Laeven, L. and R. Levine, 2009. Bank governance, regulation and risk taking, Journal of Financial Economics 93, 259 - 275.

Mester, L.J., L.I. Nakamura, and M. Renault, 2007. Transactions Accounts and Loan Monitoring, Review of Financial Studies 20, 529 - 556.

Mitchell, Stacy, 2010. "Why Small Banks Make More Small Business Loans," Institute for Local Self-Reliance, February 10. Available at: https://ilsr.org/banks-and-small-business-lending/

Parlour, C.A. and G. Plantin, 2008. Loan Sales and Relationship Banking, Journal of Finance 63, 1291 - 1314.

Srinivasan, Anand, 2015. "How Big Data Is Revolutionizing the Credit Scoring Industry," SmartData Collective, February 9. Available at: http://www.smartdatacollective.com/anandsmartdata/298071/how-big-data-revolutionizing-credit-scoring-industry

Sufi, Amir, 2014. "Bernanke's failed mortgage application exposes the flaw in banking," Financial Times, October 13. Available at: https://next.ft.com/content/b02a24c2-4d60-11e4-bf60-00144feab7de