Financial Incentives and Loan Officer Behavior[◊]

Patrick Behr[♣]
EBAPE, Getulio Vargas Foundation

Alejandro Drexler[#]
University of Texas at Austin

Reint Gropp[*]
Goethe University Frankfurt

Andre Guettler[‡]
University of Ulm

This version: Nov 5, 2013

Abstract

In this paper, we investigate the implications of providing loan officers with a compensation structure that rewards loan volume and penalizes poor performance. We study detailed transactional information of more than 45,000 loans issued by 240 loan officers of a large commercial bank in Europe. We find that when the performance of their portfolio deteriorates, loan officers shift their efforts towards monitoring poorly-performing borrowers and issue fewer loans. However, these new loans are of above-average quality, which suggests that loan officers have a pecking order and process loans only for the very best clients when they are under time constraints.

[◊] We would like to thank Phil Dybvig, Mrdjan Mladjan, Klaus Schaeck, Jerome Taillard, seminar participants at the Bank of Canada, Brazilian School of Public and Business Administration, Federal Reserve Bank San Francisco and Frankfurt School of Finance and Management for comments.

[♣] Brazilian School of Public and Business Administration (EBAPE), Getulio Vargas Foundation (FGV), Praia de Botafogo 190, 22253-900 Rio de Janeiro, Brazil, Email: patrick.behr@fgv.br.

[#]McCombs School of Business, University of Texas at Austin, 2110 SpeedwayB6600, Austin, TX 78712, United States, Email: alejandro.drexler@mccombs.utexas.edu.

[*]House of Finance, Goethe University Frankfurt, Grüneburgplatz 1, 60323 Frankfurt, Germany. Email: gropp@finance.uni-frankfurt.de.

[‡] Ulm University, Institute of Strategic Management and Finance, Helmholtzstraße 22, 89081 Ulm, Germany, Email: andre.guettler@uni-ulm.de (corresponding author).

JEL Classifications: G21, J33.
Keywords: Loan officer, incentives, monitoring, screening, loan origination

1. Introduction

While most research on bank compensation focuses on equity-linked incentives for high-level managers, there seems to be a consensus that distorted financial incentives for lower-level employees, such as loan officers and loan originators, were one of the factors at the root of the 2008-2009 financial crises. The role of loan officers' behavior in the crises opened a controversial public debate that has already caused important changes in the regulatory framework. The debate has also increased academic and practitioners' interest in exploring the implications of incentive-based compensation on the cost of credit, the availability of credit, and the stability of the financial market. Nonetheless, a full understanding of these subjects has been difficult to achieve, mostly because of data limitation.

In this paper we use exogenous variation in the compensation structure of loan officers at a large international bank to study how financial incentives affect their behavior. The bank provides detailed monthly transaction-level data at the loan officer-borrower-month level which allows us to control for unobserved loan officer and borrowers' characteristics.

The sample spans a period from January 2003 to October 2007. At the beginning of the sample period the bank used a variable compensation structure in which loan officers received a monthly cash bonus proportional to their lending volume. However, the bonus was not paid in months when the non-performing loans in the loan officer's portfolio exceeded three percent. During the sample period, this compensation plan was replaced with a fixed salary plan, eliminating any variable compensation. As reported by the management of the bank, the switch was not a reaction to a change in market conditions or to a deterioration of the portfolio. For instance, at the time of the change the bank portfolio was financially sound and the delinquency rate was below one percent.

The change in the way loan officers were compensated, together with the strong non-linearity embedded in the variable compensation plan, provide the necessary variation to

identify the effect of financial incentives on loan officers' behavior. The identification comes from comparing the change in the behavior of the loan officer when he crosses the three percent threshold during the variable compensation period to the change in the behavior of the loan officer when he crosses the three percent threshold during the no-compensation period.

Given the richness of the data, we can use our identification strategy to examine separately the three components of a loan officer's job: monitoring of existing loans, loan origination, and screening of loan applications. Overall, the results suggest that loan officers rationally distribute their time to maximize income. When loan officers find themselves above the three percent threshold (cutoff point, or cutoff henceforth) they focus on monitoring, which seems to be the task that gives them the best "bang for the buck" in terms of improving the portfolio performance and returning to the arrears level where the bonus is paid. Specifically, for loan officers above the cutoff point the arrear of the portfolio decreases by 0.21 standard deviations per month. Also consistent with rational income maximization, the increased monitoring effort of loan officers above the cutoff point is concentrated on larger loans that have a higher weight on the portfolio arrear. These results are obtained using a within estimation that follows the same loan officer and the same loan over time, during the variable and the flat compensations regimes.

The increased effort in monitoring existing loans comes at the expense of the time spent originating loans and screening loan applications; loan officers generate fewer applications but approve a higher fraction of them. The former effect dominates the later, and thus in the net the total number of new loans issued by the loan officers above the cutoff point decreases significantly. Despite approving a higher proportion of applications, these new loans are less likely to default than the loans issued when the loan officer is below the cutoff point. Apparently loan officers have a pecking order and process applications only for the very best clients when time is limited ("cherry picking").

These novel results might improve researchers and practitioners' understanding of how lower-level employees in financial institutions react to financial incentives, and how their reaction affects the overall health of the financial market. A fuller understanding of these topics can help financial institutions in the design of better incentive compensation plans, and it might also help regulators in the evaluation of restrictions in bank employees' compensation structure.

Previous empirical work has focused primarily on the impact of performance-based compensation on the loan officer's lending decision. For example, using data from a large U.S. commercial lender, Agarwal and Ben-David (2012) study how loan-volume-based compensation affects loan volume and delinquency rates. They find that when compensation rewards volume loan officers generate more but lower quality loans. Using loan files from an Indian bank, Cole et al. (2012) study in a laboratory experimental setup how compensation that rewards originated loan volume, but penalizes bad loan performance, affects lending decisions and subsequent loan performance. They find that such incentives entail more screening effort and better lending decisions. Using data of a major European bank, Berg et al. (2012) study how automated lending decisions based purely on hard information influence loan officer behavior when compensation depends on generated loan volume, and find that loan officers bias their assessment of the borrowers' risk to increase the pool of clients that are eligible to get credit.

While extant literature establishes an important causal relation between the financial incentives and the lending decision, it is mute about the effect of financial incentives on the behavior of the loan officer "after" the lending decision is made. This is surprising since it is well known that monitoring borrowers can severely affect their loans' performance (e.g. Drexler and Schoar, 2013). In a sense, previous work relies on the assumption that the performance of a loan depends exclusively on the initial screening process.

A fundamental contribution in our paper is to relax this assumption by explicitly considering that the loan officer can affect the loan's quality at any point in time, not only at the beginning of the loan cycle. Our setup facilitates the analysis of the tradeoff faced by loan officers when confronted with the triple task of generating volume (loan origination), verifying clients' ex-ante expected default (screening) and making sure the loan portfolio she originates does not deteriorate over time (monitoring).

On a broader level, our study is also related to the literature on the presence of agency problems within banks (Liberti and Mian, 2009; Hertzberg et al., 2010) and the emerging literature on loan officers in general. For instance, Drexler and Schoar (2013) study the importance of relationships between loan officers and borrowers for loan take-up and other loan outcomes. Fisman et al. (2012) study the role of cultural proximity on the efficiency of credit allocation. Qian et al. (2011) use Chinese data to study the effects of increased accountability of loan officers on the assessment of credit risk. Beck et al. (2012, 2013) analyze the impact of loan officer gender on portfolio performance gender-based discrimination. We contribute to this literature by studying how loan officers' compensation affects credit allocation and risk.

Furthermore, our study contributes to the general literature on performance compensation in firms (e.g. Jensen and Murphy, 1990; Baker et al., 1998; Lazear, 2000; Bandiera et al., 2007, 2009, 2013; Kremer et al., 2010) and, more specifically, to the literature on compensation and risk-taking in banks that has focused almost entirely on top executives (Bebchuk and Spamann, 2010; Bolton et al., 2010; Balachandran et al., 2011; Fahlenbrach and Stulz, 2011). We contribute to this literature by studying how financial incentives affect the behavior of lower-level employees throughout the entire loan cycle.

The remainder of the paper is structured as follows: In section two, we provide institutional background information about the lender and the incentive scheme, outline our

identification strategy, and discuss the sample composition. In section three, we present the main empirical results. Section four discusses the consequences of the changes in loan officer behavior on loans' terms and performance and section five concludes.

2. Data and Identification Strategy

2.1 Sources of data and institutional background information of the lender

Our data comes from a large for-profit international commercial lender serving mainly individuals and small- and medium-size enterprises. The dataset includes 55,946 loan applications and 43,063 loans issued by the lender between January 2003 and October 2007. We observe approved applications as well as rejected applications, which we use to construct measures of origination and screening effort.

The bank had 22 branches and 268 loan officers at the beginning of the sample period. Loan officers have discretionary power on the loans' approval decision, size, and terms like interest rate and maturity. Loan officers are also responsible for monitoring the loans they issue. If a loan is in arrears for more than 30 days the officer can intensify monitoring, for instance, by calling the borrower, sending him a letter or visiting him to inquire about the reasons of the delay.

Some businesses' sectors are covered by specialized loan officers; however the majority of the borrowers can be allocated to any loan officer. Loan officers process loans to their pre-existing clients, and also look for new clients pro-actively. Clients that walk into a branch are allocated to the loan officer who is available at the time, barring an assignment based on any observable or unobservable characteristics.

2.2 Loan Officer Compensation

The results in the paper rely on the comparison between two compensation plans used by the lender during the sample period. The first compensation plan was used between January 2003 and November 2004, and consisted of a fixed salary and a monthly cash bonus, in the rest of the paper we refer to this period as the *bonus period*. The bonus was proportional to the loan officer's lending volume; however in months where the amount in arrears in his portfolio was above three percent, the bonus was cancelled. The strict threshold to cancel the bonus generates a non-linearity that is crucial in our identification strategy described in the next section.

In November 2004, the bonus plan was replaced by a mixed plan and subsequently by a fixed salary plan. Specifically, between December 2004 and December 2005, the cash bonus was limited to 50 percent of the fixed salary and after January 2006 the salary of loan officers became independent of lending volume and performance. In the paper we refer to this last period as the *no bonus period*. To facilitate the interpretation of the findings in the paper we present the comparison between the bonus period and the no bonus period. However similar results are obtained when we compare the bonus plan to the mixed and fixed salary plans.

There is no formal documentation why the loan officer compensation structure was changed. However, the management of the bank was emphatic that the switch was not a reaction to a change in market conditions, or to deterioration in the quality of the portfolio.[1] Rather, the change was intended to release loan officers from short-term pressure to issue (underperforming) loans. The motivation of the modification of the salary structure creates an ideal natural experiment setup.[2] Furthermore, the change was implemented in all the bank

1 Our research about the bank competition in the region confirmed the statement of the bank management. Indeed, we don't find changes in bank competition measures such as the number of banks and the number of bank branches before the bonus plan was replaced.

2 The other dimension that can affect effort is the risk of being fired which is also smaller for loan officers with low arrear frequencies. We do not study this dimension, and for simplicity assume that this incentive mechanism does not change during the observation period. However, the econometric approach requires a weaker

branches at the same time and was immediately binding for all the loan officers eliminating potential selection bias.

2.3 Identification Strategy

We rely on two distinctive characteristics of our empirical setup to identify the effect of the financial incentives on the loan officer behavior. First, during the bonus period, the loan officers received a cash bonus only in the months where the arrear in their portfolio was below the cutoff point of three percent, arbitrarily determined by the lender. Second, we observe the performance of the same loan officer during the bonus period and the no bonus period. Ultimately we identify the effect of incentive based compensation plans by comparing the change in the behavior of the loan officer when he crosses the cutoff in the bonus period to the change in the behavior of the loan officer when he crosses the cutoff in the no bonus period.

Given our approach, we can only focus on loan officers that work for the lender both during the bonus and the no-bonus periods. We are faced with a potential selection problem if bad loan officers stay with the bank and good loan officers leave, in that case our results will reflect the effect of incentive based compensation plans on the performance of bad loan officers.

We acknowledge that it is not possible to fully address this problem because we only observe loan officers' performance which depends not only on his type but also on his good (bad) luck. However, we study the magnitude of the problem based on observable information. Table 1 shows that only 10% of the loan officers leave the bank before the bonus plan is replaced, therefore we know that the bias is limited. Although we find that departing loan officers were more experienced, they do not differ significantly from the rest with respect

assumption; that any change in the probability of being fired is linear around the cutoff point.

to loan portfolio performance. We further compare the group of loan officers who leave the bank to an experience-matched group of loan officers that stay (the top three deciles according to experience). Loan portfolio performance results remain similar. Thus it does not seem to be the case that particularly bad loan officers stay after the bonus plan is replaced. Furthermore, given that loan officers who value prefer short-term financial incentives are more likely to leave the bank; our results represent a lower bound estimation of the effect on all loan officers.

As a first step we implement a difference-in-differences estimator by tracking loan officers above and below the cutoff and before and after the removal of the bonus plan. Specifically, we measure the difference between the behavior of the loan officers below the cutoff and the behavior of the loan officers above the cutoff; this represents the "first difference" and is estimated separately during the bonus period and during the no bonus period. Next we measure the difference between the "first difference" estimated during the bonus period and the "first difference" estimated during the no bonus period; this represents the "second difference" (DD henceforth). The identifying assumption underlying the DD approach is that the difference in the behavior of loan officers below and above the cutoff is constant overtime unless there is a change in the incentive compensation. Hence, while loan officers may differ systematically due to a number of unobservable factors, the identification of the causal effect of the incentive plan on the loan officers' behavior will be robust as long as the difference in the behavior of the loan officers above and below the cutoff explained by unobservable characteristics does not change overtime.

Given the richness of our data we can relax the former assumption by including fixed effects that control for unobservable differences across loan officers. Furthermore, in the main analysis of the paper we can include loan fixed effects which let us compare the same loan officer-borrower pair overtime thus controlling for potential heterogeneity in the selection of

borrowers before and after the bonus is removed. We also include observable bank branch and (time-varying) loan officer characteristics, which are explained later in the paper.[3]

We use a placebo test to further validate our identification assumption. In this test we run the same set of regressions maintaining the cutoff at the same level but arbitrarily changing the date were the bonus was removed. If our identification is capturing time varying changes unrelated to the compensation plan then we expect to find significant differences in the placebo test. However we do not find significant differences above and below the cutoff point in the placebo supporting our view that the findings in the paper are explained by the change in the compensation structure.

2.4 Summary Statistics

The sample consists of 486,555 observations at the loan-month level; this number is the number of approved loans times its number of monthly observations in the sample period. The loan officers' monitoring effort is measured as monthly changes in the arrears of a given loan, where we use a delay of 30 days or more as the measure of arrears. Specifically, we construct the variable $\Delta Arrears30_t$, that takes the value of 1 if a loan was not in arrears in the previous month but is in arrears in the current month, it takes the value of -1 if a loan was in arrears in the previous month but is not in arrears in the current month, and it takes the value of 0 if there was no change in the arrears status.

Table 2 provides descriptive statistics for the time-varying variables used in the monitoring analysis.[4] The average monthly change in arrears is 0.13 percent. The average proportion of loans in arrears in the previous month equals 0.76 percent. The average loan

3 It may, however, be the case that there are loan officer specific time-varying unobserved factors that influence their effort and thus the likelihood of their loan portfolio ending above or below the bonus threshold. While we view this as unlikely, we cannot fully rule out this possibility.

4 Table A1 in the appendix presents descriptive statistics of additional dependent variables used in the paper.

officer experience, measured as the number of previously processed applications is 439; the average number of loans in a loan officer's portfolio is 194. The average loan outstanding amount is 3,555 Euros, and the average time to maturity is 10 months.

3. Empirical Results and Discussion

In this section we show the main results explaining how financial incentives influence loan officers' behavior along the three most important tasks of their job; monitoring, loan origination, and screening. We also provide evidence that loan officers have a pecking order and engage in cherry picking by selecting only the best borrowers when the cutoff is binding and the time to originate loans is limited. In addition, we present the results of a placebo test that provides further evidence of the robustness of our identification strategy.

3.1 Monitoring

Panel A in table 3 presents the unconditional difference in difference estimation (DD), of the effect of the incentive based compensation plan on the arrears frequency. This estimation represents the difference between the monthly change in arrears frequency of the portfolio of loan officers above the cutoff and the monthly change in arrears frequency of the portfolio of loan officers below the cutoff during the bonus period compared to the same difference calculated during the no bonus period.

During the bonus period, the average change in arrears frequency is -0.0007 when a loan officer is above the cutoff, which means loans' performance in average improves, and is 0.0011 when a loan officer is below the cutoff, which means loans' performance in average deteriorates. Consequently the first difference in the DD estimation is -0.0018 and is highly statistically significant. On the other hand the average change in the arrears frequency in the no-bonus period seems to be independent of the loan officer being above or below the cutoff, consequently the first difference is -0.0002 and is not statistically significant. These results suggest that under the financial incentive plan loan officers that surpass the cutoff change their monitoring behavior in order to reduce the average arrears in their portfolio, but when the salary is fixed loan officers do not seem to change their monitoring behavior, consequently the DD estimate is negative and highly significant. These results suggest that loan officers increase the monitoring effort when they are above the cutoff point during the bonus period.

3.2 A Closer Look into Monitoring Effort

The results in the previous subsection support our prior that an increase in monitoring effort is the most plausible reaction of a loan officer that suddenly finds herself with a poor performing portfolio that negatively affects his compensation. To the best of our knowledge, the existing literature on loan officer compensation has so far ignored that loan officers might

react to financial incentives by increasing/decreasing monitoring. This is surprising, since recent work shows that monitoring is one of the loan officers' tasks that have the highest impact on portfolio performance (Drexler and Schoar, 2013). One reason for this void in the literature could be the lack of appropriate data, because analyzing monitoring effort requires the time series of the performance of each loan and its link to individual loan officers. Specifically, to disentangle the impact of monitoring from the impact of screening the researcher needs precise information about the loan origination date and about each date when a payment was missed.

An advantage of our dataset is that we have the one-to-one match between borrowers and loan officers, and for each loan we observe the issuing date, and the date of each missed payment. This enables us to focus on the within loan variation in monthly arrears. It is apparent that screening will only affect the overall and thus time-invariant riskiness of a loan, but not its time series variation. Hence, any effect of financial incentives that we find in the setup from the previous section has to be due to changes in the extent (quality or intensity) to which loan officers monitor their borrowers.

The caveat of the results in the previous subsection is that the characteristics of loan officers above the cutoff can be very different from the characteristics of loan officers below the cutoff. Furthermore the loans observed during the bonus period can be substantially different from the loans observed during the no bonus period. In our main analysis we control for these potential differences by including loan officer, and loan fixed effects, this leads to the following specification:

$$(1) \quad \Delta Arrears30_{it} = ArrearFrequency_{jt-1} + AboveCutoff_{jt-1} + Bonus_t + b_1 * AboveCutoff_{jt-1} * Bonus_t + a_t + a_i + \eta_{ijt} + e_{jt},$$

where $\Delta Arrears30_{it}$ is the monthly change in arrear frequency for loan i and month t, a_t is a time fixed effects, and a_i is a loan fixed, η_{ijt} is a vector of time-variant loan- and loan officer-

level covariates that include the outstanding loan amount, the remaining time to maturity, the loan officer experience measured as total number of loans processed by loan officer *j* since he started working at the bank, and his workload measured as the number of outstanding loans in his portfolio at time *t*. $ArrearFrequency_{jt\text{-}1}$ is the arrears frequency in the portfolio of loan officer *j* at the previous month *t*-1, and controls for the lineal component of the effect of arrears on monitoring effort.[5] $Bonus_t$ is a dummy variable that takes on the value of one if date *t* is from January 2003 to October 2004 and zero if it is from January 2006 to October 2007, and $AboveCutoff_{jt\text{-}1}$ is a dummy variable that takes the value of one if the arrears frequency of loan officer *j* was above the cutoff at *t*-1 and zero otherwise. This specification allows us to rule out that borrower selection effects drive our findings because by exploring the within loan variation, we hold the borrower constant.[6] The parameter of interest is b_1, is the measure of the effect of compensation based incentives on loan officers' behavior. A negative value of b_1 indicates that the monthly change in arrears decreases when the loan officer surpasses the cutoff in the bonus period compared to the change in arrears when a loan officer surpasses the cutoff in the no bonus period.[7] This would support our inference from the univariate DD result that loan officers increase their monitoring effort when they surpass the cutoff.

Panel B of Table 3 presents the estimation of specification (1) along with the estimation of other specifications that test the robustness of the main finding to the inclusion of different control variables and fixed effects. Column I presents the results including a set of time

5 We also ran all the regressions using the second-order polynomial of arrear frequency as an additional control variable to account for a potential non-linearity in the effect of the arrear frequency on the different outcome variables. All results remain unchanged.

6 Any other time-invariant loan, borrower or loan officer characteristics are saturated by the loan fixed effects. We cannot fully rule out that there are time-variant borrower characteristics that are correlated with the loan officer ending up below / above the cutoff value, although this does not seem very plausible.

7 We present the results this way to facilitate the interpretation of the results, despite the bonus period being before the no-bonus period in the timeline of events.

invariant loan level covariates (described in Table A2 of the appendix) and excluding the fixed effects, the point estimate of b_1 is 0.0054 and is significant at the 5% level. The next two columns add time and loan officer fixed effects. Column 4 includes loan fixed effects that saturate the time invariant loan level characteristics, therefore this column only includes the time varying covariates outstanding loan amount, remaining time to maturity, loan officer experience, and loan officer workload.

In all the regressions we get a negative and highly significant estimate of b_1. Financial incentives seem to induce loan officers to change their monitoring behavior – they monitor either more time, more efficiently or both – in order to reduce the proportion of the portfolio in arrears and maximize their income. Crucially, this result holds when we include loan fixed effects in column 4. Furthermore, the economic effect is much stronger in this case and represents 0.21 standard deviations of the monthly change in arrears. The last result rules out that borrower selection, for instance differences in the quality of the screening of loan applications during the bonus and the no bonus period, or unobserved (time invariant) loan officer skills drive our findings.

We next analyze whether the former finding depends on loan size. The idea is as follows. The loan officers' portfolio arrears are measured as a size-weighted average of the individual loan's arrears. It should, hence, be more beneficial for the loan officer to intensify their monitoring effort of larger loans. Furthermore, the possibility of loan officers to improve the performance of a loan is generally more limited in the case of small loans (Cole et al., 2012). Therefore, we expect the monitoring effect to be more pronounced for large loans.

To test this effect, we compute a dummy variable $LargeLoan_{it}$ that takes the value of one if the outstanding amount of loan i is above the average outstanding amount across all the loans in t and zero otherwise. We then estimate an extended version of specification (1) that

includes the *LargeLoan* variable as well as its two- and three-way interaction with the variables *Bonus* and *AboveCutoff* already difined. This leads to the following specification:

$$(2) \quad \Delta Arrears30_{it} = ArrearFrequency_{jt-1} + AboveCutoff_{jt-1} + Bonus_t + LargeLoan_{it} + LargeLoan_{it}*Bonus_t + b_1*AboveCutoff_{jt-1}*Bonus_t + b_2*AboveCutoff_{jt1}*LargeLoan_{it} + b_3*AboveCutoff_{jt1}*Bonus_t*LargeLoan_{it} + a_t + a_i + x_{ijt} + e_{it},$$

where b_1 captures the effect of incentives on the loan officers' monitoring effort of loans below the average size, b_2 captures the differential increase in monitoring effort exerted by loan officers when the loan size is above the average and the arrear frequency is above the cutoff, and b_3, the coefficient of interest, quantifies the extent to which the increase in monitoring effort by loan officers above the cutoff during the bonus period compared to the increase in monitoring effort by loan officers above the cutoff during the no-bonus period depends on loan size.

Column 1 of table 4 shows the estimation of specification (2) including loan officer fixed effects, while column 2 shows the estimation using loan fixed effects; both estimations include time-varying covariates and time fixed effects. The estimate of b_3 is negative and significant in both estimations confirming our expectations that the increase in the monitoring effort exerted by the loan officers above the cutoff in the bonus period is concentrated on larger loans.

Taken together, these results provide novel and compelling evidence that financial incentives affect loan officers' monitoring behavior. For instance, loan officers seem to exert more monitoring effort when the performance of their loan portfolio is above the cutoff and they are penalized by losing the bonus payment.

3.2 Loan origination effort

We next check whether the additional monitoring effort of loan officers above the cutoff arrears comes at the expense of the other two activities they typically perform: origination and screening. To the best of our knowledge, this is the first study that examines the effect of financial incentives on loan origination effort in a real-world setup where compensation is performance-dependent.[8]

The data we use for this test are at the loan officer-month level and include 5,476 observations. We define loan origination effort $OriginationEffort_{jt}$ as the ratio of the origination volume over the outstanding loan volume of loan officer j in month t. Similarly to our analysis in specification (1) we test if the change in the effort exerted by the loan officer in this dimension when he surpasses the cutoff during the bonus period is different from the change in the effort exerted when he surpasses the cutoff during the no-bonus period. We use an OLS specification and we gradually include different sets of covariates and fixed effects to test the robustness of the results. The specification can be described as:

$$(3) \quad OriginationEffort_{jt} = ArrearFrequency_{jt} + AboveCutoff_{jt} + Bonus_t + b_1 * AboveCutoff_{jt} * Bonus_t + \gamma_{jt} + a_j + a_{bt} + e_{jt},$$

where $ArrearFrequency_{jt}$ is the volume of loans in arrears for more than 30 days as a fraction of the total volume of loan in the portfolio of loan officer j in month t. The parameter of interest b_1, measures the effect of financial incentives on loan origination effort. The parameter γ_{jt} captures loan officer experience measured as the number of loan applications handled by loan officer j until month t. To further control for loan officer heterogeneity like differences in skills or ability we include a loan officer fixed effects a_j. Finally, we include a

8 Heider and Inderst (2012) develop a theoretical framework that analyzes the effect of competition on loan origination effort. Agarwal and Ben-David (2012) analyze how financial incentives impact generated loan volume, but the incentive scheme studied by them differs in a fundamental way. In their setup, incentives are based on loan volume only and are independent of loan performance.

branch-by-time fixed effects a_{bt} to control for time variant determinants of loan origination at the branch level such as regional changes in loan demand.

Table 5 presents the OLS estimation of specification (3). Column 1 only controls for loan officer experience. The negative value of b_1 suggests that the loan officers that surpass the cutoff point during the bonus period reduce their loan origination effort compared to the loan officers that surpass the cutoff point during the no-bonus period. This result is both statistically and economically significant as the point estimate of 13.34 percent represents a difference of 0.78 standard deviations.

Columns 2 and 3 show similar results for b_1 when we add month fixed effects, and loan officer fixed effects. Importantly, column 4 also shows significant results – albeit of somewhat smaller magnitude – when we add branch-by-time fixed effects. The results in column 4 are important because they address concerns that loan officer characteristics or regional changes in loan demand may be driving the findings, but this does not seem to be the case.

3.3 Quality of selected loans

To better understand the impact of financial incentives on loan origination, we study if loan officers surpassing the cutoff during the bonus period change the quality of their originated loans and we test if this change in quality is different for loan officers surpassing the cutoff during the no-bonus period. Specifically, we would like to understand whether loan officers surpassing the cutoff during the bonus period increase the average quality but decrease the number of new loans. Such changes would be an indication of a cherry picking behavior. For instance, given the time constraints associated to increasing monitoring, loan officers might need to reduce the number of originated loans. During the bonus period it would be natural, given the structure of the

compensation plan, to focus on the highest quality loans that might push down future arrear frequencies below the cutoff value. To study this potential consequence we develop a statistical model that predicts the ex-ante credit quality of selected loan applications, and we use the predicted credit quality as the dependent variable in a regression analysis.

Our credit quality measure is constructed using information available to the loan officer at the time of the loan origination. If such borrower-specific observable characteristics have predictive power of future performance, then loan officers may be able to select higher quality "cherry pick" clients at least based on these variables (but potentially on many other unobservable variables).

Characteristics which are observable (or easily verifiable) for loan officers at the time of the loan origination are the business sector of the borrower, applied loan amount, number of employees, leverage, total assets, cash over total assets, applied loan amount over total assets, whether the client has an account at the bank, whether the client had ever applied for a loan at the bank, the juridical form, and yearly country-specific macroeconomic variables like GDP, inflation and unemployment rate. Macroeconomic variables are extracted from the World Bank webpage and are lagged in one year.

We estimate an out of sample logit regression to explain the observed arrears of more than 30 days for loans issued during the sample period. We re-calibrate the model on a yearly basis to include the most recent historical information. For example in 2003 we include all the information from 1996 to 2002, in 2004 we include all the information from 1996 to 2003, etc. Then we use the coefficients obtained from these regressions to

estimate each borrower's ex-ante probability of default (PD henceforth).[9] The estimated PDs are used as the dependent variable in the following specification:

$$(4) \quad PD_i = ArrearFrequency_{jt} + AboveCutoff_{jt} + Bonus_t + b_1 * AboveCutoff_{jt} * Bonus_t + a_t + a_j + x_{ijt} + e_{jt}$$

In this model, PD_i is the estimated one-year ex-ante PD of borrower *i* and x_{ijt} is a vector of covariates including loan-application level covariates of Table A2 of the appendix, but excluding the covariates used for the PD prediction model.

Table 6 presents the OLS estimation of specification (4). We find negative and highly significant estimates for b_1 in all three specifications. Column (3), for instance, which includes loan officers fixed effects, shows that the ex-ante PD of new borrowers is 0.51 percent lower when a loan officer is above the cutoff value during the bonus period. This represents a reduction in the unconditional ex-ante PD of about 0.2 standard deviations. These findings suggest that loan officers above the cutoff originate ex-ante better loan applications than loan officers below the cutoff value in the bonus period vis-à-vis the same comparison in the no-bonus period.

3.4 Rejection Rates

Finally, we study the impact of financial incentives on loan officers' rejection rates using the sample of all 55,946 loan applications. We estimate the following specification using an OLS estimation as before:

$$(5) \quad RejectionRate_i = ArrearFrequency_{jt} + AboveCutoff_{jt} + Bonus_t + b_1 * AboveCutoff_{jt} * Bonus_t + a_t + a_j + x_{ijt} + e_{jt},$$

where $RejectionRate_i$ is a binary variable that takes the value of one if a loan application is rejected and zero otherwise. x_{ijt} is a vector of covariates including all loan-application

9 For brevity the results of the logit estimation are not shown in the paper but they are available upon request.

level covariates of Table A2 of the appendix (except the balance sheet information in the first three specifications as these variables are often missing for rejected loan applications). The coefficient of interest is still b_1.

Column 3 of table 7 presents the results for the most comprehensive specification. The gap in the rejection rate of applications above the cutoff and the rejection rates of applications below the cutoff presents a moderate difference between the bonus and the no bonus period. In fact, rejections are comparatively lower for applications above the cutoff during the bonus period. The difference is 1.7 percent, represents 0.04 standard deviations of the unconditional rejection rate and is significant at the 10% level. In addition, column 5 analyzes the average time loan officers spent processing a loan application (measured in days). We find a negative coefficient of 0.7 days, which is not significantly different from zero however.

Taken together with the results in the loan origination and the loan quality subsections, these findings provide evidence that loan officers seem to engage in cherry picking by screening fewer but better quality borrowers, on average. Cherry picking may be based on observable or on unobservable borrower characteristics, but either way, it should improve loan performance. We examine this possibility below.

All in all, our findings suggest that loan officers seem to rationally solve an optimization problem. For instance, loan officers above the cutoff point during the bonus period reduce the time they spend in loan origination and screening and allocate additional time to monitoring in an attempt to maximize the bonus payments.

3.5 Placebo tests

In a difference-in-differences regression setup the identification is based on the assumption of a parallel trend over time. In our case this assumption would require that (in the absence of a compensation change) the difference between loan officers' behavior above and below the cutoff is constant over time, this condition would be violated, for example, if the pool of loan officers above and below the cutoff changes overtime.

Our identification strategy relies on less stringent assumptions. By including loan officers fixed effects we hold the loan officer constant and therefore we do not need that the pull of loan officers above and below the cutoff are similar overtime, instead we only need that (in the absence of a modification to the compensation plan) the change in the loan officer behavior when he crosses the cutoff is constant overtime. The non-linearity of the compensation plan relaxes the condition even more, for instance given this non-linearity we do not require that the change in the performance of the loan officer when he crosses the cutoff is constant over time, instead we only need that the change is not discontinuous. Both of these refinements make our identification strategy quite robust.

Nonetheless it is still possible, albeit unlikely, that other nonlinearities exist around the cutoff point that affects the behavior of the loan officer. To confirm that such nonlinearities are not present in the data we run a placebo test where we repeat the estimations in the paper but we arbitrary shift the date of the shock. For brevity we use only the preferred specifications for each dependent variable; monitoring effort (column 4 of Table 3's Panel B), loan origination (column 4 of Table 5), ex ante PD (column 3 of Table 6), and screening (column 3 of Table 7).

We run two separate placebo tests using all four outcome variables. First, we only focus on observations from the no-bonus period and assume that the change in

compensation structure was in the middle of the no-bonus period. Therefore the *bonus* placebo treatment variable equals one for observations from the first half of the no-bonus period and zero otherwise. As there was no change of the incentive compensation plan in the no-bonus period, we should not find any differential effect for being above or below the cutoff in the placebo test, unless there are other nonlinear effects around the cutoff.

Table 8 displays the results of the placebo test. None of the estimates, denoted as *AboveCutoff*Bonus* in the table, are statistically different from zero except for the origination effort estimate, but even this parameter is barely significant at the 10 percent level and its magnitude is four times smaller compared to the real effect presented in table 5. These results confirm our expectation that there are no other non-lineal differential effects associated to being below or above the cutoff during the no-bonus period.

In an unreported placebo test, we focus on observations from the bonus period only. Again, we split the bonus period into two sub-periods of approximately equal length and construct a placebo treatment variable (*bonus*) that takes the value of one if the observation is from the first half of the bonus period, and zero otherwise. We then re-estimate the regressions using the same four outcome variables. As expected, and similarly to the first test all the estimates for the placebo treatment dummies are also close to zero and non statistically significant. These tests validate our identification assumption and suggest that we are indeed capturing the effect of the change of the incentive compensation structure.

4. Implications on loan performance and other loan contract terms

4.1 Loan performance

Our results so far provide evidence that loan officers above the cutoff in the bonus period exert more monitoring effort and engage in cherry picking in an attempt to maximize wage payments. If a loan officer exerts more monitoring effort on its pre-existing loans and selects better borrowers when she is above the cutoff, then the loans issued when she is above the cutoff during the bonus period should outperform other loans. We test this implication using the sub-sample of all approved loans, and their observed arrears of more than 30 days during a window of period of six months as the dependent variable. Importantly, we do not use loans for which the six months period overlaps the bonus and the no bonus periods because in these cases it is not clear under which incentive scheme the loan performance changed.

Table 9 shows that the likelihood of a borrower being in arrears for more than 30 days within the first six months after the loan was granted is significantly lower when the issuing loan officer was above the cutoff during the bonus period, as indicated by the negative and significant coefficient of *AboveCutoff*Bonus*. This result holds when we include month fixed effects (column 2) and loan officer fixed effects (column 3). Columns (4) and (5) change the performance window to four and eight months, and finds similar but not statistically significant results.

Taken together, these results suggest that the performance of loans issued when the loan officers are above the cutoff value in the bonus period are of better quality compared to similar loans issued during the period without variable incentives. In this particular test we are, however, not able to disentangle whether the improvement in loan performance stems from cherry picking, changes in screening standards, increased monitoring effort, or a combination of them.

4.2 Loan contract outcomes

Besides changing the effort exerted in loan monitoring, origination, or screening, loan officers can also adjust loan contract terms in order to increase the likelihood of receiving a bonus payment. As a final test, we analyze whether loan officers use their discretion to change important loan contractual characteristics. Specifically, we study if they modify the interest rate of the loan contract, the approved loan amount, the approved share defined as the approved loan amount over the applied loan amount, and the loan maturity in days. For measurement purposes we use the replace loan amount and maturity with their natural logs.

As this analysis is performed at the loan-level, the most comprehensive specification includes covariates, time fixed effects and loan officer fixed effects.[10] The effect of incentive based compensation plans on loan terms is obtained using specification (5) with one of the aforementioned loan contract characteristics as dependent variables. We can only use approved loans for these analyses yielding an estimation sample of 43,063 approved loans.

10 We do not use the respective covariate as explanatory variable in case we use it as dependent variable. For instance, when we analyze the loan amount, we do not include the applied loan amount as explanatory variable.

Table 10 presents the OLS estimation of these specifications. We do not find significant changes in interest rates, loan amounts or loan maturity since the coefficient of interest, *AboveCutoff*Bonus*, is never significant.[11] However, we find that loan officers increase the approved share, i.e. they react more favorably to the loan size requests of borrowers that get loans during the bonus period and when the loan officers' arrear frequencies are above the cutoff value. This finding is consistent with the cherry picking hypothesis; when loan officers are above the cutoff during the bonus period they process loans for the very best clients who, compared to the average client, seem to get loan amounts that are much closer to their requested amount.

5. Conclusion

The ongoing debate about the role that loan officers and loan originators played in the recent financial crises has spurred an increased interest in studying the main drivers of their behavior. Our study contributes to this area of research in important ways; we provide novel results about the effect of financial incentives on the three major dimensions of the loan officers' job including loan origination, screening and monitoring. Furthermore, to the best of our knowledge, we are the first to show how loan officers' compensation plans can affect the effort exerted in monitoring the borrower's performance. This dimension has been ignored in previous work that has focused mostly on screening, although the omission of monitoring in the analysis may lead to an overstatement of the estimated impact of other dimensions.

We study the behavior of loan officers at a large international bank before and after the abolition of a performance-based compensation plan. What makes this setup special is that the original compensation plan is highly non-lineal. In particular, it rewards the loan officer with

11 This result stands in contrast to the findings in Agarwal and Ben-David (2012), but may be explained by the use of a fundamentally different incentive scheme in their work. However the result is consistent with the findings in Drexler and Schoar (2013), who find that loan officer adjust lending by cutting credit rather than adjusting the terms of the loans.

a bonus that increases monotonically with the loan volume as long as the proportion of the portfolio in arrears is below three percent, but is cancelled when the proportion of the portfolio in arrears surpasses that limit.

Our results indicate that when loan officers have an underperforming portfolio that leads to the cancellation of the bonus, they allocate more time to monitoring and reduce the time allocated to loan origination. This behavior seems to be effective because by increasing monitoring loan officers are able to increase borrowers' repayment rate and recover their eligibility for the bonus. The increase in the monitoring effort is concentrated on larger loans, which seems rational given that the portfolio in arrears is estimated as a volume weighted average of the arrears of each loan.

The results also suggest that loan officers have a pecking order and renew loans only for the very best clients if there are time constraints. The selected borrowers are not only of higher quality, based on observable characteristics at the time the new loan is issued, but they also present better ex-post performance.

Our findings allow us to make the general causal claim that adequate financial incentive structures for loan officers (for example the one described in the paper) are effective in improving loan quality. However, estimating the efficiency of these financial incentive plans from the perspective of the bank requires more information than is currently available.

The detailed analyses we are able to perform given our rich dataset helps to better understand not only how loan performance improves after a change in financial incentives, but also how loan officers reallocate their time in order to improve the loans' performance. This is an important result for researchers and practitioners alike that might contribute to the debate about optimal compensation schemes for loan officers and similar agents in financial institutions, as well as the debate about the implications of increasing governmental regulations on financial institutions' compensation structures.

References

Agarwal, S., Ben-David, I., 2012, Do Loan Officers' Incentives Lead to Lax Lending Standards?, Working Paper.

Baker, G., Jensen, M., Murphy, K., 1998, Compensation and Incentives: Practice vs. Theory, *Journal of Finance* 43, 593-616.

Balachandran, S., Kogut, B., Harnal, H., 2011, Did Executive Compensation Encourage Extreme Risk-Taking in Financial Institutions?, Working Paper Columbia University.

Bandiera, O., Barankay, I., Rasul, I., 2007, Incentives for Managers and Inequality among Workers: Evidence from a Firm-Level Experiment, *Quarterly Journal of Economics* 122, 729-773.

Bandiera, O., Barankay, I., Rasul, I., 2009, Social Connections and Incentives in the Workplace: Evidence from Personnel Data, *Econometrica* 77, 1047-1094.

Bandiera, O., Barankay, I., Rasul, I., 2013, Team Incentives: Evidence from a Field Experiment, *Journal of the European Economic Association* 11, 1079-1114.

Bebchuk, L., Spamann, H., 2010, Regulating Bankers' Pay, *Georgetown Law Journal* 98, 247-287.

Beck, T., Behr, P., Madestam, A., 2012, Sex and Credit: Is There a Gender Bias in Lending?, Working Paper Tilburg University and IGIER Bocconi University.

Beck, T., Behr, P., Guettler, A., 2013, Gender and Banking: Are Women Better Loan Officers?, *Review of Finance* 17, 1279-1321.

Berg, T., Puri, M., Rocholl, J., 2012, Loan officer incentives and the limits of hard information, Working Paper.

Bolton, P., Mehran, H., Shapiro, J., 2010, Executive Compensation and Risk-Taking, Working Paper Federal Reserve Bank of New York.

Cole, S., Kanz, M., Klapper, L., 2012, Incentivizing Calculated Risk Taking: Evidence from a Series of Experiments with Commercial Bank Loan Officers. Working Paper, Harvard University / World Bank.

Diamond, D., 1984, Financial Intermediation and Delegated Monitoring, *Review of Economic Studies* 51, 393-414.

Drexler, A., Schoar, A., 2013, Do Relationships Matter? Evidence from Loan Officer Turnover, Working Paper.

Fahlenbrach, R., Stulz, R., 2011, Bank CEO Incentives and the Credit Crisis, *Journal of Financial Economics* 99, 11-26.

Heider, F., Inderst, R., 2012, Loan Prospecting, *Review of Financial Studies* 25, 2381-2415.

Hertzberg, A., Liberti, J.M., Paravisini, D., 2010, Information and Incentives Inside the Firm: Evidence from Loan Officer Rotation, *Journal of Finance* 65, 795-828.

Jensen, M., Murphy, K., 1990, Performance Pay and Top-Management Incentives, *Journal of Political Economy* 98, 225-264.

Kremer, M., Kaur, S., Mullainathan, S., 2010, Self-Control at Work: Evidence from a Field Experiment, Working Paper Harvard University.

Lazear, E.P., 2000, Performance Pay and Productivity, *American Economic Review* 90, 1346-1361.

Liberti, J.M., Mian, A., 2009, The Effect of Hierarchies on Information Use, *Review of Financial Studies* 22, 4057-4090.

Qian, J., Strahan, P.E., Yang, Z., 2011, The Impact of Incentives and Communication Costs on Information Production: Evidence from Bank Lending, Working Paper Boston College.

Table 1: Loan officer selection

This table tests for loan officer selection. We compare the characteristics of loan officers who left the lender before the variable compensation plan was replaced, group (I), with loan officers who stayed, group (II). Only the latter group is included in our DD estimations below. Loan officers who leave the lender are more experienced than loan officers who stay. We thus form a third group, (III), including an experience matched group of loan officers who stay at the bank. We compare the average across loan officers of several characteristics for the period of January 2003 to October 2004 where the variable compensation plan was still in place. *Loan officer experience* is the number of loan applications that were already handled by a loan officer in the bonus period. *ArrearFrequency* is a loan officer's average loan portfolio arrear frequency in the bonus period. *AboveCutoff* is a dummy variable that takes the value of one if the arrear frequency of a loan officer was above the cutoff value of 3 percent in month *t* and zero otherwise. Colum 4 shows the differences between loan officers who left the lender and loan officers who stayed at the bank. Colum 5 shows the differences between the loan officers who left the lender and a group of loan officers with similar experience who stayed at the bank (top 3 experience deciles). Statistical inference is based on standard t-tests. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively.

	Loan officer type				Differences	
	(I) Left	(II) Stayed	(III) Stayed High experience		(I) - (II)	(I) - (III)
Loan officer experience	156.58	56.20	155.15		100.38***	1.4345
ArrearFrequency	0.0038	0.0046	0.0043		-0.0008	-0.0005
AboveCutoff	0.0168	0.0245	0.0315		-0.0077	-0.0147
N	28	240	72			

Table 2: Monitoring – Descriptive statistics

This table shows descriptive statistics for the variables used in the monitoring analysis. The data are at the loan-month level. The first row shows the dependent variable, $\Delta Arrears30_t$, which takes the value of 1 if the loan was not in arrears in the previous month but it is in arrears in the current month, it takes the value of 0 if there was no change in the arrear status, and it takes the value -1 if the loan was in arrears in the previous month but it is not in arrears in the current month. Rows two to four present time-variant loan officer characteristics. $ArrearFrequency_{t-1}$ is the loan officer's average loan portfolio arrear frequency in the previous month. *Loan officer experience*$_t$ is the number of loan applications handled until date *t*. *Number of outstanding loans*$_t$ is the loan officer's number of outstanding loans at date t, which we use as a proxy for the loan officer's work load. The last two rows present time-variant loan characteristics. *Outstanding amount*$_t$ is the loan's outstanding amount in Euro, while *Remaining maturity*$_t$ is the remaining loan maturity in months.

Variable	Mean	N	Std dev	Min	p25	p50	p75	Max
$\Delta Arrears30_t$	0.0013	486,555	0.0478	-1.0000	0.0000	0.0000	0.0000	1.0000
Loan officer characteristics								
$ArrearFrequency_{t-1}$	0.0076	486,555	0.0188	0.0000	0.0000	0.0008	0.0085	1.0000
Loan officer $experience_t$	439	486,555	284	0	221	408	608	1,474
Number of outstanding $loans_t$	194	486,555	108	1	109	195	269	545
Loan characteristics								
Outstanding $amount_t$	3,555	486,555	14,324	0	447	1,029	2,312	1,300,000
Remaining $maturity_t$	10	486,555	9	0	3	8	14	87

Table 3: Monitoring – Baseline results

Panels A and B present results that capture changes in monitoring effort. The data are at the loan-month level and are restricted to loan officers who were active before and after the removal of the bonus. Panel A presents the univariate differences-in-differences (DD) analysis. It displays the average across loan officers of the variable $\Delta Arrears30_t$, which takes the value of one if the loan was not in arrears in the previous month but it is in arrears in the current month, takes the value of zero if there was no change in the arrear status, and takes the value minus one if the loan was in arrears in the previous month but it is not in arrears in the current month. The average is presented for loan officers below and above the cutoff and during the bonus and the no-bonus period. Statistical inference is based on OLS regressions that uses standard errors clustered at the loan officer level. Panel B presents the OLS regression of specification (1) where $\Delta Arrears30_{it}$ is the dependent variable. $ArrearFrequency_{jt-1}$ is the arrear frequency of loan officer *j* in the previous month and $AboveCutoff_{jt-1}$ is a dummy variable that takes the value of one if the arrear frequency of loan officer *j* was above the cutoff value of three percent in the previous month and zero otherwise. $Bonus_t$ is a dummy variable that takes the value of one if the observation is from January 2003 to October 2004 and zero otherwise. The covariate sets are defined in the Table A2 in the appendix, the first set includes time invariant covariates at the loan level, the second set includes time variant covariates on the loan officer level, and the third set includes time variant covariates at the loan level. *,**,*** denotes significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

Panel A: Univariate DD results

	ΔArrears30, by loan officer arrear frequency		
Period	Below cutoff	Above cutoff	Difference
Bonus	0.0011	-0.0007	-0.0018***
No-bonus	0.0014	0.0011	-0.0002
DD			-0.0016**

Panel B: Multivariate regressions

	(1)	(2)	(3)	(4)
$ArrearFrequency_{jt-1}$	-0.0117	-0.0117	-0.0270	-0.0770***
	(0.0133)	(0.0135)	(0.0167)	(0.0272)
$AboveCutoff_{jt-1}$	0.0001	0.0002	-0.0013	-0.0004
	(0.0010)	(0.0010)	(0.0012)	(0.0016)
$Bonus_t$	-0.0004			
	(0.0002)			
$AboveCutoff_{jt-1}*Bonus_t$	-0.0054**	-0.0054**	-0.0044*	-0.0098**
	(0.0021)	(0.0022)	(0.0027)	(0.0048)
Time fixed effects	No	Yes	Yes	Yes
Loan officer fixed effects	No	No	Yes	No
Loan fixed effects	No	No	No	Yes
Covariate set 1	Yes	Yes	Yes	No
Covariate set 2	Yes	Yes	Yes	Yes
Covariate set 3	Yes	Yes	Yes	Yes
Observations	486,555	486,555	486,555	486,555
Adj. R square	0.0019	0.0024	0.0025	0.0013

Table 4: Monitoring – Loan size interaction regressions

This table shows the OLS regression of specification (2) and examines whether the increase in monitoring effort of loan officers that surpass the cutoff is focused on larger loans. Variables are defined as in table 4, in addition we use the variable *Large loan*$_i$ that takes the value of one if the outstanding amount of loan *i* is above the median outstanding loan amount in the respective month and zero otherwise. The covariate sets are defined in appendix Table A2. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

	(1)	(2)
ArrearFrequency$_{jt-1}$	-0.0268	-0.0759***
	(0.0165)	(0.0267)
AboveCutoff$_{jt-1}$	-0.0011	0.0024
	(0.0012)	(0.0016)
Large loan$_i$	0.0016***	0.0002
	(0.0003)	(0.0003)
AboveCutoff$_{jt-1}$*Bonus$_t$	-0.0012***	0.0011
	(0.0004)	(0.0009)
AboveCutoff$_{jt-1}$*Large loan$_i$	0.0016	0.0042
	(0.0018)	(0.0030)
Large loan$_i$*Bonus$_t$	-0.0004	-0.0048***
	(0.0010)	(0.0013)
AboveCutoff$_{jt-1}$*Bonus$_t$*Large loan$_i$	-0.0095**	-0.0223***
	(0.0041)	(0.0063)
Time fixed effects	Yes	Yes
Loan officer fixed effects	Yes	No
Loan fixed effects	No	Yes
Covariate set 1	Yes	No
Covariate set 2	Yes	Yes
Covariate set 3	Yes	Yes
Observations	486,555	486,555
Adj. R square	0.0019	0.0015

Table 5: Loan origination effort

This table shows the OLS regression of specification (3) and examines whether an incentive based compensation plan affects loan origination effort. The data are at the loan officer-month level and are restricted to loan officers who were active before and after the removal of the variable compensation plan. We measure loan origination effort as the volume of loan applications over the volume of outstanding loans per loan officer *j* at date *t*. $ArrearFrequency_{jt}$ is the arrear frequency of loan officer *j* at date *t* and $AboveCutoff_{jt}$ is a dummy variable that takes the value of one if the arrear frequency of loan officer *j* was above the cutoff value of 3 percent in month *t* and zero otherwise. $Bonus_t$ is a dummy variable that takes the value of one if the observation is from January 2003 to October 2004 and zero otherwise. The regressions control for loan officer experience and include different combinations of fixed effects and as indicated in the table. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

	(1)	(2)	(3)	(4)
$ArrearFrequency_{jt}$	0.1283	0.1357	-0.0709	-0.0710
	(0.1600)	(0.1510)	(0.1226)	(0.1055)
$AboveCutoff_{jt}$	-0.0569***	-0.0564***	0.0024	0.0082
	(0.0137)	(0.0127)	(0.0156)	(0.0146)
$Bonus_t$	0.1220***			
	(0.0095)			
$AboveCutoff_{jt}*Bonus_t$	-0.1334***	-0.1272***	-0.1355***	-0.1251***
	(0.0413)	(0.0417)	(0.0336)	(0.0309)
Time fixed effects	No	Yes	Yes	No
Loan officer fixed effects	No	No	Yes	Yes
Time-by-branch fixed effects	No	No	No	Yes
Loan officer experience	Yes	Yes	Yes	Yes
Observations	5,476	5,476	5,476	5,476
Adj. R square	0.2803	0.2971	0.4220	0.3666

Table 6: Quality of originated loans

This table shows the OLS estimation of specification (4) and explores if incentive based compensation plans affect the quality of the originated loans. The data are at the loan application level and are restricted to loan officers who were active before and after the removal of the bonus compensation plan. We measure loan quality as the predicted ex ante credit risk based on historical information. The credit risk measure is annually calibrated using variables which are observable (or easily verifiable) for loan officers at the time of loan origination: business sector of the borrower, loan amount needed, number of employees, leverage, total assets, cash over total assets, applied loan amount over total assets, whether the client had an account at the bank, whether the client had ever applied for a loan at the bank, juridical form, and the three yearly macroeconomic variables GDP, inflation and unemployment rate. The dependent variable, ex ante probability of default (*PD*), is based on a logit regression using the aforementioned variables. $ArrearFrequency_{jt}$ is the arrear frequency of loan officer *j* in month *t* and $AboveCutoff_{jt}$ is a dummy variable that takes the value of one if the arrear frequency of loan officer *j* was above the cutoff value of 3 percent in month *t* and zero otherwise. $Bonus_t$ is a dummy variable that takes the value of one if the observation is from January 2003 to October 2004 and zero otherwise. We include covariates sets 1 and 2 of table A2 of the appendix, excluding these used to calculate the ex-ante PD. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

	(1)	(2)	(3)
$ArrearFrequency_{jt}$	-0.0041	0.0008	-0.0033
	(0.0135)	(0.0133)	(0.0112)
$AboveCutoff_{jt}$	0.0033*	0.0038**	0.0016
	(0.0017)	(0.0016)	(0.0012)
$Bonus_t$	-0.0194***		
	(0.0005)		
$AboveCutoff_{jt}*Bonus_t$	-0.0077***	-0.0073***	-0.0051**
	(0.0026)	(0.0026)	(0.0021)
Time fixed effects	No	Yes	Yes
Loan officer fixed effects	No	No	Yes
Covariates	Yes	Yes	Yes
Observations	45,826	45,826	45,826
Adj. R square	0.3910	0.4099	0.3208

Table 7: Rejection Rate and Processing Time

This table shows the effect of loan officer variable compensation structure on loan rejection probability. The data are at the loan application level and are restricted to loan officers who were active before and after the removal of the bonus scheme. The dependent variable in the first four columns is the rejection rate of the 55,946 loan applications in the period of January 2003 until October 2007. The dependent variable for the fifth column is the processing time that is measured in days loan officer *j* needs to evaluate loan application *i*. $ArrearFrequency_{jt}$ is the arrear frequency of loan officer *j* at date *t* and $AboveCutoff_{jt}$ is a dummy variable that takes the value of one if the arrear frequency of loan officer *j* was above the cutoff value of 3 percent in month *t* and zero otherwise. $Bonus_t$ is a dummy variable that takes the value of one if the observation is from January 2003 to October 2004 and zero otherwise. We include covariates sets 1 and 2 of table A2 of the appendix. The reduced covariate set 1 excludes *Leverage*, *Cash over total assets*, *Total assets*, ln(*Applied maturity*), and *Applied loan over total assets* that are often missing for rejected loan applications. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

	Rejection rate					Processing time
	(1)	(2)	(3)	(4)		(5)
$ArrearFrequency_{jt}$	0.0544	0.0545	0.0365	0.0241		2.2385
	(0.0482)	(0.0485)	(0.0408)	(0.0456)		(2.7705)
$AboveCutoff_{jt}$	0.0025	0.0022	0.0026	0.0033		-0.3214
	(0.0049)	(0.0049)	(0.0034)	(0.0044)		(0.2313)
$Bonus_t$	-0.0114***					
	(0.0025)					
$AboveCutoff_{jt}$*$Bonus_t$	-0.0268***	-0.0269***	-0.0174*	-0.0204**		-0.7164
	(0.0094)	(0.0094)	(0.0089)	(0.0083)		(0.8449)
Time fixed effects	No	Yes	Yes	Yes		Yes
Loan officer fixed effects	No	No	Yes	Yes		Yes
Reduced covariate set 1	Yes	Yes	Yes	No		No
Covariate set 1	No	No	No	Yes		Yes
Covariate set 2	Yes	Yes	Yes	Yes		Yes
Observations	55,946	55,946	55,946	45,826		45,826
Adj. R square	0.9731	0.9731	0.9722	0.9141		0.2286

Table 8: Placebo tests

This table shows the OLS regression of a placebo tests where we repeat the estimations from the previous tables considering only the no bonus period and shifting arbitrarily the date of the change in the compensation plan. The placebo treatment variable, *PlaceboBonus* equals 1 for observations from the first half of the no-bonus period. The variables *ArrearFrequency* and *AboveCutoff* are measured at date *t*-1 for the analysis in the first column and are measured at date *t* for the remaining three columns. Covariates and fixed effects are included in the regressions as indicated in rows 7-10 in the table. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

	ΔArrears30	Origination effort	Ex-ante PD	Rejection rate
	(1)	(2)	(3)	(4)
$ArrearFrequency_{jt(-1)}$	-0.0509***	-0.0701	0.0084	-0.0130
	(0.0161)	(0.0835)	(0.0160)	(0.0267)
$AboveCutoff_{jt(-1)}$	-0.0022**	0.0020	-0.0009	0.0021
	(0.0011)	(0.0119)	(0.0017)	(0.0031)
$AboveCutoff_{jt(-1)}$*$PlaceboBonus_t$	-0.0003	-0.0300*	0.0022	-0.0014
	(0.0011)	(0.0157)	(0.0022)	(0.0044)
Loan officer fixed effects	No	Yes	Yes	Yes
Loan fixed effects	Yes	No	No	No
Time fixed effects	Yes	No	Yes	Yes
Time-by-branch fixed effects	No	Yes	No	No
Covariates	Yes	Yes	Yes	Yes
Observations	438,971	3,308	30,956	39,132

Table 9: Loan performance regressions

This table shows effect of loan officer incentive based compensation on ex-post loan performance. The data are at the loan level and are restricted to loan officers who were active before and after the removal of the bonus plan. The arrear likelihood is 1 if a loan was in arrears for more than 30 days at least once within the first 6 months after it was granted. We exclude loans with maturities below 6 months and loans for which the six months period overlaps the bonus and the no bonus periods. We either use a 6 months (columns 1 to 3), 4 months (column 4) or 8 months (column 5) time window. $ArrearFrequency_{jt}$ is the arrear frequency of loan officer j in month t and $AboveCutoff_{jt}$ is a dummy variable that takes the value of one if the arrear frequency of loan officer j was above the cutoff value of 3 percent at date t and zero otherwise. $Bonus_t$ is a dummy variable that takes the value of one if the observation is from January 2003 to October 2004 and zero otherwise. We include covariates sets 1 and 2 of table A2 of the appendix. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

Arrear likelihood	6 months	6 months	6 months	4 months	8 months
	(1)	(2)	(3)	(4)	(5)
$ArrearFrequency_{jt}$	0.1010*	0.1008*	-0.0033	0.0370	-0.0250
	(0.0529)	(0.0535)	(0.0552)	(0.0635)	(0.0427)
$AboveCutoff_{jt}$	-0.0036	-0.0038	-0.0132**	-0.0083	-0.0076
	(0.0052)	(0.0052)	(0.0054)	(0.0053)	(0.0059)
$Bonus_t$	-0.0022				
	(0.0018)				
$AboveCutoff_{jt}*Bonus_t$	-0.0212***	-0.0208***	-0.0166*	-0.0076	-0.0120
	(0.0054)	(0.0055)	(0.0087)	(0.0087)	(0.0159)
Time fixed effects	No	Yes	Yes	Yes	Yes
Loan officer fixed effects	No	No	Yes	Yes	Yes
Covariate set 1	Yes	Yes	Yes	Yes	Yes
Covariate set 2	Yes	Yes	Yes	Yes	Yes
Observations	27,606	27,606	27,606	34,299	22,591
Adj. R square	0.0216	0.0212	0.0176	0.0307	0.0050

Table 10: Loan contract outcome regressions

This table shows the effect of incentive based compensation plans on the interest rate, loan size, approved share (approved over applied loan amount), and loan maturity for all approved loans. Loan size and maturity are replaced with their natural logs. $ArrearFrequency_{jt}$ is the arrear frequency of loan officer j at date t and $AboveCutoff_{jt}$ is a dummy variable that takes the value of one if the arrear frequency of loan officer j was above the cutoff value of 3 percent at time t and zero otherwise. $Bonus_t$ is a dummy variable that takes the value of one if the observation is from January 2003 to October 2004 and zero otherwise. We include covariates sets 1 and 2 of table A2 of the appendix. The loan size control is excluded from the estimation in column 2, and the loan maturity control is excluded from the estimation in column 4. *,**,*** indicate significance at the 10, 5, and 1 percent level, respectively. Standard errors in parentheses are clustered at the loan officer level.

	Interest rate	ln(Loan size)	Approved share	ln(Maturity)
$ArrearFrequency_{jt}$	0.0066	0.2446	0.0806	0.0041
	(0.0131)	(0.2092)	(0.0640)	(0.1071)
$AboveCutoff_{jt}$	-0.0011	-0.0211	-0.0021	-0.0061
	(0.0019)	(0.0159)	(0.0075)	(0.0102)
$AboveCutoff_{jt}*Bonus_t$	0.0020	0.0165	0.0338***	0.0220
	(0.0026)	(0.0495)	(0.0121)	(0.0191)
Time fixed effects	Yes	Yes	Yes	Yes
Loan officer fixed effects	Yes	Yes	Yes	Yes
Covariate set 1	Yes	Yes	Yes	Yes
Covariate set 2	Yes	Yes	Yes	Yes
Observations	43,063	43,063	43,063	43,063
Adj. R square	0.4889	0.8914	0.1324	0.8266

Appendix

Table A1: Additional descriptive statistics of further dependent variables

This table shows descriptive statistics for the dependent variables of tables 5, 6, 7, 9, and 10. *Loan origination effort* is the volume of loan applications over the volume of outstanding loans per loan officer-month observation. We winsorize this measure at the 2.5 / 97.5 percent level (Table 5). *Ex ante PD* (probability of default) provides the observable borrower riskiness (Table 6). *Rejection rate* reflects the percentage of rejected loan applications, while *Processing time* is measured as the number of days elapsed from the day the loan application was submitted until the rejection/approval decision was made (Table 7). *Arrear likelihood* equals 1 if a loan was in arrears for more than 30 days at least once in the first 6 (4, 8) months after it was issued (Table 9). *Interest rate* is the loan contract interest rate, ln(*Loan size*) is the natural logarithm of the approved loan size in Euro, *Approved share* is the approved over the applied loan amount (winsorized at the 2.5 / 97.5 percent level), and ln(Loan maturity) is the natural logarithm of the loan maturity in days (Table 10).

Variable	Mean	N	Std dev	Min	p25	p50	p75	Max
Origination effort	0.1816	5,476	0.1719	0.0159	0.0729	0.1225	0.2222	0.8000
Ex ante PD	0.0535	45,826	0.0254	0.0016	0.0377	0.0488	0.0631	0.6331
Rejection rate	0.2289	55,946	0.4201	0.0000	0.0000	0.0000	0.0000	1.0000
Arrear likelihood, 6 months	0.0067	27,606	0.0818	0.0000	0.0000	0.0000	0.0000	1.0000
Arrear likelihood, 4 months	0.0054	34,299	0.0732	0.0000	0.0000	0.0000	0.0000	1.0000
Arrear likelihood, 8 months	0.0058	22,591	0.0762	0.0000	0.0000	0.0000	0.0000	1.0000
Interest rate	0.1266	43,063	0.0272	0.0249	0.1078	0.1322	0.1410	0.2520
ln(Loan size)	7.5328	43,063	1.0635	3.9773	6.7036	7.3941	8.0827	14.0779
Approved share	0.9248	43,063	0.1533	0.5000	0.8750	1.0000	1.0000	1.1765
ln(Approved maturity)	6.3488	43,063	0.4610	4.0943	6.0403	6.2916	6.5793	8.5942

Table A2: List of covariates in covariate set 1

This table shows covariates that are used in the different regressions.

Covariate	Description
Covariates set 1: Loan level	
Leverage	Total liabilities / total assets
Cash over total assets	Liquid assets / total assets
Total assets	Total assets In Euro
ln(Applied amount)	Natural logarithm of the loan size in the borrower's application in Euro
ln(Applied maturity)	Natural logarithm of the loan maturity in the borrower's application in days
Applied loan over total assets	loan size in the borrower's application in Euro / total assets
Juridical form business	1 if the client is a legal entity and 0 if the client is a natural person
Available account	1 if the client has other accounts (checking, savings, etc.) at the bank at the time of the loan application and 0 otherwise
Has been in arrears	1 if the client has been in arrears on a previous loan
Has been rejected	1 if the client has had an application rejected at the bank at a previous date
Last week of the month	1 for loans whose application was completed in the last week of the month and 0 otherwise
Number of loan application	1 for the first loan application, 2 for the second loan application etc.
Loan destination	Loan used for working capital, fixed assets, mixed working capital and fixed assets, real estate, consuming, or others
Loan category	Size and sector specific categories
Business sector	Agriculture, Production, Construction, Transportation, Trade, Other services, or Others
Covariates set 2: Loan officer-by-time level	
Loan officer experience	Number of loan applications that were already handled by a loan officer at time t
Number of outstanding loans	Number of outstanding loans per loan officer (proxy for workload) at time t
Covariates set 3: Loan-by-time level	
ln(Outstanding amount)	Natural logarithm of the outstanding loan amount at time t in Euro
ln(Remaining maturity)	Natural logarithm of the remaining maturity (in months) at time t