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Institute for Monetary and Financial Stability
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Abstract

This paper presents a novel model of the lending process that takes into account that loan officers must spend time and effort to originate new loans. Besides generating predictions on loan officers' compensation and its interaction with the loan review process, the model sheds light on why competition could lead to excessively low lending standards. We also show how more intense competition may fasten the adoption of credit scoring. More generally, hard-information lending techniques such as credit scoring allow to give loan officers high-powered incentives without compromising the integrity and quality of the loan approval process. The model is finally applied to study the implications of loan sales on the adopted lending process and lending standard.

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1 Introduction

This paper develops a simple model of the loan-origination process that explicitly takes into account that loan officers must spend time and effort to generate new loan applications. The model allows to derive new implications on the determinants of banks' lending standard and the adoption of hard-information lending techniques such as credit scoring. We find that so as to mitigate their *internal* agency problem vis-á-vis loan officers, banks have a tendency to implement too low lending standards, if judged solely by the NPV of newly made loans. The adopted lending standard further decreases under more intense competition, leading to a further deterioration of the average quality of the loan portfolio.

The model also suggests that more competition triggers a switch from soft- to hard-information lending, as this allows to give loan officers more high-powered incentives without compromising the integrity and quality of the loan approval process. While it has been frequently observed that the switch to hard-information lending intensifies competition as it reduces the importance of closeness to the borrower, the present model thus suggests a reverse causality.[1] This novel perspective may help to explain why the adoption of credit scoring to commercial lending seems not to have gathered pace equally across countries.[2]

At the heart of this paper is a novel model of the loan-origination process. In the case of soft-information lending, the loan officer has two tasks to perform: firstly, to spend time and effort on contacting clients so as to generate new loan opportunities;[3] secondly, to feed his "soft" information into the loan-approval process. The second task has been much discussed in the literature on relationship lending and entails two key assumptions: that the loan officer has privileged access to information about the borrowing firm and that some of this information is “soft” i.e., “hard to quantify, verify and communicate through

[1]Such a shrinking distance between lenders and small-business borrowers has been documented for the US by, for instance, Petersen and Rajan (2002). For a contrasting European perspective based on Belgian data see, however, Degryse and Ongena (2005).

[2]See Berger and Frame (2005) for a detailed account of the spread of small business credit scoring in the US, as well as Akhavein et al. (2001) for a quantitative analysis. Clearly, the evolution of credit scoring also depends crucially on developments in IT, as a main benefit lies in the lower costs of processing applications. Though this should equally apply to Europe, in their detailed analysis of the small business loan data from a large Belgian bank, Degryse, Laeven, and Ongena (2006) note that credit scoring was virtually non-existing in the late 90s.

[3]For instance, the loan officer may inquire in regular intervals about a client's needs to expand existing credit facilities or to extend existing services, say cash management, into lending. For more aggressive banks, it may also involve active prospecting for new clients.

the normal transmission channels of a banking organization" (Berger and Udell, 2002).[4] In contrast to the extensive treatment of the role of soft information, the first task in the loan origination process, i.e., the task of originating new loan applications in the first place, has been largely ignored in the literature. We find that the interaction of the two tasks under soft-information lending may bias the loan officer towards "overlending". This bias does not arise from collusion with the borrower.[5] Instead, the bias arises endogenously under the optimal compensation scheme. To counter this bias, the bank must monitor the performance of loan officers and it may have to reward better performing loan officers with higher "rents".[6]

With hard-information lending, which is the second lending regime that we study, the loan officer no longer plays an active role at the loan approval stage, apart from keying in the *hard and verifiable* information about the loan applicant.[7] The loan officer´s incentives can thus be fully directed towards the single objective of originating new loan-making opportunities.[8] The loan officer's role is then reduced to that of a salesperson. As we will argue, this may be part of a bank's strategy to more aggressively pursue opportunities in new markets, while for other banks this may simply be necessary to defend its home turf against increasing competition.

[4]On more details on the definition of soft information see Petersen (2004). In our model, the loan officer could well be asked to provide some (ordinal) information about more qualitative factors. Also, some of these factors may be verifiable, albeit only at additional costs through the bank's review process.

[5]On the potential for collusion see Udell (1989) and Berger and Udell (2002), as well as more recently Hertzberg, Liberti, and Paravisni (2006).

[6]While nowadays a bank routinely reviews its whole loan portfolio to comply with regulatory requirements, the extent to which a given rating is further scrutinized internally remains still at the bank's discretion. As noted by Treacy and Carey (1998), in their interviews conducted with large banks "[...] managers indicated that the internal rating system is at least partly designed to promote and maintain the overall credit culture.[...] Strong review processes aim to identify and discipline relationship managers [...]." Udell (1989) provides evidence that banks invest more in monitoring when more authority is delegated to loan officers, which further testifies to its disciplining role.

[7]Most notably, Stein (2002) has also looked into the organizational "black box" of banks' lending processes, albeit with a focus on the internal capital market operated in large banks. He shows how incentives for local staff to generate information can be undermined if this information cannot be communicated to headquarters due to its soft and subjective nature. On the theoretical side, our model of the double-task problem borrows also from Inderst and Ottaviani (2007). There, the focus is, however, on public policy to prevent the (mis-)selling of expert goods through agents.

[8]We conceive here that the adoption of credit scoring does more than just providing the loan officer with a new tool, but that it coincides with a fundamental change in the lending regime. Consequently, at the point of switching to hard-information lending the informativeness of the lending decision decreases as soft information is discarded. This contrasts our analysis to that in Hauswald and Marquez (2003), who have studied how borrowing conditions are affected as banks become more efficient in generating or using information.

For instance, according to James and Houston (1996) Wells Fargo has since the 80s rolled out credit scoring by sending out its agents "armed with a laptop computer [...] to "plug in" the borrower's information into the computer model – and, in many cases, to approve loans on the spot." More lately, Wells Fargo has even proceeded towards delegating the origination of loans to community banks, which use Wells Fargo's proprietary system and are paid a fee per loan (see Berger and Frame, 2005). While a loan origination system that enlists other banks' employees may be rare in *commercial* lending,[9] the job description of loan officers by the US Department of Labor suggests that by now commercial loan officers are indeed often treated like salespeople and receive a substantial fraction of their pay through commissions or loan-origination fees:[10]

> "In many instances, loan officers act as salespeople. Commercial loan officers, for example, contact firms to determine their needs for loans. If a firm is seeking new funds, the loan officer will try to persuade the company to obtain the loan from his or her institution. [...] The form of compensation for loan officers varies. Most are paid a commission that is based on the number of loans they originate. In this way, commissions are used to motivate loan officers to bring in more loans. Some institutions pay only salaries, while others pay their loan officers a salary plus a commission or bonus based on the number of loans originated."

The model suggests that loan officers who still have the twin roles of originating new loan opportunities and of feeding "soft" information into the approval process will have less high-powered incentives and are thus paid more like bureaucrats. Loan officers are also paid more like salespeople and less like bureaucrats as competition increases.

When a bank wants to or simply has to step up the incentives of its loan officers under increasing competition, this makes a switch to hard-information lending more profitable. As noted above, the literature has, instead, focused on the opposite causality, as credit scoring creates competition also from more distant banks. Taken together, the two hy-

[9] As stated in more detail below, the focus of this paper will be squarely on commercial and *not* on retail lending, and especially not mortgage lending. Though these areas of banking share similar issues that are also touched upon in this paper, we do not aspire to capture institutional details of retail lending, let alone of the US (subprime) mortgage market.

[10] See http://www.bls.gov/oco/ocos018.htm

potheses jointly suggest a strong complementarity between competition and the adoption of hard-information lending techniques.

In our model, when the bank increases its loan officers' incentives to generate loans, it *optimally* lowers the applied lending standard. The intuition is the following. When the bank's compensation scheme puts a higher reward on loan making, loan officers' *own* incentives to approve loans–or, likewise, to influence the bank's approval decision in this way–increase. While the bank could fully counteract this with a more thorough loan review process, optimally it will only partially do so. In fact, the "marginal" loan that is made under the bank's chosen lending standard will always have negative expected NPV. With more competition the set of negative-NPV loans widens.[11] If this is due to the opening of a market to new entrants, then in contrast to the extant literature (cf. Bofondi and Gobbi 2004), which has focused on the lemons' problem of entrants, the present model would predict that also the incumbents' default rate increases.[12]

Though this link is not explicitly formalized in the model, it has been suggested that there is more competition during booms.[13] Our model would thus predict an *excessive* relaxation of lending standards in booms (cf. Asea and Blomberg 1998 or Lown and Morgan 2004). Previous work has associated this with organizational inertia (Berger and Udell 2004) or a more general misperception of changes in risk (Borio, Furfine, and Lowe 2001). Furthermore, countercyclical standards arise in Rajan (1994) from a model where bank managers can better hide losses when most borrowers do well and in Ruckes (2004), as well as Weinberg (1995), from an optimal adjustment of screening intensity.[14]

[11] While the present model explicitly closes down the interest rate channel, through which competition could affect loan performance, some of the extant theory would suggest the opposite implication for default rates: As competition brings down the loan rate, this would either attract borrowers with a more creditworthy project or, through leaving borrowers with a larger stake in their own venture, induce more effort and thus on average a higher probability of success (cf. Stiglitz and Weiss 1981 and Boyd and De Nicolo 2005).

[12] At this point, our paper ties in with the large literature that tries to establish, both theoretically and empirically, a relationship between market structure and stability in banking. Though a number of papers has suggested that various proxies of more intense competition are negatively correlated with banking stability, this view is not uniformly shared (cf. most recently the discussion in Beck, Demirgüç-Kunt, and Levine 2006).

[13] That competition intensifies during booms has been suggested based on the documented reduction in banks' margins as well as borrowers' credit spreads (cf. Dueker and Thornton, 1997; Corvoisier and Gropp, 2002). Dell'Ariccia and Marquez (2006) suggest that an increase in competition could be due to a reduction in adverse selection between banks, given that a boom brings in new borrowers. They show that this may induce banks to no longer screen borrowers by requiring collateral.

[14] There is also a small theoretical literature that *jointly* endogenizes business cycle conditions and changes in the pool of funded projects and thus the likelihood of future default. For instance, in Suarez

Sections 2-6 analyze how, under the optimal compensation scheme for loan officers, the bank optimally chooses both its lending standard and its loan-making technology. While our focus is on the role of competition, the analysis generates also some additional, more immediate implications on other determinants of the choice of the bank's lending technology, e.g., the informativeness of credit scoring. While in Sections 2-5 it is presumed for tractability that the loan officers' effort choice is discrete, Section 6 extends the model to continuous effort.

In Section 7 we use the modelling framework to generate additional implications. Amongst other things, the model is used to analyze the implications of loan-selling on both the applied lending standard and the chosen lending technology. We find that as more loans are sold off, the quality of loans deteriorates *both* as this accelerates the switch to hard-information lending and as the implemented standard is lower. We also discuss how the bank would optimally invest in its loan review process and how its internal employment relationship should interact with the adopted lending technology and lending standard.

Section 8 concludes. All proofs can be found in the Appendix.

2 The Model

Lending Technology

We focus first on the soft-information lending regime, where the loan officer has to perform two tasks. The first task is to generate new loan applications. Here, the main analysis considers the most simple discrete-choice model and thus stipulates that the loan officer can exert a given level of effort at private disutility $c > 0$ or no effort at all. Effort generates a loan application with probability $\pi > 0$. Without exerting effort the respective probability is zero. All agents in our model a risk neutral, while the loan officer has limited liability.

There are two types of borrowers: low types $\theta = l$ and high types $\theta = h$. The *ex-ante* probability that a borrower is of the high type equals $0 < \mu < 1$. A borrower of type θ defaults with probability $1 - p_\theta$, where $0 \leq p_l < p_h \leq 1$, in which case the bank obtains a zero repayment. Otherwise, the bank receives a contractually stipulated repayment of R. Letting k denote the initial loan size, the NPV from the loan is $v_\theta := p_\theta R - k$. We stipulate

and Sussmann (1997) lower margins in the boom create more need for external finance, which through a moral hazard problem triggers more risk taking and thus a higher probability of future default.

that $v_h > 0 > v_l$. Normalizing the risk-free rate to zero, from the bank's perspective it is thus only profitable to lend to high-type borrowers. Finally, it is not profitable to indiscriminately grant a loan to all borrowers as $v := \mu v_h + (1-\mu)v_l < 0$.

By using his soft information, the loan officer can make a more informed decision. Suppose thus that the loan officer can privately observe a signal $s \in [0,1]$, which is realized according to the type-dependent distribution function Ψ_θ. Signals are ordered such that Ψ_h dominates Ψ_l according to the Monotone Likelihood Ratio property. With continuous densities satisfying $\psi_h(1) > 0$, $\psi_l(0) > 0$, and $\psi_h(0) = \psi_l(1) = 0$, the signal is also fully informative at the boundaries.

The *ex-post* probability with which the borrower is of the high type is given by

$$\mu(s) := \Pr[\theta = h \mid s] = \frac{\mu\psi_h(s)}{\mu\psi_h(s) + (1-\mu)\psi_l(s)},$$

which is strictly increasing in s. Next, the conditional success probability is given by $p(s) := \mu(s)p_h + [1-\mu(s)]p_l$, such that the conditional NPV of making a loan equals $v(s) := p(s)R - k$. This is continuous and strictly increasing in s. Together with $v(0) = v_l < 0$ and $v(1) = v_h > 0$, we then have a unique (and from the bank's perspective first-best optimal) threshold $0 < s_{FB} < 1$ where $v(s_{FB}) = 0$.

In what follows, it will be convenient to express the bank's optimization program by working with the conditional values $p(s)$ (for the probability of repayment) and $v(s)$ (for the expected NPV) together with the *ex-ante* distribution over the signal s, which is given by $G(s)$ with density $g(s) := \mu\psi_h(s) + (1-\mu)\psi_l(s)$.

Loan Officer Compensation

If the loan officer was paid like a bureaucrat with a fixed wage w, his preferences at the loan approval stage would be aligned with those of the bank.[15] (Precisely, the loan officer would then always be indifferent.) The crux, however, is that if the loan officer was paid like a bureaucrat, he would have no incentives to originate a new loan in the first place.

Neither the signal s nor the time and effort that the loan officer spends on the origination of new loans are observable by his principal, the bank. Realistically, it is also not feasible to remunerate the loan officer on the basis of the number of filled-in applications,

[15] If observing s required to exert costly effort, then under a fixed-wage contract there would not be any incentives to acquire soft information in the first place. It can be shown that the following results would go through if next to the cost of originating a loan, c, additional effort at cost $\widehat{c}$ was necessary to acquire information.

which could simply be bogus applications. A compensation scheme can thus only be made contingent on whether a new loan was approved or not.

Before setting up the general compensation scheme, it should be noted that we can suppose without loss of generality that the approval decision is delegated to the loan officer. That is, it is straightforward to show that this implements the optimal mechanism.[16] Furthermore, another instrument that the bank has at its disposal is the loan review process, through which the loan officer's approval decisions are monitored. For this we stipulate that with probability m the bank observes early on whether the borrower will subsequently default.[17]

Taken together, in this environment the different states on which a compensation contract can condition are thus the following: first, the state where a loan has not been made; second, the state where a loan has been made and where no negative information was obtained in the loan review process; and finally the state where a loan has been made and where negative information was subsequently revealed. It is immediate that in the final case, given limited liability of the loan officer, it is optimal to set the loan officer's wage equal to zero (the limited liability constraint). This leaves us with two wage levels to specify. We refer to the wage that is paid if no loan was made as the base wage w. Otherwise, a loan-origination fee f is paid in addition to w.[18]

Discussion

Before proceeding to the analysis, we comment on the chosen specifications. We already discussed the role of the loan review process in the Introduction. As $m < 1$ holds, it is immediate that the bank would want to withhold any payment to the loan officer until it receives itself full payment from the borrower, which provides an additional signal of the

[16] A general mechanism is described by a standard message-game approach, by which the bank would specify a mapping of the loan officer's message $\widehat{s} \in [0, 1]$ into the space of contracts and decisions. Loan officers with strong relationships often seem to indeed enjoy a high level of discretion (cf. the case described in Hertzberg, Liberti, and Paravisni 2006). This holds despite the fact that due to regulatory requirements loan approvals regularly have to be co-signed by the bank's risk management side.

[17] All that is important for our analysis is that some information is received, irrespective of how noisy it is and irrespective of whether it relates directly to the borrower's type θ or, as presently specified, to subsequent default.

[18] Note that it is not possible to separately verify whether *no* negative information was obtained as the particular loan was not reviewed with the necessary scrutiny or whether it was reviewed but the information was positive. Otherwise, it would be optimal to "load" all of the fee on the state where a loan review was performed and revealed positive information. To ensure that then still *all* of the following results hold, we would need to assume that the loan review process is noisy. (Presently, we assume for simplicity that it perfectly reveals θ.)

type θ. This may, however, lie too far in the future to be of much use for disciplining the loan officer.[19] Based on this observation, one may equally doubt that all of the promised wage payment, $w+f$, may be forfeited by a loan officer in case of a negative outcome of the loan review process. Our results extend, however, to the case where only a fraction $\alpha > 0$ of $w+f$ can be withheld or "clawed back". In fact, the comparative analysis in α would then be completely analogous to that of a change in m.

Finally, note that in Section 7 we allow the bank to choose both the compensation contract as well as the optimal intensity of its loan review process, m.

3 Loan Officers' Incentives

We currently suppose that the loan officer performs two tasks for the bank: that of originating new loan-making opportunities and that of using his only privatively observed information so as to allow the bank to make more informed approval decisions. In what follows, we derive first the respective incentive constraints.

Suppose first that the loan officer has already generated a new loan application. In case the loan is not approved, the loan officer realizes only his base wage w. Otherwise, his wage depends on the outcome of the subsequent loan review process. After observing the signal s and approving a borrower, the loan officer can expect that with aggregate probability $1-m+mp(s)$ no negative information will subsequently be revealed. (We use here that a loan review will only generate information with probability m and that the conditional success probability is $p(s)$.) Consequently, the loan officer prefers to approve a loan only when

$$[1-m+mp(s)]\,(w+f) \geq w. \tag{1}$$

If he loan officer prefers to approve a loan for some signal $s<1$, then he will strictly do so for all higher signals $s' > s$. From optimality for the bank, we can safely rule out the cases where a loan is never or always approved. Taken together, there is thus an interior

[19] The insight that it may be beneficial to withhold wages or, in addition, have workers post a bond until more of the uncertainty surrounding the choice of effort has been resolved is not novel. Incidentally, in the area of consumer loans to high-risk borrowers (e.g., the case of "doorstep lending" in the UK) it is sometimes observed that loan officers are indeed paid exclusively out of the collections that they personally make from borrowers.

threshold $0 < s^* < 1$ at which the loan officer is just indifferent, such that from (1)

$$\frac{f}{w} = \frac{m\left[1 - p(s^*)\right]}{1 - m\left[1 - p(s^*)\right]}. \tag{2}$$

Suppose that the bank wants to change the implemented threshold s^*. As the right-hand side of condition (2) is strictly decreasing in s^*, to obtain a stricter standard s^* the ratio f/w must decrease. Hence, a stricter standard has to go together with a more low-powered compensation scheme. Furthermore, the right-hand side of (2) is strictly increasing in m. Intuitively, if the loan review process is more informative, a lower base wage w is sufficient to ensure that the loan officer follows a given standard s^*.

We turn next to the loan officer's second incentive constraint, which ensures that new loan-making opportunities are created in the first place. When exerting effort at private cost c, the loan officer finds an interested applicant with probability π. Consequently, from an *ex-ante* perspective a loan will only be made with probability $\pi\left[1 - G(s^*)\right]$. Using also that the loan officer earns the base wage w without a loan and that he forfeits all compensation in case the loan review reveals negative information about an approved loan, we obtain that exerting costly effort is only optimal if

$$\int_{s^*}^{1} \left[\left[1 - m + mp(s)\right](w + f) - w\right] g(s)ds \geq D := \frac{c}{\pi}. \tag{3}$$

To incentivize the loan officer to exert effort, there must thus be a sufficiently large wedge between the expected compensation in case of making a loan (for all $s \geq s^*$) and the base wage w, which is paid even when no loan was made. The additional (expected) compensation must be larger the harder it is to generate a new application, as expressed by D.

For given s^*, the bank chooses (w, f) to maximize *ex-ante* profits

$$\Pi = \pi \int_{s^*}^{1} \left[\nu(s) - \left[1 - m + mp(s)\right](w + f)\right] g(s)ds - w\left[\pi G(s^*) + (1 - \pi)\right], \tag{4}$$

which takes into account both the conditional NPV from the loan, $\nu(s)$, and the expected wage payment. The optimal contract is straightforward to derive and uniquely characterized by constraint (1) and the binding incentive constraint (3).

Proposition 1 *The optimal contract for a given threshold s^* specifies a base wage*

$$w = \frac{D}{m}\left[\frac{1 - m\left[1 - p(s^*)\right]}{\int_{s^*}^{1}\left[p(s) - p(s^*)\right] f(s)ds}\right] \tag{5}$$

and a loan-origination fee

$$f = D\left[\frac{1-p(s^*)}{\int_{s^*}^1 [p(s)-p(s^*)]\, f(s)ds}\right]. \quad (6)$$

That constraint (3) must be binding, which is what we used for the characterization in Proposition 1, follows immediately from the fact that the base wage w represents a pure *rent* for the loan officer. Intuitively, this follows as the loan officer could earn w even without exerting effort. The loan officer's total expected compensation is thus equal to $w+c$, with w characterized in (5). Next, from differentiating (5) and (6), respectively, we obtain the following results.

Corollary 1 *In order to implement a higher lending standard s^*, the bank has to pay both a higher base wage w and a higher loan-origination fee f. Still, the higher s^* the flatter becomes the compensation scheme as f/w decreases. On the other hand, a more informative loan review process is, for given s^*, associated with a steeper compensation scheme.*

Note that from Corollary 1 the two incentive instruments, namely the steepness of the compensation scheme and the loan review process, are complementary: A higher monitoring intensity is associated with a steeper incentive scheme. To derive implications for the loan officer's compensation scheme we must, however, first solve for the bank's optimally chosen level of s^*.

4 Lending Standard

Substituting the optimal compensation scheme from Proposition 1 into the bank's objective function (4), we obtain

$$\Pi = \pi \int_{s^*}^1 \nu(s)g(s)ds - (c+w), \quad (7)$$

which is the expected profit from lending minus the expected wage bill, $c+w$. Hence, holding the wage bill constant, from an *ex-ante* perspective it would clearly be optimal to set $s^* = s_{FB}$, thereby ensuring that loans are made if and only if they represent a positive-NPV investment.[20]

[20] In fact, it is also easy to see that this would be the optimal choice if s was verifiable and the bank could, therefore, impose any choice of s^*, regardless of the chosen compensation. In this case, the bank would also choose $w=0$ and would thus not pay the loan officer a rent.

Maximizing (7), we have $d\Pi/ds^* = 0$ whenever[21]

$$\pi\nu(s^*)g(s^*) = -\frac{dw}{ds^*}, \tag{8}$$

which after substituting from Proposition 1 and using Corollary 1 becomes

$$\pi\nu(s^*)g(s^*) = -\frac{D}{m}\frac{d}{ds^*}\left[\frac{1 - m\left[1 - p(s^*)\right]}{\int_{s^*}^{1}\left[p(s) - p(s^*)\right]f(s)ds}\right] < 0. \tag{9}$$

Hence, at the optimally implemented standard s^* the respective (marginal) loan represents a negative-NPV investment for the bank: $\nu(s^*) < 0$. The bank optimally chooses $s^* < s_{FB}$ as this allows to reduce the internal agency costs.

Proposition 2 *The bank's optimal choice of the lending standard s^* is given by (9) and is strictly below the zero-NPV threshold: $s^* < s_{FB}$.*

Having established the optimal lending standard, we conduct now our key comparative analysis in the parameter $D = c/\pi$. From implicit differentiation of (9), while using strict quasiconcavity, we have the following result.

Corollary 2 *The optimal lending standard s^* is strictly decreasing in D.*

In words, as it becomes increasingly difficult to generate a new loan-making opportunity, either as π decreases or as c increases, the bank optimally responds by lowering the lending standard s^* that the loan officer subsequently applies. More formally, this result hinges on the fact that the *marginal* cost of raising the standard s^*, i.e., $dw/ds^* > 0$, is itself strictly increasing in D:

$$\frac{d^2w}{ds^*dD} > 0. \tag{10}$$

Our interpretation of Corollary 2 is in terms of competition in the loan market. We would argue that more intense competition makes it *harder* for an individual loan officer to generate loan applications. In our model, this can be captured either through an increase in the cost c or through a reduction in the probability π. Intuitively, we could imagine that in the extreme case where a bank has a monopoly, most entrepreneurs with a viable business prospect or most firms that wish to expand their business will sooner or later end up anyway at the bank's doorstep. With intense competition, in particular if rival lenders'

[21] We suppose here for convenience that the program is strictly quasiconcave.

loan officers are themselves actively prospecting for new borrowers, this is no longer the case.

When extending the model to the case with continuous effort below, we will, in addition, allow competition to affect not only the overall likelihood with which a loan opportunity arises, but also the "responsiveness" to changes in effort. As we discuss there, in line with the standard notion from Industrial Organization theory, competition thus makes loan demand *more elastic* to loan officers' effort.

Our interpretation of Corollary 2 in terms of competition is agnostic about the reasons for why competition could increase. As suggested in the Introduction, this could be linked to deregulation and the opening up of a market to outside competition. Corollary 2 together with Proposition 2 then suggest not only that the average default probability increases, which in our case is given by

$$\int_{s^*}^{1} [1 - p(s)] \frac{g(s)}{1 - G(s^*)} ds,$$

but also that more loans are made that represent a negative-NPV investment for the respective bank. Crucially, however, this is not due to a misperception of risk or herd behavior. Instead, banks willingly tolerate a lower lending standard when they increase their loan officers' incentives to originate loans.

5 Soft- vs. Hard-Information Lending

If a bank does not harness a loan officer's soft information, then the respective loan officer faces only a single task, namely that of generating loan applications. Instead, the loan application process becomes fully automated. In this case, we stipulate that based only on hard information, the observed signal $\widehat{s}$ is more noisy. With probability $1 - \lambda > 0$ it is drawn from the uniform distribution over $\widehat{s} \in [0, 1]$. This specification ensures that soft information always adds value. The larger is λ, the less information is lost when basing the loan approval decision solely on hard information, instead of basing it on both soft and hard information.

The posterior probability $\widehat{\mu}(\widehat{s})$:=$\Pr[\theta = h \mid s]$ is then given by the convex combination $\widehat{\mu}(\widehat{s})$=$\lambda\mu(\widehat{s}) + (1 - \lambda)\mu$. With the *ex-ante* success probability $p := \mu p_h + (1 - \mu)p_l$, we have likewise the new conditional success probability $\widehat{p}(\widehat{s}) := \lambda p(\widehat{s}) + (1 - \lambda)p$ and thus the conditional NPV $\widehat{v}(\widehat{s}) := R\widehat{p}(\widehat{s}) - k$. Finally, the signal is now distributed according to $G(\widehat{s}) := \lambda G(\widehat{s}) + (1-\lambda)\widehat{s}$, where we use that $\widehat{s} \in [0,1]$ is chosen from the uniform distribution with probability $1-\lambda$.

The bank optimally approves a loan if $\widehat{v}(\widehat{s}) \geq 0$. In case of an interior optimal lending standard $\widehat{s}_{FB}$, we then have that $\widehat{v}(\widehat{s}_{FB}) = 0$. As the lending standard is now mechanically imposed by the bank, the loan officer receives a loan-origination fee of

$$f_H = D\frac{1}{1-G(\widehat{s}_{FB})}, \tag{11}$$

which just compensates him for the respective cost of effort, and a zero base wage: $w_H = 0$. (Note that in what follows, it will frequently be convenient to denote some key parameters by a subscript H if they refer to the hard-information regime and by a subscript S for the soft-information regime.)

As we explore below, the fact that the loan officer always realizes a strictly smaller rent under hard-information lending carries over to the case with continuous effort choice, though there the bank must leave the loan officer with positive rent even under hard-information lending. Moreover, with discrete effort and $w_H = 0$ it is presently trivial that the compensation scheme is more high-powered under hard-information lending. We therefore postpone a comparative analysis of compensation contracts under the two lending regimes until we deal with the case of continuous effort below.

Note next that the bank's expected profits under hard-information lending equal

$$\Pi_H := \pi \int_{\widehat{s}_{FB}}^{1} \widehat{v}(s)\widehat{g}(s)ds - c,$$

as from an *ex-ante* perspective the choice of f_H in (11) just compensates the loan officer for the cost of effort c. With soft-information lending, wage costs are equal to $w_S + c$, where the base wage under soft-information lending, $w_S > 0$, was derived in Proposition 1. Taking this into account, expected profits under soft-information lending equal

$$\Pi_S := \pi \int_{s^*}^{1} v(s)g(s)ds - D\frac{1}{m}\left[\frac{1-m\left[1-p(s^*)\right]}{\int_{s^*}^{1}\left[p(s)-p(s^*)\right]f(s)ds}\right] - c.$$

A switch from soft-information lending towards hard-information lending is thus profitable in case $\Pi_H > \Pi_S$. Intuitively, such a shift is less likely the less severe is the agency problem (and thus the smaller is the agency rent) under soft-information lending. This is in turn the case if m is higher. Likewise, a shift to hard-information lending is less likely if this entails a more severe loss in information as represented by a lower value of λ.

If it is harder to generate a loan application, the bank must under either lending regime compensate the loan officer for the additional disutility. Under soft-information lending, however, the wage bill increases by more than the differential in effort cost, dc, as also $dw_S/dc > 0$. Holding first s^* constant, this is the case as an increase in the loan-origination fee, which is necessary to still incentivize the loan officer, must be accompanied by an increase in the base wage w_S. Otherwise, the loan officer would choose to approve even less promising applicants.

To see more formally how Π_S adjusts *relative* to Π_H following a marginal increase in c, note that by the envelope theorem we have that

$$\begin{aligned} \left|\frac{d\Pi_S}{dc}\right| - \left|\frac{d\Pi_H}{dc}\right| &= \frac{\partial w_S}{\partial c} \\ &= \frac{1}{m}\frac{1}{\pi}\left[\frac{1-m\left[1-p(s^*)\right]}{\int_{s^*}^{1}\left[p(s)-p(s^*)\right]f(s)ds}\right] > 0. \end{aligned}$$

Next, though here the formal argument is slightly more complicated, intuitively the same comparative result applies to the case where π decreases. Overall, we can thus conclude that if it becomes more difficult to originate a new loan, i.e., if $D = c/\pi$ increases, then it is more likely that the hard-information regime is more profitable. The following Proposition summarizes the comparative results.

Proposition 3 *A switch to hard-information lending becomes more likely, i.e., the difference in the respective profits* $\Pi_H - \Pi_S$ *increases, if:*
i) hard-information lending is more informative as λ *is higher;*
ii) the agency problem under soft-information lending is less severe as m *is higher;*
iv) or if it becomes harder to generate a new loan-making opportunity as either c *increases or* π *decreases (resulting in an increase of* $D = c/\pi$*).*

As we show in the proof of Proposition 3, holding all other parameters fixed, as we shift either one of the parameters λ, m, c, or π, there exists in all cases an interior (and in the case of c bounded) threshold value for the comparison of profits under the two lending regimes. Proposition 3 implies that a shift towards a hard-information lending regime, e.g., through the adoption of credit scoring, becomes more profitable as competition intensifies, provided that this leads to a higher value of D. Cross-sectionally one should thus be more likely to observe the spread of such lending technologies in countries where competition is more intense, while otherwise banks may be more likely to still adopt a soft-information lending regime, with loan officers playing a vital role in the loan approval decision. Though we lack comparative studies, it seems that the use of credit scoring has spread extensively in the United States, at least in the area of small business lending, while this seems to be much less the case in Europe (cf. the Introduction). Proposition 3 suggests that variations in competition could provide an explanation.[22]

6 Continuous Effort Choice

The Modified Model

Let now the loan officer choose continuous effort $e \geq 0$, which results with probability $q(e)$ in a new loan-making opportunity and which comes at private cost $c(e) = e^2/(2\gamma)$, where γ will always be chosen sufficiently large to ensure that $q(e) < 1$ holds in equilibrium. Under soft-information lending, the loan officer's signal s is now perfectly informative: He observes $s \in \{0, 1\}$, where $s = 0$ is generated with probability one if the borrower is of type $\theta = l$, while $s = 1$ is generated with probability one if $\theta = h$.[23] In case of hard-information lending, the signal is noisy: Type $\theta = h$ generates $\widehat{s} = 1$ only with probability $0 < \lambda < 1$, while $\theta = l$ generates $\widehat{s} = l$ with the same probability λ.

We choose for $q(e)$ the linear relationship $q(e) = \alpha + \beta e$, where $\alpha \geq 0$ and $\beta > 0$. In the subsequent comparative analysis, an increase in competition is presumed to lead to a lower α or a higher β (or both). Either of the two changes makes loan demand *more elastic* to the loan officer's effort[24]. In the working paper version, the linear relationship in $q(e)$ is derived from first principles. There, a "contact" from a loan officer tilts a borrower more towards the respective bank as it reduces “transaction costs”, which could comprise, for instance, the time and effort that is otherwise spent on locating a branch or finding out about the prevailing loan terms.[25]

[22] That being said, the analysis of Boot and Thakor (2000), which studies the intensity of relationship loans in the face of increased competition, could also suggest a more differentiated response of banks to more competition. Some banks could find it more profitable to stick to soft-information lending and to focus on the clientele that is either locked-in or for which it can provide superior value-added.

[23] Though ideally we would want both the choice of effort and that of the lending standard to be continuous, we found that the resulting complexity heavily obfuscates results.

[24] Recall that elasticity, here with respect to e, is defined as $(dq/de)/(e/q)$.

[25] As is shown there as well, higher effort from competing loan officer or better alternative loan terms both reduce α and increase β. The increase in β, which is less immediate, follows as the loan officer's own effort is only effective if a borrower would otherwise have

Hard-Information Lending

Given that the *ex-ante* NPV of a loan is negative, it cannot be optimal for the bank to approve a borrower after $\widehat{s}=0$ was revealed. To ensure that approving a loan is optimal in case of $\widehat{s}=1$, we assume that[26]

$$\upsilon_h\mu(1+\lambda)+\upsilon_l(1-\mu)(1-\lambda)>0. \tag{12}$$

Note that (12) always holds if λ is not too low. Next, the probability with which a loan will be made is given by

$$\sigma := \frac{1}{2}\left[\mu(1+\lambda)+(1-\mu)(1-\lambda)\right].$$

Using in addition that $q(e)=\alpha+\beta e$ and private costs $c(e)=e^2/(2\gamma)$, the loan officer will optimally choose the effort level

$$e^*=f_H\gamma\beta\sigma. \tag{13}$$

Here, e^* is higher if the loan-origination fee is higher (higher f_H), if loan demand is more responsive to effort (higher β), and if the marginal cost of effort is lower (higher γ).

Denote next the bank's wage cost of inducing effort by $C_H(e^*)$, which after substitution from (13) equals

$$C_H(e^*)=\frac{e^*}{\gamma\beta}(\alpha+\beta e^*). \tag{14}$$

Note that with continuous effort the loan officer now receives a rent even though $w_H=0$ holds.[27] Given the expected profits from an approved loan

$$\upsilon_{EH} := \frac{1}{2}\left[\upsilon_h\mu(1+\lambda)+\upsilon_l(1-\mu)(1-\lambda)\right],$$

the bank thus chooses the loan-origination fee f_H and, thereby, the effort level e^* from (13) so as to maximize expected profits: $q(e^*)\upsilon_{EH}-C_H(e^*)$.

Proposition 4 *If*

$$\upsilon_{EH}>\frac{\alpha}{\gamma\beta^2}, \tag{15}$$

chosen a competing offer. The formal analysis can be downloaded at http://www.wiwi.uni-frankfurt.de/profs/inderst/Corporate_Finance_and_Banking/Cfab_english.htm

[26] We use for this that the conditional probabilities are $\Pr(\theta=h\mid\widehat{s}=1)=\frac{\mu(1+\lambda)}{\mu(1+\lambda)+(1-\mu)(1-\lambda)}$ and $\Pr(\theta=l\mid\widehat{s}=1)=\frac{(1-\mu)(1-\lambda)}{\mu(1+\lambda)+(1-\mu)(1-\lambda)}$.

[27] Precisely, the bank's total expected wage costs $C_H(e^*)$ in (14) are made up of the true costs of effort provision, $(e^*)^2/(2\gamma)$, and of a rent equal to $(e^*)^2/(2\gamma)+\alpha e^*/(\gamma\beta)$.

then the optimal incentive scheme under hard-information lending specifies a loan-origination fee of

$$f_H = \frac{1}{2\sigma}\left(v_{EH} - \frac{\alpha}{\gamma\beta^2}\right), \tag{16}$$

which induces the loan officer to exert effort

$$e_H^* := \frac{\gamma\beta}{2} v_{EH} - \frac{\alpha}{2\beta}. \tag{17}$$

Otherwise, i.e., if (15) does not hold, then $f_H = 0$ *and* $e_H^* = 0$*.*

Condition (15) deserves some comments. If the loan demand function is insensitive to effort (low β) or if the marginal cost of effort is high (low γ), $e_H^* = 0$: The loan officer then behaves like a bureaucrat, waiting for potential clients to knock on his door, which happens with probability α.[28] With positive effort, this will be higher under the optimal contract if a newly made loan is more profitable (higher v_{EH}), if effort is less costly (higher γ), or if the loan demand function is more elastic (lower α or higher β). As these comparative results hold invariably under both lending regimes, though, we do not comment on them in more detail.

Soft-Information Lending

To ensure that the loan is not approved for $s = 0$ under soft-information lending, it must hold that $(f_S + w_S)(1 - m) \leq w_S$. As this binds by optimality, we have that

$$w_S = f_S \left(\frac{1-m}{m}\right). \tag{18}$$

Furthermore, as a loan application is now approved with probability μ, the loan officer chooses the effort level

$$e^* = f_S \gamma\beta\mu. \tag{19}$$

Substituting from (18) and (19) into the bank's expected wage bill, $w_S + \mu q(e^*) f_S$, the total costs from implementing effort e^* under soft-information lending can be expressed as

$$C_S(e^*) = C_H(e^*) + \left(\frac{1-m}{m}\frac{1}{\mu}\right)\frac{e^*}{\gamma\beta}. \tag{20}$$

[28] Even though we specified that the true marginal cost of providing effort is zero at $e^* = 0$, given that $c(e) = e^2/(2\gamma)$, this follows as the incremental agency rent $e^*/\gamma + \alpha/(\gamma\beta)$ is for $\alpha > 0$ strictly positive for all e^*.

The difference to $C_E(e^*)$ captures the rent that arises from the additional task under soft-information lending. The additional rent is higher the larger is e^*:

$$\frac{dC_S(e^*)}{de^*} = \frac{dC_H(e^*)}{de^*} + \rho, \text{ with } \rho := \frac{1}{\gamma\beta}\frac{1-m}{m}\frac{1}{\mu}. \tag{21}$$

From maximizing the bank's objective function $q(e^*)v_{ES} - C_S(e^*)$, where we use $v_{ES} := \mu v_h$, we have the following results.

Proposition 5 *If*

$$v_{ES} > \frac{1}{\gamma\beta^2}\left(\alpha + \frac{1-m}{m}\frac{1}{\mu}\right), \tag{22}$$

then the optimal incentive scheme under soft-information lending induces the loan officer to exert effort

$$e_S^* := \frac{\gamma\beta}{2}v_{ES} - \frac{\alpha}{2\beta} - \frac{1}{2\beta}\left(\frac{1-m}{m}\frac{1}{\mu}\right), \tag{23}$$

where $f_S = e_S^*/(\gamma\beta\mu)$ *and*

$$w_S = e_S^*\frac{1}{\gamma\beta\mu}\left(\frac{1-m}{m}\right). \tag{24}$$

Otherwise, i.e., if (22) does not hold, then $w_S = f_S = e_S^* = 0$.

Soft- vs. Hard-Information Lending

Soft-information lending is more informative, as expressed formally by the higher expected value of a new loan-making opportunity, $v_{ES} > v_{EH}$, but comes at higher wage costs (cf. (20)). Importantly, from (21) the cost difference vis-a-vis hard-information lending increases with the level of induced effort, while higher effort is in turn optimal when the loan-demand function $q(e)$ is more elastic (cf. both Propositions 4 and 5). The effect of a reduction in α mirrors our previous analysis for the case with discrete effort. What is new, an increase in β, which makes eliciting more effort more profitable, has the same effect.

Proposition 6 *Hard-information lending becomes relatively more profitable as the loan-demand function becomes more elastic to the loan officer's effort, i.e., as either* α *decreases or* β *increases.*

Our final observations relate to the steepness of the loan officer's incentive scheme and to the, thereby, implemented level of effort, which proxies for the "aggressiveness" with which loan officers will operate in the market.

Corollary 3 *If competition increases (lower α or higher β), then the compensation scheme becomes steeper as the bank optimally induces a higher level of effort from the loan officer. This holds, in particular, at the point where the bank optimally switches to hard-information lending. In this case, we would observe a notable (discrete) increase in loan officers' incentives and their induced (sales) effort.*

7 Discussion and Further Extensions

7.1 Investment in the Loan Review Process

In the preceding analysis, the intensity of the loan-review process, m, was taken to be exogenously given, leaving only the compensation scheme (w, f) as a strategic variable to influence the loan officer. As noted in the Introduction, however, banks also choose strategically the extent to which they scrutinize internal ratings and past loan-making decisions. To capture this, suppose that the bank can choose the probability m at strictly increasing cost $\Phi(m)$. From Proposition 1 the bank's cost of incentivizing the loan officer and implementing a credit standard s^* under soft-information lending is then equal to

$$K(s^*) := \min_{m} \{\Phi(m) + w\}, \tag{25}$$

where w is given by (5). Note that as w is strictly convex in m, provided that Φ is also convex the program in (25) yields a unique outcome. For $\Phi(m) = \phi m$ we have explicitly, provided that this is interior, the optimal monitoring level

$$m^* = \sqrt{D\frac{1}{\phi}\frac{1}{\int_{s^*}^{1}[p(s) - p(s^*)]\, f(s)ds}}. \tag{26}$$

After substitution to obtain $K(s^*)$ from (25), note that $\frac{dK(s^*)}{ds^*} > 0$ and, in particular, that still $\frac{d^2K(s^*)}{ds^*dD} > 0$.

To complete the picture, we specify that under hard-information lending, where there is no (strategic) reason for the bank to review loans beyond what is required by regulation, the bank must monitor at some minimum level $m = \underline{m} \geq 0$. For the following analysis, we choose $\underline{m}$ and ϕ so as to ensure that under the optimal standard s^* for soft-information lending it holds that $\underline{m} < m^* < 1$. From the preceding observations, together with a comparative analysis of (26), we have the following results.

Proposition 7 *Suppose that the loan-review intensity, m, can be chosen at cost $\Phi(m) = \phi m$. Then all previous comparative statics results (of the optimal lending standard and the switch to hard-information lending) still hold. In addition, an increase in D now leads both to higher pay w and to more monitoring m under soft-information lending, albeit the standard s^* still decreases.*

7.2 Loan Selling

As noted in the Introduction, the key application of the present model is to commercial lending. In particular, the model does not intend to capture specific features of retail lending, especially in the mortgage industry. One such feature is that originating institutions rarely hold on to mortgages. The practice of re-selling loans has, however, also spread increasingly into commercial lending, in particular with respect to SME lending. The packaging and selling-on of loans is facilitated under hard-information lending, given that this makes individual loans more comparable and the whole process more transparent. Hard-information lending may thus be seen as being conducive to the spread of loan sales. Our model supports, however, the reverse causality: If a larger fraction of loans *can* be sold off, e.g., as a liquid market develops, this makes hard-information lending relatively more profitable, even absent any direct (cost) savings from it.

Suppose thus that a given loan is sold off with probability ψ and at "price" p, which will be endogenized subsequently. To keep expressions short, we take the price to be net of the original capital outlay. If under soft-information lending a loan is approved after the loan officer observed some signal s, then the bank's expected payoff is now $v_{sell}(s) = (1-\psi)v(s) + \psi p$. As ψ does not affect w, as characterized in (5), for given p the first-order condition for the lending standard s^* becomes in analogy to (8)

$$\pi v_{sell}(s)g(s^*) = -\frac{dw}{ds^*}. \tag{27}$$

To characterize the equilibrium, p has still to be endogenized. For given s^*, a competitive market will pay the expected NPV: $p = E[v(s) \mid s \geq s^*]$. As the bank's chosen standard is not observable, the applicable equilibrium concept is that of a rational-expectations equilibrium: The first-order condition (27) as well as the market's expectations, as expressed in the requirement that $p = E[v(s) \mid s \geq s^*]$, must be jointly satisfied.

Proposition 8 *If a loan is resold with probability ψ under soft-information lending, then there is a unique rational-expectations equilibrium. The applied lending standard and the price p that the market pays are strictly lower the higher is ψ. Absent direct benefits from reselling, the bank's expected profits are strictly lower the higher is ψ.*

Recall that at $\psi = 0$ the bank's "marginal loan" (at $s = s^*$) has negative NPV, which follows from the fact that raising s^* is costly: $dw/ds^* > 0$. When a loan will be resold with positive probability, then the bank cares more about earning the fixed price p and less about the loan's true NPV. In addition, the bank has less incentives to spend additional resources to sustain internally a higher lending standard (i.e., through a higher w or, as in Section 7.1, through higher monitoring costs $\Phi(m)$). As the market, however, rationally anticipates the bank's behavior, the bank's profits are strictly lower.[29]

With hard-information lending, we presume that the respective information–or, likewise, the process through which information is gathered and approval decisions are made–is verifiable: The loan officer is left with no discretion, implying that the (unobservable) internal compensation scheme has no influence on the quality of loans.[30] As is immediate to show, this implies that the bank optimally chooses the same standard regardless of ψ (namely, $\widehat{s}_{FB}$ such that $\widehat{v}(\widehat{s}_{FB}) = 0$). Given that we abstracted from direct benefits of reselling loans, the bank's profits are thus not affected by ψ under hard-information lending. Together with Proposition 8, we thus have the following result.

Corollary 4 *As ψ increases, hard-information lending becomes relatively more profitable compared to soft-information lending.*

In contrast to our analysis in the previous sections, what drives Corollary 4 is thus the agency problem between the bank and the market under soft-information lending. However, this agency problem becomes aggravated by the bank's internal agency problem vis-á-vis loan officers as from $dw/ds^* > 0$ the bank has less incentives to sustain its internal standard.

[29] Admittedly, recent observations in the subprime mortgage markets indicate a lack of "anticipation" or, at least, "awareness". With such a (short-term) behavior, the market may then set $p = E[v(s) \mid s \geq s^*]$ at the standard s^* that is chosen for $\psi = 0$, inducing a further reduction of the "true" standard.

[30] In practice, this may typically not hold in this clear-cut way. For instance, not all information that is hard and verifiable will be actually verified, both by the bank and by those who purchase the loans (or rate the underlying risk). In particular, loan officers may then be tempted to "collude" with borrowers (cf. the Introduction).

7.3 Contracting and Employment Relationship

In the present model, the bank ensures, through the loan review process and through paying a rent $w > 0$, that the loan officer not only generates new loan applications, but also adheres to the bank's lending standard. Paying a high rent may, however, involve not only "direct costs" (of w), but also "indirect costs" in terms of the pool of attracted applicants. This is the case as any successful applicant can earn w irrespective of whether he actually has the skills to generate new loans. In this Section, we suppose that this ("lemons") problem is sufficiently severe such that the bank is forced to compensate agents only based on originated loans, namely through the fee f. To ensure compliance to the chosen lending standard, the bank must now rely on repeated interaction.

Precisely, for the limited purpose of this section we restrict attention to the following setting. In a stationary environment, all parties use the same discount factor $0 < \delta < 1$. The relationship between a given loan officer and the bank is severed with probability $0 \leq 1-\varphi < 1$ in each period. We comment on this additional exogenous variable below. If no loan was made, the loan officer now receives zero compensation and is retained (unless the relationship is severed exogenously with probability φ). If a loan was made, the loan officer earns the fee f. If subsequent monitoring reveals $\theta = l$, the loan officer is removed from his position, either by firing him or by employing him in a (back-office) position where he no longer earns fees (but instead only his market wage, which we normalized to zero).[31]

The key restriction in this incentive scheme, apart from requiring that $w = 0$, is that payments to the loan officer cannot condition on performance in earlier periods. It is well known that through multi-period interactions the agency problem arising from moral hazard could be mitigated through such compensation schemes, though this requires commitment by the principal.[32] If the outcome of the loan review process is only privately observed, the principal, i.e., the bank in the present setting, may opportunistically deny the loan officer compensation for past performance. In contrast, this is not the case in the chosen incentive scheme, given that each period the fee is paid up-front once a loan

[31]It is straightforward to extend the analysis to the case where also the fraction $0 \leq \alpha \leq 1$ of the fee can be clawed back if the loan officer is replaced.

[32]In general, multi-period interactions allow both to filter out noise from the agent's performance and to alleviate his limited liability constraint (namely, through using past compensation as a "bond" for future performance). For an early and seminal contribution to this vast literature see Radner (1985).

was made and can not be clawed back. In addition, as we assume that finding an equally capable replacement comes at zero cost to the bank, there is also no commitment problem when it comes to punishing the loan officer.

We frame the analysis in the model of Section 6. For brevity, set also $\alpha = 0$ such that $q(e) = \beta e$. Denote next by U the loan officer's stationary continuation payoff at the beginning of each period. Provided that he only approves a loan when $s = 1$, then with $u := \max_e\{q(e)\mu f - c(e)\}$ we have

$$U = \frac{u}{1 - \delta\varphi}. \tag{28}$$

To ensure that loans are only approved if $s = 1$, it must hold that

$$f \leq \frac{\delta\varphi}{1 - \delta\varphi} mU, \tag{29}$$

where we used that $s = 0$ and thus $\theta = l$ is detected with probability m. Substituting (28) into (29) and using also that $e^* = \gamma\beta\mu f$, we have the requirement that

$$f \geq 2\frac{1 - \delta\varphi}{\delta\varphi}\frac{1}{\gamma\mu^2\beta^2 m}. \tag{30}$$

Interestingly, to ensure compliance of the loan officer to the bank's lending standard (i.e., $s = 1$), the fee f must now be sufficiently *high*. This at first counterintuitive result follows from the following observations. An increase in f not only affects the left-hand side of the respective constraint (29), but it also affects the right-hand side through an increase in U. If we were to hold the officer's effort level constant when increasing f, U would also increase proportionally with f. As the loan officer, however, optimally adjusts his effort level, U increases *more than proportionally* with f (namely quadratic in the present case). The stronger indirect effect is then reflected in the lower threshold for f in (30).

Before commenting further on this threshold, consider the bank's optimal choice of f, which maximizes per-period profits $\pi := q(e)[v_h - f]$. This yields $f^* := v_h/2$, which from (30) is thus only feasible if

$$\frac{1 - \delta\varphi}{\delta\varphi} \leq \frac{v_h}{4}\left(\gamma\mu^2\beta^2 m\right). \tag{31}$$

Otherwise, i.e., if (31) does not hold, the bank must increase the fee above the level that is optimal, so as to ensure that the loan officer's continuation value, U, is sufficiently high. We assume now $\gamma\mu\beta v_h < 1$, which ensures that even at $f = v_h$, which would deprive the bank of all profits, the resulting effort level e^* is interior. The following result is then immediate from the previous observations.

Proposition 9 *Take the model with repeated interaction, where only an up-front fee f for each new loan is contractible. If (31) holds, the bank can implement the optimal fee level and thus also the optimal effort level under soft-information lending. If instead*

$$\frac{v_h}{4}\left(\gamma\mu^2\beta^2 m\right) < \frac{1-\delta\varphi}{\delta\varphi} \leq \frac{v_h}{2}\left(\gamma\mu^2\beta^2 m\right) \tag{32}$$

holds, the bank must pay a strictly higher fee, leading to a higher effort level but lower profits for the bank. Finally, if

$$\frac{1-\delta\varphi}{\delta\varphi} > \frac{v_h}{2}\left(\gamma\mu^2\beta^2 m\right) \tag{33}$$

holds, then it is not feasible for the bank to realize positive profits while ensuring that the loan officer uses his soft information in the bank's interest.

We want to interpret the results of Proposition 9 in terms of changes in $1-\varphi$, the probability with which the employment relationship is severed exogenously in each period. As it becomes increasingly likely that the employment relationship will end, it is from (33) no longer feasible at all to sustain the soft-information lending regime. While for higher levels of φ, together with sufficiently high levels of δ, the bank can make positive profits under soft-information lending, profits are compromised as it must choose the fee and thus the implemented effort above the second-best level. Even though φ does not directly enter profits, given that the bank can replace a loan officer at no additional costs, in this case its profits are strictly increasing in φ. Finally, for high levels of φ, together with sufficiently high levels of δ, the bank can achieve the second-best outcome under soft-information lending.[33]

A cautious interpretation of φ could be in terms of the bank's internal employment relationship. Though this is admittedly outside the model, in particular given the considered stationary environment, φ could measure the extent to which the bank buffers internally shocks in the demand for loans. While we cannot present even stylized empirical results, judging by the job description of the US Department of Labor (cf. footnote 10) commercial loan officers in the US not only face substantial fluctuations in earnings over the business cycle but also substantial risk of losing their job in downturns. Arguably, this is much

[33] With a continuous lending standard s^*, albeit in this case with only discrete effort due to tractability, it can be shown that an increase in φ has two effects. First, it increases the maximum lending standard that the bank *can* implement. Second, if the bank's optimal lending standard is strictly below this threshold, then it strictly increases in φ.

less the case in other countries, where *any* job with a large bank may be considered to be particularly safe and where employment relationships are long term.[34] Proposition 9 would suggest that in the latter environment banks can make better use of loan officers' soft information and pay lower fees.

Unfortunately, we are not aware of any research conducting cross-country comparisons in loan officers' pay and employment conditions. Proposition 9, as well as the preceding results in the present paper, suggest that such data may be of importance also in order to understand the *borrowing conditions* faced by commercial lenders, i.e., how banks make their approval decisions and what lending standard they apply

8 Conclusion

At the heart of this paper is a novel model of the loan-origination process. Under soft-information lending, the loan officer performs two tasks, namely that of originating new loan applications and that of using his soft information at the loan-approval stage. A first set of results analyzes the implications for the optimal lending standard that the bank wants to implement. In particular, we find that as competition makes it harder to originate new loans, the bank chooses a lower lending standard. This may also help to explain why lending standards are (excessively) countercyclical. Furthermore, under the chosen lending standard even negative-NPV loans are made, in particular if competition is more intense. As we stressed above, this is optimal as it serves to mitigate the agency problem vis-á-vis the bank's loan officers. In particular, in our model this does not follow from excessively high leverage.

A further set of implications relate to loan officers' incentive schemes and the interaction with the banks' internal loan review process. Our model suggests that loan officers tend to be paid more like salespeople and less like bureaucrats as competition intensifies and, in particular, as the bank switches from a soft- to a hard-information lending regime. In the latter case, the loan officer's task becomes one-dimensional as he no longer has authority at the loan approval stage. Such a switch to hard-information lending, e.g., through the adoption of credit scoring, is again more likely as competition increases. This observation complements the role of other factors such as the cost of adopting credit scoring

[34] Germany could come to mind here, although this must again remain only a casual observation.

or the value of the thereby generated information. Moreover, it provides a contrasting perspective to the alternative view that competition intensifies through the adoption of credit scoring, given that it allows more distant lenders to enter an incumbent bank's local turf. As we noted above, the adoption of credit scoring and more competition can thus be complementary developments, which are mutually reinforcing. This may explain also large cross-country differences.

In several extension the simple model of the bank's internal agency problem vis-á-vis its loan officers was used, amongst other things, to shed light on how the switch to hard-information lending may also be driven by other factors, such as the possibility of loan sales or banks' internal employment relationship. Again, both factors may help to explain cross-country differences. As we agued, stable and more long-term employment relationships may be conducive to soft-information lending, while the access to a liquid market for the sale of commercial loans may trigger a switch to hard-information lending.

Appendix: Proofs

Proof of Corollary 2. Implicit differentiation of (9) yields

$$\frac{ds^*}{dD} = -\left(\frac{-d^2w/(ds^*dD)}{d^2\Pi/d(s^*)^2}\right),$$

where we can substitute $d^2\Pi/d(s^*)^2 < 0$ as well as

$$\frac{d^2w}{ds^*dD} = \frac{1}{m}\frac{d}{ds^*}\left[\frac{1-m\left[1-p(s^*)\right]}{\int_{s^*}^1 \left[p(s)-p(s^*)\right]f(s)ds}\right] > 0.$$

Q.E.D.

Proof of Proposition 3. We take first the comparative statics in λ. Existence of an interior threshold λ' such that hard-information lending is optimal for $\lambda > \lambda'$ and soft-information lending for $\lambda < \lambda'$ follows from strict monotonicity of Π_H, from $\Pi_H > \Pi_S$ for $\lambda = 1$, and from $\Pi_H < 0$ for all sufficiently low λ.

For the case of m note next that Π_S is continuous and strictly increasing in m given that monotonicity holds also for w. Moreover, for $m = 1$ we have $s^* = s_{FB}$ and $w = 0$, implying $\Pi_S > \Pi_H$, while as $m \to 0$ we clearly have for any s^* bounded away from zero that Π_S must become negative given that $w \to \infty$. This together implies again existence of an interior threshold for m.

We have further $\Pi_S > \Pi_H$ for $c = 0$ given that then $w = 0$ and $s^* = s_{FB}$. On the other side, as long as s^* remains bounded away from zero we have $w \to \infty$ as $c \to \infty$. Together with strict monotonicity of $\Pi_H - \Pi_S$, this implies existence of a bounded threshold $c' > 0$.

Take finally π. Using the envelope theorem, we have that

$$\begin{aligned}\frac{d(\Pi_H - \Pi_S)}{d\pi} &= \left[\int_{\widehat{s}_{FB}}^{1} \widehat{v}(s)\widehat{g}(s)ds - \int_{s^*}^{1} v(s)g(s)ds\right] + \frac{1}{\pi}w \\ &= \frac{1}{\pi}\left[\Pi_H - \Pi_S\right].\end{aligned}$$

This implies monotonicity on either side of a threshold $0 < \pi' < 1$ at which $\Pi_H = \Pi_S$. Such an interior threshold π' exists if $\Pi_S > \Pi_H$ holds at $\pi = 1$. **Q.E.D.**

Proof of Propositions 4 and 5. Substituting for $C_H(e^*)$ into the profit function $q(e^*)v_{EH} - C_H(e^*)$, we can observe that this is strictly quasiconcave in e^*. The characterization of e_H^* follows then from the first-order condition in case (15) applies. This can also be substituted back to obtain profits of

$$\Pi_H = \frac{1}{\gamma\beta^2}q^2(e_H^*) = \frac{(\alpha + \beta e_H^*)^2}{\gamma\beta^2}. \tag{34}$$

Proceeding likewise for the case of soft-information lending, we obtain for $e_S^* > 0$ profits of

$$\Pi_S = \frac{1}{\gamma\beta^2}\left[q^2(e_S^*) + \alpha\left(\frac{1-m}{m}\frac{1}{\mu}\right)\right] = \frac{1}{\gamma\beta^2}\left[\frac{(\alpha + \beta e_S^*)^2}{\gamma\beta^2} + \alpha\left(\frac{1-m}{m}\frac{1}{\mu}\right)\right]. \tag{35}$$

Q.E.D.

Proof of Propositions 6. We consider first a comparative analysis of the difference $\Pi_H - \Pi_S$ in β. We have from (34) and (35) that

$$\Pi_H - \Pi_S = \frac{1}{\gamma\beta^2}\left[q^2(e_H^*) - q^2(e_S^*) - \alpha\left(\frac{1-m}{m}\frac{1}{\mu}\right)\right]. \tag{36}$$

We argue that whenever β is such that $\Pi_H = \Pi_S$, then at this point we must always have that

$$\frac{d}{d\beta}(\Pi_H - \Pi_S) > 0. \tag{37}$$

From the envelope theorem we have that

$$\begin{aligned}\frac{d}{d\beta}(\Pi_H - \Pi_S) &= -\frac{2}{\gamma\beta^3}\left[q^2(e_H^*) - q^2(e_S^*) + \alpha\left(\frac{1-m}{m}\frac{1}{\mu}\right)\right] \\ &\quad + \frac{1}{\gamma\beta^2}\left[q(e_H^*)e_H^* - q(e_S^*)e_S^*\right].\end{aligned} \tag{38}$$

At $\Pi_H = \Pi_S$, the first term in (38) is zero, implying that at this point the sign is determined by the second term and is thus strictly positive in case $e_H^* > e_S^*$. This, i.e., that $e_H^* > e_S^*$, follows finally from $\Pi_H = \Pi_S$ while using (34) and (35).

Observe next that for low β, where $e_H^* = e_S^* = 0$, it holds that $\Pi_H < \Pi_S$. (Precisely, this is the case if both $\beta \leq \sqrt{\frac{\alpha}{\gamma v_{EH}}}$ and $\beta \leq \sqrt{\frac{\alpha + \frac{1-m}{m}\frac{1}{\mu}}{\gamma v_{EH}}}$.) Using finally continuity of Π_H and Π_S, we have thus shown that one of the following cases must apply as we increase β: either $\Pi_H < \Pi_S$ holds for all feasible values $\beta \geq 0$ or $\Pi_H < \Pi_S$ holds for $0 \leq \beta < \beta'$ and $\Pi_H > \Pi_S$ for $\beta > \beta'$.[35]

Take next changes in α, where the argument is analogous. Differentiating $\Pi_H - \Pi_S$ at $\Pi_H - \Pi_S = 0$, the sign is strictly negative whenever

$$2q(e_H^*) - 2q(e_S^*) - \left(\frac{1-m}{m}\frac{1}{\mu}\right) < 0. \tag{39}$$

As in addition $\Pi_H - \Pi_S$ holds if

$$q^2(e_H^*) - q^2(e_S^*) = \alpha \left(\frac{1-m}{m}\frac{1}{\mu}\right),$$

condition (39) holds if $2\alpha < q(e_H^*) + q(e_S^*)$, which from $e_H^* \geq e_S^*$ finally holds (and also strictly if $e_H^* > 0$). **Q.E.D.**

Proof of Proposition 8. Note that $p = E[v(s) \mid s \geq s^*]$ generates a strictly increasing function p of s^*, while with strict quasiconcavity of the bank's objective function we obtain from (27) a strictly decreasing function s^* of p. These observations together ensure uniqueness. Note now that $v_{sell} > v(s^*)$. For a comparative analysis in ψ, observe that this does not affect the determination of p, for given s^*, but only (27). From implicit differentiation, we have that, for given p, an increase in ψ leads to a lower s^*, given that $v_{sell} > v(s^*)$. From this we have finally that in equilibrium both p and s^* are decreasing in ψ. **Q.E.D.**

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