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Federal Reserve Bank of Chicago

**Perverse Incentives at the Banks?
Evidence from a Natural Experiment**

Sumit Agarwal and Faye H. Wang

WP 2009-08

Perverse Incentives at the Banks?
Evidence from a Natural Experiment*

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Abstract

Incentive provision is a central question in modern economic theory. During the run up to the financial crisis, many banks attempted to encourage loan underwriting by giving out incentive packages to loan officers. Using a unique data set on small business loan officer compensation from a major commercial bank, we test the model's predictions that incentive compensation increases loan origination, but may induce the loan officers to book more risky loans. We find that the incentive package amounts to a 47% increase in loan approval rate, and a 24% increase in default rate. Overall, we find that the bank loses money by switching to incentive pay. We further test the effects of incentive pay on other loan characteristics using a multivariate difference-in-difference analysis.

JEL Classification: D3, G2, J3

Key Words: Incentive Compensation; Small Business Lending; Loan Officers; Piece Rate
and Salaries

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“Despite the vast outpouring of commentary and outrage over the financial crisis, one of its most fundamental causes has received surprisingly little attention. I refer to the perverse incentives built into the compensation plans of many financial firms, incentives that encourage excessive risk-taking with OPM -- Other People's Money”

Professor Alan Blinder, Wall Street Journal, May 28, 2009

1. Introduction

The current financial crisis has led to much debate about incentive provision at financial institutions.¹ While the causes of the mortgage meltdown are complex, many would argue that perverse economic incentives are an important factor contributing to the current mess. Specifically, many banks in recent years gave out incentive packages to encourage loan underwriting. While such financial incentives were designed to promote greater employee efforts, anecdotal evidence suggests that they also encouraged loan officers to make more loans to unqualified borrowers.² In this paper, we study the effects of an incentive pay based on loan origination by formally modeling two tasks loan officers perform: their efforts to assess loan quality and their loan origination decisions. The model allows us to derive testable implications regarding the approval rates, default rates and other characteristics of booked loans under an incentive pay. In addition, we provide answers to two central questions in the incentive provision literature: 1) do incentives matter, that is, do agents respond to contracts that reward performance? 2) are these responses in the firm's interest, or do such contracts induce perverse incentives?

We employ a unique data set from a large, national commercial bank on loan officer compensation, which allows us to empirically study loan officers' incentives and loan performances. In January 2005, the management of the bank switched half of the loan officers from fixed-wage compensation contracts to a new incentive compensation

¹ See Fahlenbrach and Stulz (2009) and Bebchuck and Spamann (2009).

² See Morgenson, Gretchen, “Was there a loan it didn't like?,” *New York Times*, November 1, 2008.

package based on loan origination. We examine the status of more than 30,000 small business loan applications received at the bank from 12 months before the compensation change to 12 months after and the performance of more than 140 loan officers. The effects of such incentive pay on approved loan characteristics are dramatic, and are largely consistent with economic theory.

For this purpose, we develop a theory of loan officers' incentives to assess loan quality, with emphasis on the predictions that pertain to the compensation changes at this bank. Consistent with our model's predictions, we highlight the following empirical results:

- 1) A switch to incentive pay increases the loan approval rate by 47%, the total number of booked loans by 44%, the average dollar amount of booked loans by 45%, and the default rate by 24%.
- 2) The average amount of time spent per loan applications drops by 21%.
- 3) The above effects of incentive pay are stronger for larger and longer maturity loans, and loans that contain more soft-information.
- 4) Although the bank shares the gains in more loan origination, the large amount of loan defaults results in a welfare loss for the bank.

These results are in line with the model we developed on loan origination, which takes into account the loan officer's career concerns and different loan information regimes. The loan origination process starts when a loan officer receives a loan application that contains observable information. The loan officer then studies the credit risks of the borrower and investigates the loan quality by exerting costly effort. We assume that the probability of revealing the loan quality depends on the loan officer's

unobservable effort. She then makes a loan origination decision based on the information she reveals. This information may be hard or soft information. One distinction between hard information and soft information is that soft information is a signal that cannot be verified ex post (Petersen, 2004). We study cases where the loan officer makes the loan approval decision based on unverifiable information, or soft information, and where she makes the decision based on verifiable information, or hard information. With soft information lending, the loan officer may lie about the information she reveals in order to approve the loan.

Much of the literature on incentive provision has focused on the role of output-based contracts in solving the agency problem for the principal: if effort cannot be monitored, output-based contracts can address the moral hazard problem induced by agents' hidden actions. We show that the effectiveness of such contracts in mitigating moral hazard depends crucially on whether hard or soft information is used in the loan origination decision. If hard information is used, incentive compensation works well to align the loan officer's incentive to search for good loans. High-powered incentive compensation, in this case, motivates loan officers to work harder at assessing loan quality and writing more and better loans. If, however, the lending decision is based on soft information, incentive compensation may distort the loan officer's incentive to "overbook" risky loans. This conclusion is consistent with Inderst (2008).³

The loan officer's career concern, on the other hand, also plays an important role as a disciplinary device in soft-information lending. The loan officer trades off a monetary bonus with her career concern. In this case, incentive compensation may distort

³ Inderst (2008) studies loan officers' incentive to generate new loan applications and their loan origination decisions under soft- and hard-information lending. The focus is more on bank competition and the optimal lending standard.

the loan officer's effort, depending on the strength of the incentives given. Indeed, we find that younger loan officers respond to the incentive pay by booking more loans, without sacrificing loan quality, compared to older loan officers whose loans have a much higher default rates under the incentive pay. This is consistent with the view that younger agents have more career concern at stake.

This paper offers new insights into the process of originating small business loans by focusing on the incentives faced by loan officers and how this affects the underwriting process. The conflict of interest between the loan officers and the bank has rarely been studied in the literature, with the exception of Udell (1989). By surveying 140 mid-western banks, Udell finds that banks increase monitoring of their loan officers when the bank explicitly compensates loan officers for generating more new business. Our model provides a theoretical foundation for this result.

Our paper also relates to a broader literature on incentive provision to individuals in organizations, which is a central issue in modern microeconomics (see Prendergast (1999) for an extensive survey). In the context of compensation contracts, the provision of incentives usually takes the form of pay-for-performance, or piece-rate contracts (Lazear and Rosen (1981); Stiglitz (1981); Holmstrom (1982); Green and Stokey (1983)). Researchers have analyzed the choice of one compensation system over another (see Gibbons (1998), literature review). In particular, piece-rate payment has the effects of inducing appropriate effort levels and sorting workers across jobs (Lazear (1986)). Alternatively, economists also argue that such incentive contracts may give rise to dysfunctional behavioral responses, where agents emphasize only those aspects of performance that are rewarded (Baker (1992)). For example, agents may choose quantity

over quality. Following Holmstrom and Milgrom (1990) and Baker (1992), this incentive problem has become known as multi-tasking, where agents will allocate effort toward those activities that are directly rewarded and away from the uncompensated ones. Loan officers' compensation provides a perfect opportunity for studying multi-tasking. Incentives are provided on the dimension of quantity and not on quality. We show that distortion arises for soft-information lending in particular.

Due to the lack of data, there has been little work documenting the effect of compensation policies on performance. Lazear (1996) studies the performance of auto windshield workers and documents the incentive and worker selection effects of piece-rate contracts. Paarsch and Shearer (1996) provide similar evidence using data on Canadian tree planters. It is important to bear in mind that these studies document cases in which the jobs carried out are relatively "simple," in the sense that 1) performance is easily measured and 2) the quality is easily observed. The loan officer's job in our paper is much more complicated than those in the previous papers. Most importantly, the quality of the loan officer's work is not easily measured due to unobservable randomness of other factors. Our data set is richer, in the sense that it allows us to further analyze the effects of incentive contracts on multi-tasking behavior of the agents. In addition to providing empirical evidence for the existing theories, we add to the banking literature by studying how loan officers' incentives affect the process of small business loan underwriting.

The rest of the paper proceeds as follows. Section 2 develops a model of incentive compensation. Section 3 provides a detailed description of the data. Section 4 provides empirical results. Section 5 concludes.

2. Model Description

The primary motivation behind the incentive scheme is to increase worker efforts. A central role that loan officers play in the process of loan origination is to assess loan quality. In particular, loan origination depends on a significant amount of soft and subjective information from loan officers (Udell (1989)). In this section, we study the loan officer's choice of effort to detect bad loans and her loan origination decisions under the incentive pay. We find conditions under which such incentive scheme gives rise to loan officers' responses that are not in the bank's interest.⁴

A loan application is characterized by (Y, T, q) , where Y denotes the requested loan amount, T is the time to maturity and q captures the *ex-ante* observable risk profile of the loan. Assume that q is uniformly distributed on $[0,1]$. There are two types of loans: a loan is "good" with probability q , and "bad" with probability $1-q$. A good loan is repaid with probability p —that is, with probability $1-p$ even a good loan may fail. A bad loan defaults with certainty. Therefore, the higher q , the lower the probability of default. In addition, we assume that the bank makes a profit on good loans only and loses money on bad and questionable ones.

To focus on the loan officer's choice of effort to assess loan quality, we model a risk neutral loan officer's decision to exert unobservable effort, e , and her loan origination decision. The probability θ that the loan officer reveals the loan type depends on her effort e . With probability $1-\theta$, the loan type remains uncertain. We assume that $\theta'(e) > 0$, $\theta(0)=0$ and $\theta(\infty)=1$.⁵ We also assume that $e'(\theta) \in [0, \infty)$ and $e''(\theta) > 0$.⁶

⁴ See Inderst (2008) for an analysis of optimal compensation contracts.

⁵ Assume that θ is continuous. Then the inverse function $e(\cdot)$ is continuous and $e'(\theta) > 0$.

Assume that a compensation contract is given by $a + b(Y)$, where a is the base salary and $b(\cdot)$ is the bonus based on the amount of loans originated. Assume that $b(Y) \geq 0$, and $b'(Y) > 0$. For notional simplicity, we normalize a to zero.⁷ In the case a loan is denied, the loan officer receives no bonus component. If a loan is booked, she receives

$$b(Y) - e(\theta) - \rho c(T),$$

where ρ is the probability that a loan defaults, and $c(T)$ is the negative career consequences of a defaulted loan. Specifically, we assume that $c(T)$ takes the functional form $c(T) = Ke^{-\delta\tau(T)}$, where $K > 0$ is the negative career shock to the loan officer when a default occurs, and $\tau(T)$ is the expected default time of a loan with maturity T , and is an increasing function of T .⁸ δ is the discount rate.

We focus on a loan officer's decision to assess loan quality under an incentive scheme that rewards her for loan originations. The basic game proceeds as follows: a loan officer reviews a loan application characterized by (Y, T, q) . She exerts costly effort e , and reveals the loan type with probability $\theta(e)$. For soft-information lending, the loan officer has private access to information about the borrowing firm that is "hard to quantify, verify and communicate through the normal transmission channels of a banking organization." (Berger and Udell (2002).) She can conceal, or lie about, the information she reveals. On the other hand, if lending is primarily based on hard information, the loan officer cannot conceal the information she reveals and this information is verifiable ex post by the bank. The loan officer then makes an approval decision and receives payoffs accordingly.

⁶ One such example of the functional form of $e(\cdot)$ would be $e(\theta) = \tan(\theta * \pi/2)$.

⁷ In an optimal contract, a is set such that the loan officer's individual rationality condition is satisfied.

⁸ This assumption can be justified by a model with a constant Poisson intensity of default.

With hard-information lending, the loan officer no longer plays an active role at the loan origination stage, since only loans revealed to be good may be booked. The problem reduces to a pure moral hazard problem, in which the only decision factor is the loan officer's hidden effort. Consistent with economic theory, incentive pay promotes greater effort without sacrificing the loan quality. We provide a formal analysis in Appendix A.

2.1 Perverse incentives with soft-information lending

In this section, we study the loan officer's decisions in a soft-information lending regime. The loan officer makes a lending decision based on her privately observed soft information, which cannot be verified by the bank. She may lie about the soft information she reveals in order to book the loan. In this case, whether monetary incentives create perverse incentives depend on the loan officer's career concern and the strength of the incentives.

We analyze the soft-information lending problem in two steps. We first focus on the approval decision, then derive the loan officer's optimal effort level. The loan officer's approval decision now depends on the information revealed and privately observed by her: the loan type is good (G), bad (B), or no information is revealed, that is, the loan quality remains questionable (Q). In order for the loan to be approved, the loan officer may revise her subject input of the loan application's risk rating downwards for a bad or questionable loan. If a loan is booked, the loan officer gets the following payoffs based on revealed types:

$$\begin{aligned}
P(G) &= b(Y) - (1 - p)c(T) - e(\theta), \\
P(B) &= b(Y) - c(T) - e(\theta), \\
P(Q) &= b(Y) - (q(1 - p) + (1 - q))c(T) - e(\theta).
\end{aligned}$$

Depending on the loan officer's career concern and the size of the monetary bonus, which is tied to the amount of the loan requested, it may be in the loan officer's interest to not only book the good loans but also the questionable ones. In other words, monetary bonus may induce her to take more risks for these loans.

If the incentives are small enough or the loan officer's career concern is large enough such that she only writes good loans, we find that the effect of incentive contract is exactly the same as with the hard-information case: incentive compensation promotes effort without sacrificing loan quality. If the monetary bonus gets too large, such that the loan officer will accept any loan applications even the bad ones, we show that the loan officer has no incentive to exert effort and that incentive packages are purely costly to the bank. We discuss these two cases in more depth in Appendix B.

We focus on the case where the loan officer approves both the good loans and the questionable ones, but her career concern is large enough that she wants to avoid writing bad loans. Recall that if no information is revealed, the prior assumption that the loan is good with probability q , in which case, the bank loses money on such loans. Such questionable loans cannot be booked with hard-information lending, nor does the loan officer have incentives to book such loans when the monetary incentive is small relative to her career concern. However, as the monetary incentives get large, the loan officer may find it profitable to write such loans at the bank's expense. This is where an incentive pay may induce perverse incentives.

The question becomes when will the loan officer be incentivized to write questionable loans? The loan officer will revise her subjective input for the loan quality upwards for a questionable loan when the following constraints are satisfied:

$$\begin{aligned} b(Y) - (1 - p)c(T) &\geq 0, \\ b(Y) - (q(1 - p) + (1 - q))c(T) &\geq 0, \\ b(Y) - c(T) &< 0. \end{aligned}$$

We next analyze the loan officer's choice of effort under the above conditions. Recall that when the loan officer exerts costly effort e , with probability θ the loan type will be revealed, and with probability $1 - \theta$ its type remains questionable, in which case the loan is good with probability q , and bad with probability $1 - q$. The loan officer has incentive to book both the good loans and the questionable ones if the monetary incentive is large or when her career concern is relatively weak. The loan officer gets payoff

$$q\theta[b(Y) - (1-p)c(T)] + (1-\theta)[b(Y) - (q(1-p) + 1-q)c(T)] - e(\theta),$$

yielding a FOC:

$$\begin{aligned} q[b(Y) - (1 - p)c(T)] - [b(Y) - (q(1 - p) + 1 - q)c(T)] &= e'(\theta) \\ \Rightarrow \\ -(1 - q)b(Y) + (1 - q)c(T) &= e'(\theta). \end{aligned}$$

From the above FOC, we can derive the approval rate, the default rate of booked loans, and other comparative statics. We summarize these results in the following proposition. All proves are in the appendix.

Proposition 1 *If the monetary incentive is large or the loan officer's career concern is small, the loan officer will book a loan unless it is revealed to be bad. In this case,*

1. *The loan officer's effort level to investigate loan quality decreases with the loan amount, the time to maturity, the ex-ante score of the loan and the strength of monetary incentives, and increases with her career concern.*
2. *The probability of loan origination decreases with the loan officer's effort, increases with the loan amount, the time to maturity, the ex-ante score of the loan, and the strength of monetary incentives, and decreases with her career concern.*
3. *The probability of defaults decreases with the loan officer's effort, increases with the loan amount, the time to maturity, and the strength of monetary incentives, and decreases with her career concern.*

We see that monetary incentives induce preserve incentives in these that they reduce the loan officer's effort to assess loan quality. The intuition is as follows. The loan officer receives a monetary bonus only when a loan is booked. Since both the good loans and the questionable ones are booked, her effort to investigate loan quality only affects her booking decision of bad loans, which she will not book weighing in her career concerns. In other words, the loan officer's effort decreases the likelihood that she will book a loan and receive the monetary bonus. Career concern, on the other hand, serves as an effective disciplinary device and motivates the loan officer to exert effort to avoid booking bad loans.

Interestingly, the ex-ante quality of a loan, q , does not predict the likelihood of loan origination or the default probability of a booked loan. Taking the derivatives with respect to q to the FOC, we get $b(Y) - c(T) = e''(\theta) \frac{\partial \theta^*}{\partial q}$. Since $c(T) > b(Y)$, it is easy to see that the loan officer's effort decreases with q . In this case, the loan officer increases her effort to investigate lower quality loans to avoid booking a bad loan. Although these

lower quality loans are more likely to be bad and will default with greater probability, the loan officer also spends more effort to investigate them and avoids making loan originations. Thus, there is no direct relationship between the score and the expected default probability.

2.2 Empirical Implications

In the previous section, we analyze whether incentive pay creates perverse incentives for loan officers by studying their choices of effort to investigate loan quality and their loan origination decisions. While the choice of effort is hidden, the probability of default, which decreases with the level of effort, is observable. We thus have the following predictions:

***Prediction 1** Under incentive pay, the likelihood that a loan is booked increases with the loan amount Y , the time to maturity T , and the ex-ante score q .*

***Prediction 2** Under incentive pay, the default probability of booked loans increases with the loan amount Y and the time to maturity T , when the strength of monetary incentive is large.*

***Prediction 3** The likelihood of booking a loan decreases with the loan officer's career concern.*

Our analysis on information verifiability and compensation schemes sheds lights on how incentives affect the subsequent loan performance based on the amount of soft information used in the loan origination process. We show above that with hard-information lending, incentive compensation encourages loan officers to investigate loan

quality and to avoid booking bad loans. Only when information becomes unverifiable does a monetary bonus distort incentives.

***Prediction 4** Both the likelihood of loan origination and the default probability are higher for more informationally opaque loans with soft-information lending than with hard-information lending.*

3. Description of the Market and Data

3.1 The Loan Officer's Job Function

Loan officers play a central role in the process of loan origination. The process begins when the loan officers initiate contacts with the firms to determine their needs for loans. After the initial contact has been made, loan officers assist the clients through the process of loan application. The loan officer gathers personal and business information about the borrower and explains the different types of loans and credit terms available to the client. Loan officers then verify the basic information of the borrower to assess the creditworthiness of the borrower and the probability of repayment. Specifically, loan officers assign credit scores to the potential borrower and determine collateral requirements. A loan that would otherwise be denied may be approved if the client can provide the lender with appropriate collateral property pledged as security for the repayment of a loan. For a more detailed description of the process, see Agarwal and Hauswald (2007, 2008).

Loan officer compensation usually takes the form of fixed payment salary or incentive plans based on loan origination. Neither of these compensation schemes is tied to loan repayment or failure and the eventual profitability of these loans. Such

compensation contracts may distort loan officers' incentive and encourage them to make any loan, regardless of its quality. While bonuses based on loan profitability would have the advantage of giving direct incentives to search out good credit risks, such performance measure would also give the loan officers greater risk, because many things can happen to borrowers that are essentially unknowable when a loan is written. The additionally imposed risks on loan officers are costly to the bank through higher wages. Baker (2002) argues that the trade-off between risk and distortion in this case is made in favor of lower risk and higher distortion.

3.2 Data from a natural experiment

The data set used in this paper comes from a large, national commercial bank. Starting January 2005, the management of the bank implemented a new incentive compensation package for half of the small business credit services approval officers (henceforth referred to as the treated group). The other half of the loan officers remained on fixed wage (henceforth referred to as the control group). The selection of the loan officers was quasi-random. The management had multiple legacy portfolios as a result of earlier merger and acquisition activities over the years. They were broadly being managed under two legacy database management systems. The portfolio of loans under both these management systems had identical underwriting standards, geographical focus, portfolio management practices, and loss outcomes (see Table 3a and 3b). To evaluate the success of the incentive compensation package, the bank implemented the change on one of the management systems while leaving the other on fixed wage compensation.

The incentive package provides a “pay for performance” bonus opportunity based on individual results. Before that, all loan officers were paid a fixed salary. Specifically, loan officers will receive an annual bonus based on the percentage of new money applications booked compared to the previous year, the type of decisions made, and the timeliness of the decision. The details of the incentive package are summarized in Table 1 and 2. The goal of this program is to “recognize and reward those associates whose performance most aggressively contributes to the overall success of small business credit services,” and “to attract and retain outstanding talent.”

The incentive plan comes with a quality assessment. In order for a loan officer to be eligible to participate in the incentive program, their total of unsatisfactory underwriting must not exceed 5% of total approvals, reviewed in a post approval review process.

The data cover 12 months before the compensation change and 12 months after. To study the effects of incentive compensation on loan officers’ incentives and the implications for subsequent loan origination decisions and characteristics of the booked loans, we employ two control groups: data on loan officers and loans of the group before the implementation of the incentive plan, and data from the other half of the loan officers whose salary remained fixed during the same period. Data from the control group allow us to better control for macroeconomic fluctuations over this period. Our sample contains data on more than 140 loan officers and the status of 15,784 loan applications in the treated group and 14,484 loan applications in the control group. The data are summarized in Table 3 and Table 4.

4. Empirical Evidence

4.1 Do incentives matter?

4.1.1 Loan Origination Decisions

Not surprisingly, loan officers are motivated to book more loans under the incentive pay structure. Table 3a summarizes the status of loan applications for both groups in year 2004 and 2005. While there is no apparent increase in the number of new applications from year 2004 to year 2005, the number of booked loans increases by 1,132 in the treated group, a 44.4% increase. Approval rate in the treated group goes up from 32% to 47%, consistent with our model's prediction.

Also consistent with Prediction 1, in addition to booking more loans, loan officers in the treated group are booking larger loans and longer maturity loans. Table 3a shows that the average dollar amount of booked loans increases by \$96,470, a 44.7% increase. Table 3d shows that loan officers are more likely to approve bigger loans than smaller loans and longer maturity loans than shorter maturity loans. The effect is stronger after the implementation of the incentive plan: Big loans, those with requested amount above \$700,000, have an approval rate of 55% under the incentive pay, compared to an approval rate of 33% for small loans. Long term loans have a 52% approval rate compared to a 37% approval rate for short term loans.

4.1.2 Are Loan Officers Booking Riskier Loans?

One potential concern of paying piece rates is that quality may deteriorate. In our case, does a piece rate contract distort incentives in a way that results in loan officers booking riskier loans? The model suggests that loan officers have stronger incentives to

investigate and approve loan applications with inferior ex-ante quality. One observable key risk factor that lenders use to assess qualifying borrowers for loans is the loan-to-value ratio (LTV). Our subsequent multivariate analysis also confirms that a higher LTV value predicts higher loan default probability. Table 3b shows that while the average LTV of loan applications decreased slightly from 2004 to 2005 in the treated group, the LTV of booked loans increases from 76.24 to 84.10, a 10.32% increase, suggesting that loan officers were booking riskier loans.

Table 3c shows a noticeable increase in the number of booked loans secured by collaterals after year 2005 in the treated group. The average percentage of booked loans without collateral goes down by 13%, a 55% drop compared to the average percentage prior to the implementation of the incentive plan, whereas the pool of applicants without collateral does not change. Berger and Udell (1990) find that collateral is associated with ex-ante observably riskier borrowers and riskier loans. The increase in the percentage of secured loans adds to the evidence that loan officers are approving loans from riskier borrowers.

On the other hand, Table 3b shows that the average business scores and personal scores of approved loans go up in year 2005, and the internal risk ratings go down. Since the internal risk ratings reflect a large amount of soft information possessed by loan officers, this implies that loan officers have been identifying safer borrowers since the implementation of incentive compensation (also see Agarwal and Hauswald (2007, 2008)).

4.2 Who respond to incentives and when?

As suggested in the literature, incentive compensation may have a sorting effect of attracting more able workers (Lazear (2000)). Table 4a shows that the treated group attracts younger loan officers and more male loan officers after year 2005, who are likely to be more aggressive in their career paths – the average age of the loan officers in the treated group goes down from 41 to 37, and the percentage of males goes up from 68% to 74%. There is also evidence of higher turnover in the treated group, as it is reflected by lower average tenure.⁹

Indeed, in Table 5a, we find that loan officers in the age group 25-34 are most aggressive at approving loans, while they have the lowest default rates among all age groups. Consistent with our model, achieving a higher approval rate without sacrificing loan quality is possible if the loan officers put in more effort to investigate the loan quality. Thus, the evidence above suggests that younger loan officers, who are likely to have stronger career concerns, work harder than older loan officers. This effect gets amplified by the incentive pay.

We find similar evidence for male loan officers compared to female loan officers. Table 5b reports that after the implementation of the incentive pay, the gap in the approval rate between male and female loan officers goes up. While the female loan officers also approve more loans under the incentive pay, the default rate among these loans is much higher than in year 2004, and higher than their male colleagues. This evidence is consistent with the literature that female workers have short careers, and thus less career concerns than males. In the context of our model, such loan officers are most

⁹ Our results are both qualitatively and quantitatively very similar if we have a constant pool of loan officers before and after the treatment period.

likely to have distorted incentives under the incentive plan, in the sense that loan quality deteriorates the most.

We find further evidence that loan officers' career concern becomes an important disciplinary device under the incentive pay in our multivariate analysis.

A less studied question is the response time of the agents to incentive contracts. Do agents respond to incentives immediately, as assumed in the theoretical literature on incentive contracts, or is there a learning curve? In other words, if incentive contracts leave room for agents to game the compensation system, will agents respond to it as predicted by the rational theory immediately?

The analysis of this question also provides a robustness check for our results. That is, was the information leaked to the loan officers prior to the actual implementation of the incentive pay in January 2005 so that loan officers may hold back from approving loans before they can receive the bonus linked to those booked loans? If there was such an information leak and loan officers did hold back booking loans in year 2004, our results would be weakened.

Table 6 provides a month by month break-down of the status of loan applications. We plot the loan approval status in Figure 1 and observe a significant increase in approval rate and a decrease in rejection rate since January 2005. Figure 2 shows that both the average dollar amount of booked loans and the percentage of loans booked increase since January 2005, and the structural change takes place in January 2005. Figures 3, 4 and 5 show similar structural breaks in January 2005 for LTV, days-spent-per-loan-application, and internal risk rating.

In summary, we find evidence that loan officers respond immediately as predicted by economic theory to the incentive pay, and we find no evidence that loan officers hold back approving loans prior to January 2005.

4.3 Does an incentive pay induce perverse incentives?

Much of the study in the literature is on whether agents' responses to incentive pay are in the firm's interest. Our analysis and preliminary empirical results above show that incentive pay may create perverse incentives to loan officers by encouraging overbooking of inferior loans, especially for larger and longer maturity loans, whereas loan officer's career concerns serve as a good disciplinary device. We provide further evidence with a multivariate analysis.

4.3.1 Multivariate Analysis

We examine whether during the treatment period, (i) the treated loan officers are more likely to approve or decline loan applications; and (ii) the booked loans are more likely to default. We employ the standard logit model specification to estimate these models.

Our results reveal that loan officers' inputs of internal risk ratings, LTV of the loans, loan amounts, and collateral are important for loan officers' approval decisions. Table 7a shows that these variables are statistically significant and marginally important for loan approvals. Consistent with our intuition, riskier loans and larger loans are less likely to be approved, whereas collateral requirements increase loan approval rates. Moreover, we see that the variable, Treated Dummy*2005 Dummy is significantly

positive and marginally large, indicating that the implementation of the new incentive package in the treated group increases loan approval rates. While larger loans possess risk of a greater loss, the implementation of the incentive plan encourages loan officers to book larger loans, consistent with our model's prediction; we see in Table 7a that the variable, $\text{Log}(\text{loan amount requested}) * \text{treated} * 2005$ is significantly positive. Similarly, $\text{loan maturity} * \text{treated} * 2005$ becomes significantly positive, indicating that loan officers in the treated group are more likely to book longer maturity loans as predicted by the model.

We further analyze the subsequent loan performance of approved loans by examining the default probability of the loans based on loan characteristics. The results are reported in Table 7b. We confirm that internal risk ratings, LTV of the loan, loan amount requested, and loan maturity are important factors in predicting loan defaults. Collateral requirements, however, decrease the probability that a loan defaults, consistent with the moral hazard view of collateral requirements. In addition, we also find that Days Spent per Loan is negative, suggesting that the longer a loan officer spends on a loan application, the less likely it will default. We can interpret the number of days spent on the loan application as a measure of the loan officer's effort to investigate loan quality. The harder the loan officer works, the less likely it is that an approved loan will default. This variable becomes especially important after the implementation of the incentive plan. Furthermore, we see evidence that loan officers in the treated group are booking larger and longer maturity loans that are riskier and more likely to default. The variables $\text{Loan-to-Value of the Loan} * \text{treated} * 2005$ and $\text{Loan maturity} * \text{treated} * 2005$ are both significantly positive.

We further study loan officer's fixed effect on loan approval and default rates. Table 8 summarizes the results from logit regressions of loan approval decisions and defaults on loan officer's characteristics. Consistent with our prior findings, internal risk ratings, LTV of the loan, loan amount requested, loan terms, and collateral requirements are the key risk factors that drive approval decisions and predict subsequent loan defaults. Moreover, Treated Dummy*2005 Dummy is highly significant in both regressions, suggesting that loan officers in the treated group are more likely to book loans in year 2005, and that these approved loans are more likely to default.

Our detailed micro-level information on loan officers allows us to study questions such as how the incentive plan interacts with loan officers' career concerns. Our model indicates that loan officers' career concerns serve as a powerful control mechanism that mitigates the distortion of incentives caused by monetary bonus. A loan officer with greater career concern will be more conservative in making loan approval decisions. We find evidence of this from the results in Table 8. Using loan officers' ages and number of years on the job (tenure) as proxies for career concerns, we see that loan officers' career concerns become significant after the implementation of the incentive plan in year 2005. The career concerns are insignificant on their own, but become significant after interacting with the treated dummy and the year 2005 dummy. Following previous literature, we argue that career concern is strongest when a person is just starting her career, thus *tenure* measures the reverse strength of career concern. We find that the marginal effects of Loan officer tenure * treated dummy * 2005 dummy and Loan officer tenure (sq) * treated dummy * 2005 dummy are 7.24% and 3.98%, respectively. That is, controlling for a loan officer's age, the fewer years on the job, the less likely that she

books a loan. Interestingly, *tenure* does not predict default probability linearly. We see that the marginal effect of Loan Officer Tenure * Treated Dummy * 2005 Dummy on loan default probability is 6.77%. The positive number is consistent with our findings of loan officers' approval decisions that the longer the tenure, the smaller the career concern, and thus, the more likely that the loan officer books riskier loans motivated by monetary incentives. Loan Officer Tenure squared, however, has the opposite effect in predicting loan defaults. Loan Officer Tenure (sq), Loan Officer Tenure (sq) * Treated Dummy, and Loan Officer Tenure (sq) * Treated Dummy * 2005 Dummy have negative marginal effects. In particular, the marginal effect of Loan Officer Tenure (sq) * Treated Dummy * 2005 Dummy is -1.91%, much larger than the other two, confirming that loan officers' tenure is an important factor in loan approval decisions after the implementation of the incentive package. We interpret this as a "learning-on-the-job" effect. The longer the loan officer is on the job, the more experience she gains on detecting loan quality, thus, the lower the likelihood of booking a bad loan. This learning effect, however, becomes important only when the time on the job is sufficiently long.

We also observe that Days Spent Per Loan*Treated Dummy * 2005 Dummy is marginally important for both the loan approval decision and loan default probability. We interpret Days Spent per Loan as a proxy for the loan officer's effort to assess loan quality. We see that the longer the time spent reviewing the loan application, the less likely that it will be approved, and the less likely that the loan will default. In addition, the effect of this variable is large only after the implementation of the incentive plan among the loan officers in the treated group.

4.3.2 Soft-information vs. hard-information lending

Our theoretical analysis suggests that whether incentive pay induces perverse incentives for loan officers depends crucially on the type of lending regime, soft-or hard-information lending. Hard information contained in a loan application is captured by its observable risk factors, such as Experian scores, LTV, loan amount, loan terms, and maturity, whereas the internal risk rating contains loan officers' subjective input, much of which is soft information. Following Agarwal and Hauswald (2008), we capture the residual soft information collected by the bank by orthogonalizing the internal risk rating with the above set of publicly available information controlling for branch, year, and industry effects. Hence, we estimate the following regression:

$$IntRiskRating_i = \beta_0 + \beta_1 XCI_i + \beta_2 XPAR_i + u_i,$$

where XCI contains the Experian business score and personal score, and XPAR includes other publicly available risk factors such as LTV, loan amount, loan terms, loan maturity, and personal and business collateral. We refer to the residual from the above regression as "Internal Risk Rating Residual."

We then estimate the logit regression as in the previous sections by replacing Internal Risk Rating with the residual from the above regression. The results are reported in Table 9. We see that while the residual information itself is not significant in predicting default, it is significant for the treated group in year 2005. This suggests that under the incentive plan, loan officers book riskier loans that contain more soft information. This observation is consistent with the model's prediction on the interaction between incentive compensation and soft information lending.

Furthermore, we form quintiles based on the size of the Internal Risk Rating Residual for both the treated group and the control group in year 2004 and 2005, with the top quintile containing loans with the largest residual, or the greatest amount of soft information. Our theoretical analysis suggests that under the incentive pay, loan officers are more likely to make reckless approval decisions for loans that contain more soft information. For these loans, both the approval rate and the default rate are higher than those with mostly hard information. Indeed, Table 10 reports the ratio of the approval rates and the default rates of the loans in the highest quintile to those in the lowest quintile. During the treatment period, loans that contain the greatest amount of soft information are 2.36 more likely to be approved than those that contain the least amount of soft information. Moreover, these loans are 3.05 times more likely to default than those with the least amount of soft information.

4.3.3 Welfare Analysis

Finally, did the bank profit from the incentive pay? Although there are more defaults, loan officers are indeed booking more loans, of which the bank can make a profit from the fees. To answer this question, we carry out a simple welfare analysis.

$$Welfare = Volume \times fees - Wages - Loss\ given\ default - other\ unobservables$$

Here the unobservables include the externalities of not making a loan, the cost of funding for the bank, and utility loss by extending additional effort.

The marginal welfare, therefore, is

$$\Delta\ welfare = increased\ volume \times fees - increased\ wages - \Delta\ Loss\ given\ default$$

Table 4a shows that the average income of loan officers in the treated group increases by \$6,597 from \$42,422 to \$49,019 from year 2004 to 2005. Under the incentive plan, \$6,500 is amount of bonus that a loan officer gets if she reaches 100% of the performance goal (see Table 2). This suggests that the 100% goal may create a focal point for loan officers to aim for.

Following industry standards, fees are assumed to be 2% of the loan originated and the loss given default is assumed to be 50% (see, Agarwal et. al. 2007).

Table 11 reports the marginal welfare of the incentive pay. We see that the bank experiences a loss of \$6,880,446 in year 2005. The program was eventually discontinued in the first quarter of 2006 due to losses to the bank.

5. Conclusion

A central question addressed by much research on incentive compensation has been whether incentive contracts provide the right incentives. In this paper, we propose a model that studies two tasks that loan officers perform in the loan origination process: their efforts to investigate loan quality and their loan origination decisions. Our model demonstrates that monetary incentives may distort loan officers' incentives to identify bad loans. The distortion is greater under a soft-information lending regime. Loan officers' career concerns serve as a good disciplinary device to mitigate the agency problem.

Using a unique dataset from a major national commercial bank that implemented an incentive compensation package for half of its loan officers, we are able to test many of the model's predictions. We find that observable risk factors such as Experian scores,

LTV, loan amount, term, maturity, and collateral are important for loan officers' approval decisions and predict subsequent loan defaults. Moreover, the internal risk ratings, which contain a large amount of soft information, also predict defaults.

Motivated by the incentive package, loan officers in the treated group book more loans and, in particular, book larger and longer maturity loans, consistent with the model's predictions. These larger and longer maturity loans are more likely to default within two years of loan origination, indicating that these are riskier loans on average. Using loan officers' age and tenure as proxies for their career concerns, we find that loan officers with greater career concerns are more conservative in their approval decisions, and their booked loans have lower default rates. Also consistent with the model, we find evidence that loans with a greater amount of soft information are more likely to be approved under the incentive scheme. These loans, however, are also more likely to default.

Our research suggests that hardening the soft information used in lending decisions will reduce distortion of incentives of piece-rate contracts. Moreover, counteracting incentives with more stringent lending standards may also reduce some of the agency problems.

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Table 1: Performance Metric

Metric	Weighting	Annual Goal
Pull-through yield	50%	48% of new money applications booked based on applications received from January 1- November 30, 2005.
Decision Points	25%	1,080 points*
Application to decision time (% met)	25%	68.5%**

*Decision points are allocated as follows: (i) Score + (all products) = 1 point ; (ii) S/L – basic (term \$500M - \$1MM) = 2 points; (iii) S/L (term \$1 - \$3MM, lines of credit < \$750M) = 3 points; (iv) S/L – complex (term > \$3MM, lines of credit > \$750M) = 5 points; (v) Letters of credit (S/L) = 2 points; (vi) Commercial card (S/L) = 2 points

**Decision time guidelines are as follows: (i) Score + guideline is 3 days; (ii) S/L guideline is 5 days

Table 2: Incentive Plan

Total Score	Incentive award
Less than 80% of goal	No award
80% of goal	\$4,000 + \$125 per percentage point above 80% of goal
100% of goal	\$ 6,500 + \$150 per percentage point above 100% of goal
120% of goal	\$ 9,500 + \$175 per percentage point above 120% of goal

Notes: A brief description of the incentive plan that outlines the score achievement and incentive award for each score band.

Table 3a: Descriptive Statistics of Loan Applications – Loan Status

Variable	2004 (January - December)				2005 (January - December)			
	Control Group		Treated Group		Control Group		Treated Group	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
Number of Loan Requests	6920		7996		7564		7788	
Number of Loans Booked	2192		2548		2744		3680	
Approval Rate	31.68%		31.87%		36.28%		47.25%	
Number of Defaults	91		107		119		192	
Default Rate	4.15%		4.20%		4.34%		5.22%	
Avg \$ of Loans Requested	\$ 455,240	\$ 336,805	\$ 426,480	\$ 378,698	\$ 454,141	\$ 369,635	\$ 444,137	\$ 381,829
Avg \$ of Loans Booked	\$ 224,614	\$ 279,361	\$ 216,048	\$ 229,403	\$ 253,219	\$ 257,801	\$ 312,518	\$ 404,976
Days Spent/Loan Requested	1.38	0.85	1.35	0.70	1.32	0.75	1.06	0.53

Table 3b: Descriptive Statistics of Loan Applications – Risk Profile

Variable	2004 (January - December)				2005 (January - December)			
	Control Group		Treated Group		Control Group		Treated Group	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
Internal Risk Ratings	5.23	1.84	5.38	1.52	5.44	1.3	4.93	1.53
Business Score of Applicants	200.86	72.23	195.88	75.87	195.99	75.27	200.36	68.47
Business Score of Booked Loans	184.87	68.95	186.11	78.92	185.50	93.09	196.09	87.01
Personal Score of Applicants	731.85	70.31	725.41	68.06	725.91	74.39	728.06	76.72
Personal Score of Booked Loans	716.69	87.44	718.90	88.58	719.54	98.25	725.77	66.51
LTV of Applicants	61.28	43.00	65.30	44.03	65.16	46.87	63.05	43.48
LTV of Booked Loans	72.99	31.48	76.24	30.90	74.90	33.10	84.10	50.10

Table 3c: Descriptive Statistics of Loan Applications – Collaterals

Variable	2004 (January - December)				2005 (January - December)			
	Control Group		Treated Group		Control Group		Treated Group	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
Avg % of Applicants with Personal Collateral	69%	46%	68%	47%	64%	48%	70%	46%
Avg % of Applicants with Business Collateral	25%	44%	26%	44%	28%	45%	24%	43%
Avg % of Applicants with No Collateral	5%	23%	6%	24%	8%	28%	6%	24%
Avg % of Booked Loans with Personal Collateral	9%	35%	7%	26%	4%	20%	19%	29%
Avg % of Booked Loans with Business Collateral	63%	48%	68%	47%	67%	47%	69%	49%
Avg % of Booked Loans with No Collateral	27%	42%	25%	44%	28%	45%	11%	46%

Notes: Panels a, b, and c outline the loan statistics, risk profile, and collateral requirements for the control and treated samples during and control and treatment time period.

Table 3d: Descriptive Statistics of Loan Applications – Loan Size and Maturity

Treated Group: Loan Approval and Performance

Loan Size / Type	2004			2005		
	% approval	% rejection	% walk away	% approval	% rejection	% walk away
Big loan (> \$700K)	35%	57%	8%	55%	36%	8%
Medium loan (\$250K-\$700K)	31%	56%	13%	49%	40%	11%
Small loan (< \$250K)	27%	55%	18%	33%	51%	16%
Long term loan (Larger than One Year)	32%	55%	13%	52%	36%	12%
Short term loan (One Year)	29%	58%	13%	37%	51%	12%

Treated Group: Risk Profile, Collateral

Loan Size / Type	2004			2005		
	Personal Collateral	Risk Score	LTV	Personal collateral	Risk Score	LTV
Big loan (> \$700K)	4	717	77	20	713	79
Medium loan (\$250K-\$700K)	4	720	74	19	720	84
Small loan (< \$250K)	4	721	72	19	725	89
Long term loan (Larger than One Year)	4	721	74	20	717	81
Short term loan (One Year)	4	717	72	19	720	90

Table 3d: Statistics of Loan Applications – Loan Size and Maturity (Con’t)

Control Group: Approval and Performance

Loan Size / Type	2004			2005		
	% approval	% rejection	% walk away	% approval	% rejection	% walk away
Big loan (> \$700K)	35%	60%	8%	34%	59%	8%
Medium loan (\$250K-\$700K)	31%	56%	13%	30%	57%	13%
Small loan (< \$250K)	27%	56%	18%	26%	57%	17%
Long term loan (Larger than One Year)	32%	56%	13%	31%	57%	13%
Short term loan (One Year)	29%	59%	13%	29%	58%	13%

Control Group: Risk Profile, Collateral

Loan Size / Type	2004			2005		
	Personal Collateral	Risk Score	LTV	Personal collateral	Risk Score	LTV
Big loan (> \$700K)	4	737	74	4	724	73
Medium loan (\$250K-\$700K)	4	751	73	4	723	71
Small loan (< \$250K)	4	722	72	4	724	70
Long term loan (Larger than One Year)	4	727	71	4	752	73
Short term loan (One Year)	4	739	70	4	730	69

Notes: Panels d outline the loan approval, performance, and collateral requirements for the control and treated samples during and control and treatment time period for a given loan size and type.

Table 4a: Demographics of Loan Officers

Variable	2004		2005	
	Control Group	Treated Group	Control Group	Treated Group
Total Number of Loan Officers	63	70	65	65
Gender – Male	58%	68%	59%	74%
Income	\$42,363	\$42,422	\$42,976	\$49,019
Age	43	41	43	37
Tenure	3.49	3.66	3.58	2.91

Table 4b: Percentage of Loan Officers in Each Age Group

Loan Officer Age	2004		2005	
	Control Group	Treated Group	Control Group	Treated Group
25-34	22.33	26.92	26.90	33.04
35-44	24.98	29.07	24.30	37.58
45-55	31.67	24.66	27.00	21.04
55+	21.02	19.35	21.80	8.34

Notes: Panels a and b outline the loan officer demographics – gender, income, age, tenure, and fraction of loan officers by age groups for the control and treated samples during and control and treatment time period for a given loan size and type.

Table 5a: Loan Status in the Treated Group for Each Age Group – 2004

Loan Officer Age	% of Loan Officers	Approval Rate	Loan Size	Credit Scores	Default Rate
25-34	26.92	34.91	142,029	5.32	3.46
35-44	29.07	33.01	166,083	5.37	4.36
45-55	24.66	29.78	211,327	5.4	4.84
55+	19.35	26.00	232,022	5.37	4.46

Table 5a: Loan Status in the Treated Group for Each Age Group – 2005

Loan Officer Age	% of Loan Officers	Approval Rate	Loan Size	Credit Scores	Default Rate
25-34	33.04	56.08	229,116	5.04	4.73
35-44	37.58	52.70	244,892	4.97	4.74
45-55	21.04	43.46	328,117	4.89	5.99
55+	8.34	40.01	387,727	4.81	6.58

Notes: Panel a outline the fraction of loan officers by age groups, the approval rates, loan sizes, credit scores, and default for the control and treated samples during and control and treatment time period for a given loan size and type.

Table 5b: Percentage bookings in the treated group by gender groups – 2004

Loan Officer Gender	% of Loan Officers	Approval Rate	Loan Size	Credit Scores	Default Rate
Male	68.40	32.28	193,092	5.27	4.51
Female	31.60	28.41	185,029	5.39	3.71

Table 5b: Percentage bookings in the treated group by gender groups – 2005

Loan Officer Gender	% of Loan Officers	Approval Rate	Loan Size	Credit Scores	Default Rate
Male	74.30	51.19	299,101	5.03	5.21
Female	25.70	40.27	280,583	4.79	5.26

Notes: Panel b outline the fraction of loan officers by gender groups, the approval rates, loan sizes, credit scores, and default for the control and treated samples during and control and treatment time period for a given loan size and type.

Table 6: Monthly Loan Approval Status

Months	Number of Loans in the Treated Group							Number of Loans in the Control Group						
	Received	Rejected	Withdraw	Booked	Received	Rejected	Withdraw	Booked	Received	Rejected	Withdraw	Booked		
Jan-04	548	380	69.34%	76	13.87%	92	16.79%	532	252	47.37%	103	19.36%	177	33.27%
Feb-04	582	346	59.45%	133	22.85%	103	17.70%	531	327	61.58%	78	14.69%	126	23.73%
Mar-04	688	354	51.45%	71	10.32%	263	38.23%	538	386	71.75%	86	15.99%	66	12.27%
Apr-04	679	344	50.66%	92	13.55%	243	35.79%	520	258	49.62%	102	19.62%	160	30.77%
May-04	747	342	45.78%	75	10.04%	330	44.18%	655	217	33.13%	86	13.13%	352	53.74%
Jun-04	742	344	46.36%	83	11.19%	315	42.45%	644	323	50.16%	78	12.11%	243	37.73%
Jul-04	759	370	48.75%	76	10.01%	313	41.24%	632	391	61.87%	79	12.50%	162	25.63%
Aug-04	639	313	48.98%	88	13.77%	238	37.25%	570	301	52.81%	79	13.86%	190	33.33%
Sep-04	618	401	64.89%	54	8.74%	163	26.38%	553	334	60.40%	89	16.09%	130	23.51%
Oct-04	649	389	59.94%	107	16.49%	153	23.57%	568	283	49.82%	88	15.49%	197	34.68%
Nov-04	692	411	59.39%	84	12.14%	197	28.47%	604	371	61.42%	67	11.09%	166	27.48%
Dec-04	653	416	63.71%	99	15.16%	138	21.13%	573	261	45.55%	89	15.53%	223	38.92%
Jan-05	584	262	44.86%	93	15.92%	229	39.21%	574	311	54.18%	56	9.76%	207	36.06%
Feb-05	593	243	40.98%	74	12.48%	276	46.54%	599	310	51.75%	83	13.86%	206	34.39%
Mar-05	638	204	31.97%	71	11.13%	363	56.90%	637	345	54.16%	98	15.38%	194	30.46%
Apr-05	531	276	51.98%	73	13.75%	182	34.27%	645	335	51.94%	73	11.32%	237	36.74%
May-05	764	316	41.36%	57	7.46%	391	51.18%	630	394	62.54%	52	8.25%	184	29.21%
Jun-05	783	268	34.23%	66	8.43%	449	57.34%	636	333	52.36%	91	14.31%	212	33.33%
Jul-05	662	249	37.61%	61	9.21%	352	53.17%	604	280	46.36%	93	15.40%	231	38.25%
Aug-05	642	289	45.02%	74	11.53%	279	43.46%	591	353	59.73%	66	11.17%	172	29.10%
Sep-05	643	255	39.66%	75	11.66%	313	48.68%	683	284	41.58%	87	12.74%	312	45.68%
Oct-05	635	258	40.63%	75	11.81%	302	47.56%	639	337	52.74%	68	10.64%	234	36.62%
Nov-05	688	297	43.17%	87	12.65%	304	44.19%	692	258	37.28%	60	8.67%	374	54.05%
Dec-05	625	289	46.24%	96	15.36%	240	38.40%	634	378	59.62%	75	11.83%	181	28.55%

Table 7a: Loan Acceptance Decisions based on loan characteristics

Variable	Coeff Val.	t-stats	Marg Eff		Coeff Val.	t-stats	Marg Eff	
Intercept	-4.0768	-2.99			-3.7241	-2.84		
Internal Risk Ratings	-0.3046	-2.92	-2.93%	**	-0.2837	-2.97	-2.89%	**
Experian Business Score	0.2719	16.57	0.27%	**	0.2641	16.82	0.25%	**
Experian Borrowers Score	0.1238	13.31	0.30%	**	0.1188	13.36	0.30%	**
Loan-to-Value of the Loan	-0.0373	-2.32	-4.06%	**	-0.0344	-2.25	-3.92%	**
log(Loan Amount Requested)	-0.0406	-2.07	-5.39%	**	-0.0395	-2.17	-5.15%	**
Loan Term	-0.0046	-5.14	-6.49%	**	-0.0042	-4.87	-5.99%	**
Loan maturity	0.6106	0.92	0.12%		0.6082	0.98	0.12%	
Treated Dummy	0.6479	0.99	5.21%		0.6124	1.00	4.96%	
2005 Dummy	0.7218	1.07	1.20%		0.6757	1.05	1.13%	
Treated Dummy*2005 Dummy	0.7825	4.36	12.66%	**	0.7109	4.33	12.29%	**
Days Spent Per Loan	0.5733	0.87	0.25%		0.5309	0.85	0.24%	
Internal Risk Ratings * treated Dummy	-0.2282	-0.50	0.13%		-0.2210	-0.52	0.13%	
Experian Business Score * Treated Dummy	0.4988	1.55	-0.18%		0.4945	1.59	-0.18%	
Experian Borrowers Score* Treated Dummy	0.0882	0.26	0.01%		0.0828	0.25	0.01%	
Loan-to-Value of the Loan* Treated Dummy	-0.7004	-1.70	0.01%	*	-0.6704	-1.79	0.01%	*
log(Loan Amount Requested)* Treated Dummy	-0.5060	-1.34	-0.05%		-0.4795	-1.35	-0.05%	
Loan Term* Treated Dummy	-1.1192	-1.83	-0.03%	*	-1.0905	-1.91	-0.03%	*
Loan maturity* Treated Dummy	0.4422	1.75	0.08%	*	0.4080	1.66	0.08%	
Days Spent Per Loan* Treated Dummy	0.1436	1.40	0.28%		0.1390	1.44	0.28%	
Internal Risk Ratings * Treated * 2005	-0.1570	-0.26	-0.11%		-0.1492	-0.24	-0.11%	
Experian Business Score * Treated* 2005	0.4035	0.97	0.21%		0.3675	0.94	0.19%	
Experian Borrowers Score* Treated * 2005	0.2342	0.49	0.25%		0.2110	0.45	0.23%	
Loan-to-Value of the Loan* Treated * 2005	-0.4229	-1.47	-0.29%		-0.3949	-1.41	-0.28%	
log(Loan Amount Requested)* Treated * 2005	0.7490	3.57	2.92%	**	0.7322	3.82	2.87%	**
Loan Term* Treated * 2005	-0.1440	-1.09	-0.08%		-0.1320	-1.09	-0.07%	
Loan maturity* Treated * 2005	0.9435	3.81	5.53%	**	0.8917	3.75	5.19%	**
Days Spent Per Loan* Treated * 2005	1.7321	6.20	0.06%	**	1.5733	6.24	0.05%	**
Personal Collateral	0.5634	3.13	6.41%	**	0.5372	3.11	5.99%	**
Business Collateral	0.5669	3.59	3.76%	**	0.5575	3.58	3.52%	**
Personal Collateral*Treated Dummy	0.1743	1.41	0.30%		0.1720	1.40	0.29%	
Business Collateral*Treated Dummy	0.2528	1.64	0.25%		0.2296	1.51	0.25%	
Personal Collateral * Treated Dummy*2005 Dummy	0.1785	1.56	0.37%		0.1697	1.51	0.36%	
Business Collateral*Bank A Dummy*2005 Dummy	0.1726	1.32	0.26%		0.1590	1.22	0.25%	
SIC Dummy	Yes				Yes			
Loan Officer Dummy	No				Yes			
Number of Observations	30268							
R-Square	17.28%							

Notes: We report the coefficients, the Std Err, the T-stats and marginal effects for the decision to deny credit (Y = 1). We obtain the marginal effects by simply evaluating $\Pr x_j$ at the regressors' sample means and coefficient estimates. Since the probabilities of offering and denying credit sum to 1 the marginal effects for the decision to reject a loan application are simply the opposite of the reported ones. The pseudo-R2 is McFadden's likelihood ratio index.

Table 7b: Probability of Loan Default on Loan Characteristics

Variable	Coeff Val.	Std. Err.	t-stats	Marg Eff		Coeff Val.	Std. Err.	t-stats	Marg Eff	
Intercept	-2.3794	0.9712	-2.45			-2.2942	0.9288	-2.47		
Internal Risk Ratings	0.1784	0.0426	4.19	8.78%	**	0.1769	0.0395	4.47	8.72%	**
Experian Business Score	-0.0847	0.0110	-7.71	-0.44%	**	-0.0780	0.0102	-7.60	-0.40%	**
Experian Borrowers Score	-0.0847	0.0066	-12.41	-0.59%	**	-0.0809	0.0065	-12.53	-0.53%	**
Loan-to-Value of the Loan	0.0517	0.0120	4.30	1.28%	**	0.0482	0.0118	4.09	1.25%	**
log(Loan Amount Requested)	0.0289	0.0075	3.87	1.77%	**	0.0263	0.0068	3.88	1.73%	**
Loan Term	0.0012	0.0007	1.75	0.03%	*	0.0011	0.0006	1.81	0.03%	*
Loan maturity	0.4728	0.1168	4.05	6.79%	**	0.4510	0.1080	4.17	6.76%	**
Treated Dummy	0.0686	0.0716	0.96	0.33%		0.0623	0.0691	0.90	0.32%	
2005 Dummy	0.4781	0.1385	3.45	3.38%	**	0.4522	0.1286	3.51	3.07%	**
Treated Dummy*2005Dummy	0.4274	0.1073	3.98	6.51%	**	0.4115	0.1059	3.88	5.87%	**
Days Spent Per Loan	-0.4869	0.1912	-2.55	-1.21%	**	-0.4723	0.1796	-2.62	-1.13%	**
Internal Risk Ratings * Treated	0.1269	0.0427	2.97	0.10%	**	0.1218	0.0393	3.10	0.09%	**
Experian Business Score * Treated	-0.0235	0.0225	-1.04	-0.09%		-0.0235	0.0223	-1.00	-0.08%	
Experian Borrowers Score* Treated	-0.5274	0.0531	-9.94	0.02%	**	-0.4857	0.0479	-10.14	0.02%	**
Loan-to-Value of the Loan* Treated	-0.2573	0.0944	-2.27	-0.55%	**	-0.2544	0.0913	-2.78	-0.50%	**
log(Loan Amount Requested)* Treated	-0.0205	0.2780	-0.07	0.00%		-0.0186	0.2597	-0.07	0.00%	
Loan Term* Treated	-0.0645	0.0780	-0.83	-0.01%		-0.0583	0.0722	-0.80	-0.01%	
Loan maturity* Treated	0.6061	0.1711	3.54	3.34%	**	0.5781	0.1623	3.56	3.05%	**
Days Spent Per Loan* Treated	0.0807	0.0587	1.38	0.01%		0.0760	0.0555	1.36	0.01%	
Internal Risk Ratings * Treated * 2005	0.2441	0.1755	1.39	0.08%		0.2261	0.1718	1.31	0.08%	
Experian Business Score * Treated * 2005	-0.1005	0.1595	-0.63	-0.06%		-0.0942	0.1485	-0.63	-0.05%	
Experian Borrowers Score* Treated * 2005	-0.3635	0.2916	-1.25	-0.94%		-0.3404	0.2706	-1.25	-0.91%	
Loan-to-Value of the Loan* Treated * 2005	1.4476	0.1115	12.98	-1.82%	**	1.3847	0.1015	13.60	-1.68%	**
log(Loan Amount Requested)* Treated * 2005	0.3568	0.1045	3.41	4.05%	**	0.3356	0.0966	3.47	3.64%	**
Loan Term* Treated * 2005	0.3231	0.0986	3.28	4.40%	**	0.3066	0.0924	3.31	4.12%	**
Loan maturity* Treated * 2005	0.8975	0.1839	4.88	9.30%	**	0.8788	0.1808	4.86	9.26%	**
Days Spent Per Loan* Treated* 2005	-0.2368	0.0746	-3.17	-1.70%	**	-0.2330	0.0739	-3.15	-1.56%	**
Personal Collateral	-1.5637	0.1571	-9.95	-4.91%	**	-1.4954	0.1434	-10.42	-4.44%	**
Business Collateral	-1.8806	0.3037	6.19	-1.29%	**	-1.7135	0.2884	-5.94	-1.17%	**
Personal Collateral*Treated Dummy	-0.2745	0.2659	-1.03	-0.16%		-0.2549	0.2543	-1.00	-0.14%	
Business Collateral*Treated Dummy	-0.1077	0.1029	-1.05	-0.33%		-0.1007	0.0994	-1.01	-0.30%	
Personal Collateral*Treated Dummy*2005 Dummy	-0.1132	0.1702	-0.67	-0.11%		-0.1019	0.1571	-0.64	-0.10%	
Business Collateral*Treated Dummy*2005 Dummy	-0.1453	0.3771	-0.39	-0.35%		-0.1439	0.3409	-0.42	-0.32%	
SIC Dummy	Yes					Yes				
Loan Officer Dummy	No					Yes				
Number of Observations	11164									
R-Square	7.99%									

Notes: We report the coefficients, the Std Err, the T-stats and marginal effects for the decision to default on the credit (Y = 1). We obtain the marginal effects by simply evaluating $\Pr x_j$ at the regressors' sample means and coefficient estimates. Since the probabilities of offering and denying credit sum to 1 the marginal effects for the decision to reject a loan application are simply the opposite of the reported ones. The pseudo-R2 is McFadden's likelihood ratio index.

Table 8: Loan approval decisions and defaults

Variable	Acceptance				Default		
	Coeff Val.	t-stats	Marg Eff		Coeff Val.	t-stats	Marg Eff
Intercept	-4.1326	-2.73			-2.5701	-2.37	
Internal Risk Ratings	-0.3311	-3.15	-3.25%	**	0.1811	3.93	9.30%
Experian Business Score	0.2904	16.46	0.28%	**	-0.0932	-7.70	-0.46%
Experian Borrowers Score	0.1317	13.70	0.30%	**	-0.0920	-13.08	-0.64%
Loan-to-Value of the Loan	-0.0407	-2.24	-4.45%	**	0.0529	4.16	1.32%
log(Loan Amount Requested)	-0.0415	-2.01	-5.63%	**	0.0305	3.99	1.85%
Loan Term	-0.0049	-5.28	-6.92%	**	0.0013	1.84	0.04%
Treated Dummy	0.6606	0.94	5.34%		0.0750	0.94	0.36%
2005 Dummy	0.7966	1.14	1.24%		0.5172	3.38	3.69%
Treated Dummy*2005 Dummy	0.8250	4.21	13.02%	**	0.4503	3.99	6.77%
Days Spent Per Loan	0.6328	0.92	0.25%		-0.4917	-2.34	-1.23%
Loan Officer Gender (Female)	1.0382	1.44	0.14%		-0.6228	-12.00	-4.79%
Loan Officer Age	0.4458	0.68	0.58%		0.1607	2.66	0.27%
Loan Officer Age(sq)	-0.5601	-0.82	-0.21%		-0.0618	-1.36	-0.21%
Loan Officer Tenure	0.4179	0.62	0.01%		0.7065	3.18	0.15%
Loan Officer Tenure (sq)	0.9105	1.39	0.01%		-0.5330	-3.67	-0.60%
Days Spent Per Loan*Treated Dummy	-0.7350	-1.06	-0.27%		-0.0801	-0.18	-0.06%
Loan Officer Gender (Female)*Treated Dummy	-1.2078	-1.66	-0.07%		-0.2054	-1.60	-0.01%
Loan Officer Age*Treated Dummy	0.4993	0.69	0.15%		0.4904	2.78	0.76%
Loan Officer Age(sq)*Treated Dummy	-0.5918	-0.83	-0.60%		-0.1099	-0.70	-0.10%
Loan Officer Tenure*Treated Dummy	0.4399	0.56	0.79%		0.3096	2.09	0.16%
Loan Officer Tenure (sq)*Treated Dummy	1.0422	1.35	0.44%		-0.9549	-3.89	-0.41%
Days Spent Per Loan*Treated Dummy*2005 Dummy	-1.3716	-1.87	-4.31%	*	-0.5589	-3.17	-2.25%
Loan Officer Gender (Female)*Treated Dummy*2005 Dummy	-1.9498	-2.53	-8.09%	**	-0.5634	-4.83	-2.68%
Loan Officer Age*Treated Dummy*2005 Dummy	1.8456	2.62	6.13%	**	0.3650	2.36	2.41%
Loan Officer Age(sq)*Treated Dummy*2005 Dummy	-1.4044	-1.87	-5.26%	*	-0.2437	-1.15	-0.43%
Loan Officer Tenure*Treated Dummy*2005 Dummy	2.4137	3.05	7.24%	**	0.9385	2.73	6.77%
Loan Officer Tenure (sq)*Treated Dummy*2005 Dummy	1.9412	2.80	3.98%	**	-0.7134	-5.68	-1.91%
Personal Collateral	0.6172	11.71	7.00%	**	-1.6722	-10.52	-5.41%
Business Collateral	0.5948	14.73	3.97%	**	-2.0781	-65.00	-1.35%
Personal Collateral*Treated Dummy	0.1867	1.37	0.30%		-0.2997	-1.00	-0.17%
Business Collateral*Treated Dummy	0.2620	1.62	0.27%		-0.1158	-1.06	-0.33%
Personal Collateral*Treated Dummy*2005 Dummy	0.1961	1.60	0.37%		-0.1217	-0.67	-0.11%
Business Collateral*Treated Dummy*2005 Dummy	0.1857	1.35	0.28%		-0.1531	-0.39	-0.38%
SIC 2 Digit Dummies	Yes				Yes		
Number of Observations	30268						
R-Square	18.93%						

Notes: We report the coefficients, the Std Err, the T-stats and marginal effects for the decision to deny credit ($Y = 1$). We obtain the marginal effects by simply evaluating $\Pr x_j$ at the regressors' sample means and coefficient estimates. Since the probabilities of offering and denying credit sum to 1 the marginal effects for the decision to reject a loan application are simply the opposite of the reported ones. The pseudo-R2 is McFadden's likelihood ratio index.

Table 9: Probability of Loan Default with Soft/hard Information

Variable	Coeff Val.	Std. Err.	t-stats	Marg Eff		Coeff Val.	Std. Err.	t-stats	Marg Eff
Intercept	-2.3506	0.9608	-2.44			-2.2298	0.9151	-2.43	
Internal Risk Ratings Residual	0.0703	0.0423	1.66	0.55%		0.0762	0.0384	1.92	0.39% *
Experian Business Score	-0.0843	0.0107	-7.87	-0.43%	**	-0.0763	0.0102	-7.49	0.40% **
Experian Borrowers Score	-0.0820	0.0064	-12.88	-0.57%	**	-0.0788	0.0065	-12.22	0.51% **
Loan-to-Value of the Loan	0.0498	0.0116	4.31	1.24%	**	0.0467	0.0116	4.01	1.21% **
log(Loan Amount Requested)	0.0278	0.0072	3.83	1.71%	**	0.0253	0.0067	3.80	1.72% **
Loan Term	0.0012	0.0007	1.78	0.03%	*	0.0011	0.0006	1.80	0.03% *
Loan maturity	0.4560	0.1148	3.97	6.75%	**	0.4366	0.1043	4.18	6.71% **
Treated Dummy	0.0664	0.0692	0.96	0.32%		0.0607	0.0686	0.88	0.31%
2005 Dummy	0.4622	0.1375	3.36	3.27%	**	0.4479	0.1265	3.54	3.06% **
Treated Dummy*2005Dummy	0.4220	0.1048	4.02	6.37%	**	0.4042	0.1042	3.87	5.76% **
Days Spent Per Loan	-0.4770	0.1875	-2.54	-1.18%	**	-0.4550	0.1770	-2.57	1.12% **
Internal Risk Ratings Residual* Treated	0.1066	0.0425	2.51	3.10%	**	0.1001	0.0389	2.57	4.09% **
Experian Business Score * Treated	-0.0228	0.0225	-1.01	-0.09%		-0.0228	0.0222	-1.02	0.08%
Experian Borrowers Score* Treated	-0.5116	0.0530	-9.64	0.02%	**	-0.4817	0.0463	-10.39	0.02% **
Loan-to-Value of the Loan* Treated	-0.2480	0.0943	-2.62	-0.54%	**	-0.2465	0.0895	-2.75	0.50% **
log(Loan Amount Requested)* Treated	-0.0203	0.2680	-0.07	0.00%		-0.0180	0.2576	-0.06	0.00%
Loan Term* Treated	-0.0640	0.0750	-0.85	-0.01%		-0.0580	0.0721	-0.80	0.01%
Loan maturity* Treated	0.5935	0.1668	3.55	3.31%	**	0.5591	0.1601	3.49	2.93% **
Days Spent Per Loan* Treated	0.0805	0.0566	1.42	0.01%		0.0760	0.0549	1.38	0.01%
Internal Risk Ratings Residual * Treated * 2005	0.1840	0.0532	3.46	0.08%	**	0.1985	0.0692	2.87	0.08% **
Experian Business Score * Treated * 2005	-0.0968	0.1560	-0.62	-0.06%		-0.0926	0.1430	-0.64	0.05%
Experian Borrowers Score* Treated * 2005	-0.3560	0.2805	-1.26	-0.91%		-0.3347	0.2641	-1.26	0.88%
Loan-to-Value of the Loan* Treated * 2005	1.4024	0.1074	13.06	-1.78%	**	1.3457	0.0981	13.71	1.65% **
log(Loan Amount Requested)* Treated * 2005	0.3429	0.1009	3.39	4.04%	**	0.3302	0.0958	3.44	3.62% **
Loan Term* Treated * 2005	0.3136	0.0956	3.28	4.37%	**	0.2970	0.0897	3.31	4.10% **
Loan maturity* Treated * 2005	0.8749	0.1828	4.78	9.18%	**	0.8773	0.1756	4.99	9.12% **
Days Spent Per Loan* Treated* 2005	-0.2274	0.0719	-3.16	-1.65%	**	-0.2321	0.0724	-3.20	1.52% **
Personal Collateral	-1.5421	0.1562	-9.87	-4.80%	**	-1.4719	0.1416	-10.39	4.32% **
Business Collateral	-1.8410	0.3001	-6.13	-1.28%	**	-1.6782	0.2866	-5.85	1.12% **
Personal Collateral*Treated Dummy	-0.2715	0.2566	-1.05	-0.15%		-0.2501	0.2538	-0.98	0.14%
Business Collateral*Treated Dummy	-0.1038	0.1022	-1.01	-0.32%		-0.0979	0.0994	-0.98	0.30%
Personal Collateral*Treated Dummy*2005 Dummy	-0.1099	0.1656	-0.66	-0.11%		-0.1015	0.1537	-0.66	0.10%
Business Collateral*Treated Dummy*2005 Dummy	-0.1440	0.3753	-0.38	-0.34%		-0.1427	0.3400	-0.41	0.31%
SIC Dummy	Yes					Yes			
Loan Officer Dummy	No					Yes			
Number of Observations	11164								
R-Square	8.27%								

Notes: We report the coefficients, the Std Err, the T-stats and marginal effects for the decision to default on credit ($Y = 1$). We obtain the marginal effects by simply evaluating $\Pr x_j$ at the regressors' sample means and coefficient estimates. Since the probabilities of offering and denying credit sum to 1 the marginal effects for the decision to reject a loan application are simply the opposite of the reported ones. The pseudo-R² is McFadden's likelihood ratio index.

Table 10: Comparison of Hard- vs. Soft-information Lending

Ratio of Highest/Lowest Quintile of Soft Info	Approval rate		Default rate	
	2004	2005	2004	2005
Control group	1.27	1.29	1.16	1.12
Treated group	1.24	2.36	1.19	3.05

Table 11: Welfare Analysis

	2005	2004	Remarks
Average loan size	\$312,518	\$216,048	
# of loans booked	3680	2548	
Increased volume	\$599,575,936		Average loan size × Δ loans booked
Δ Fees generated	\$11,991,519		2% × increased volume
Average income	\$49,019	\$42,422	
Increased wages	\$428,805		Δ Average income × # of loan officers
# of defaults	192	107	
Defaulted loans	\$60,003,456	\$23,117,136	Average loan size × # of defaults
Δ Loss given default	\$18,443,160		50% × Δ defaulted loans

$$\Delta \text{Welfare} = \Delta \text{Fees generated} - \text{Increased wages} - \Delta \text{Loss given default} = -\$6,880,446$$

Figure 1: Monthly Loan Approval Status

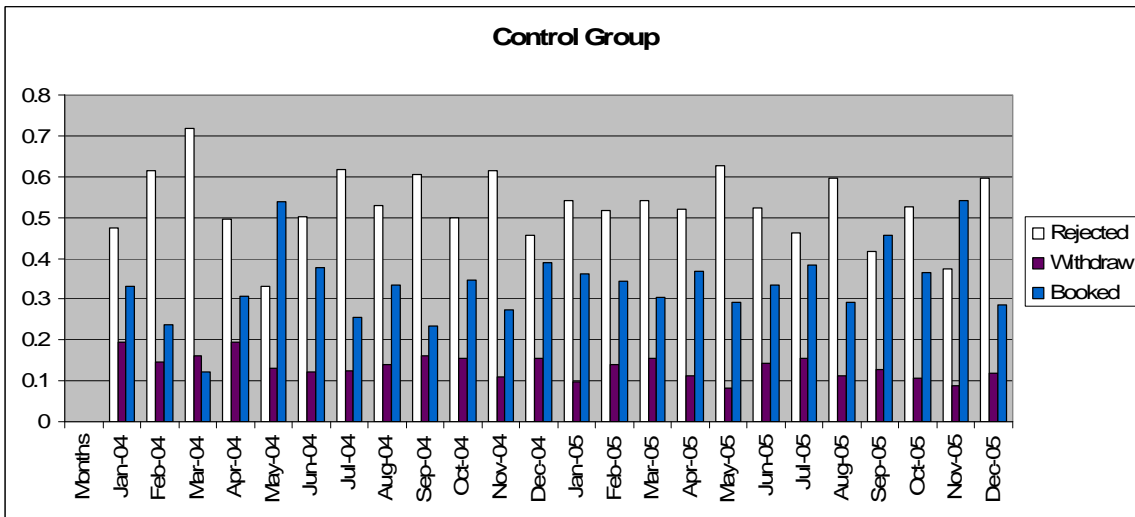
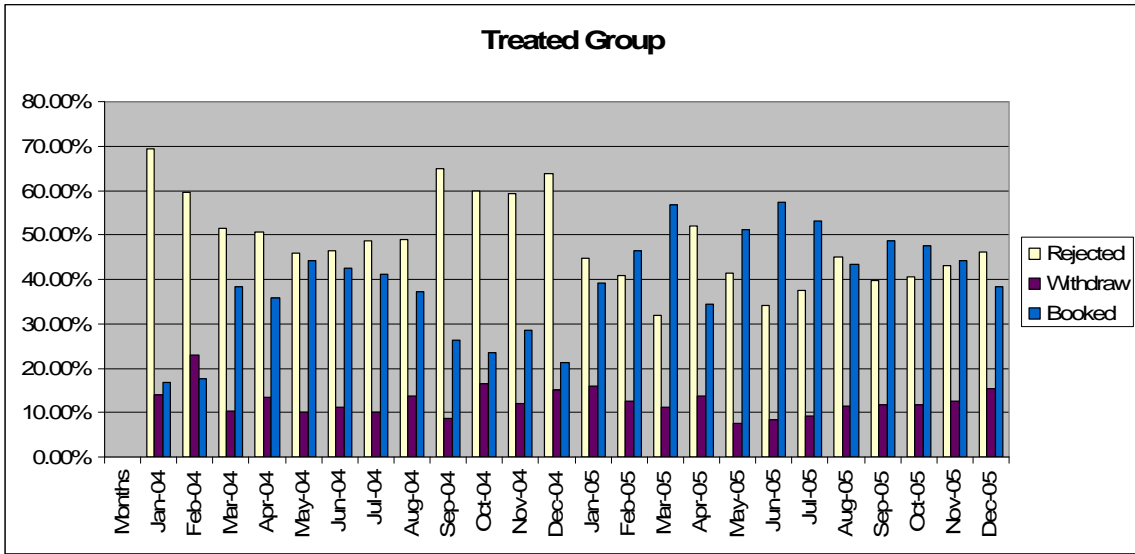


Figure 2: Loan Applications Booked in the Treated Group

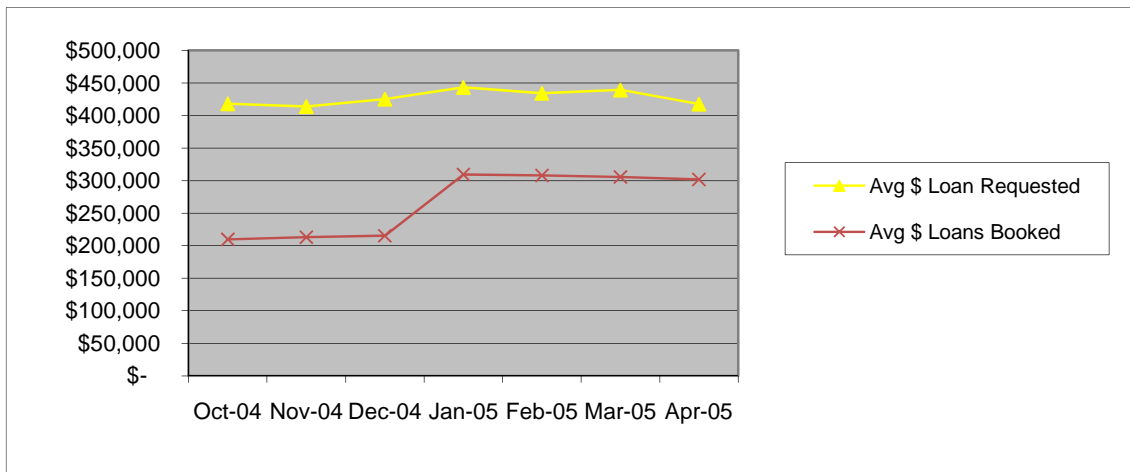


Figure 3: Loan-to-Value Ratios

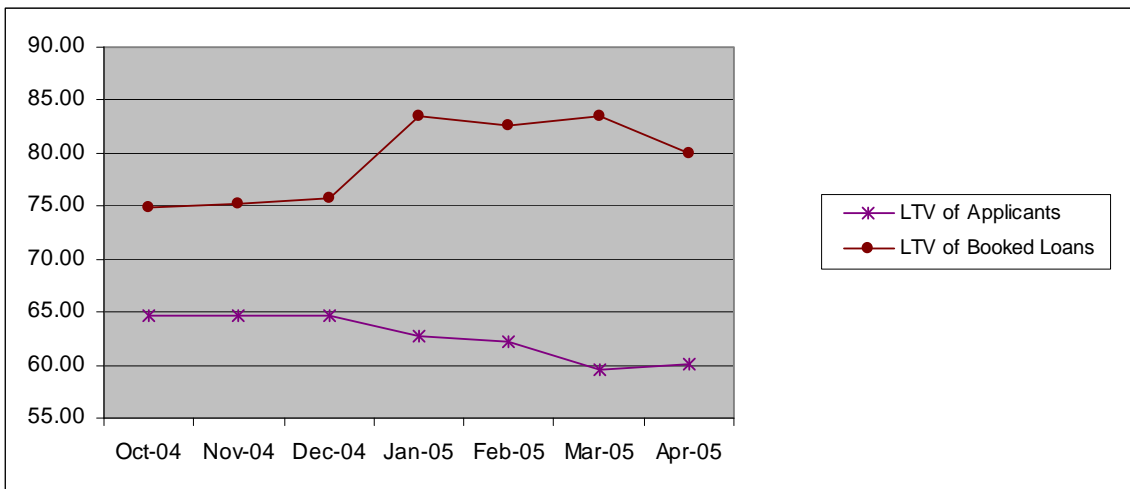


Figure 4: Days Spent on Loan Requested in the Treated Group

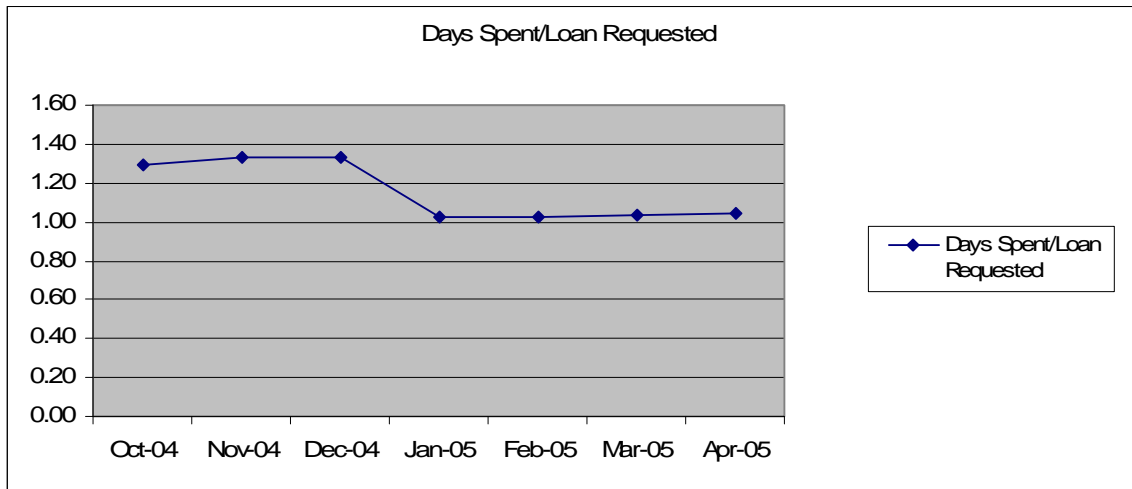
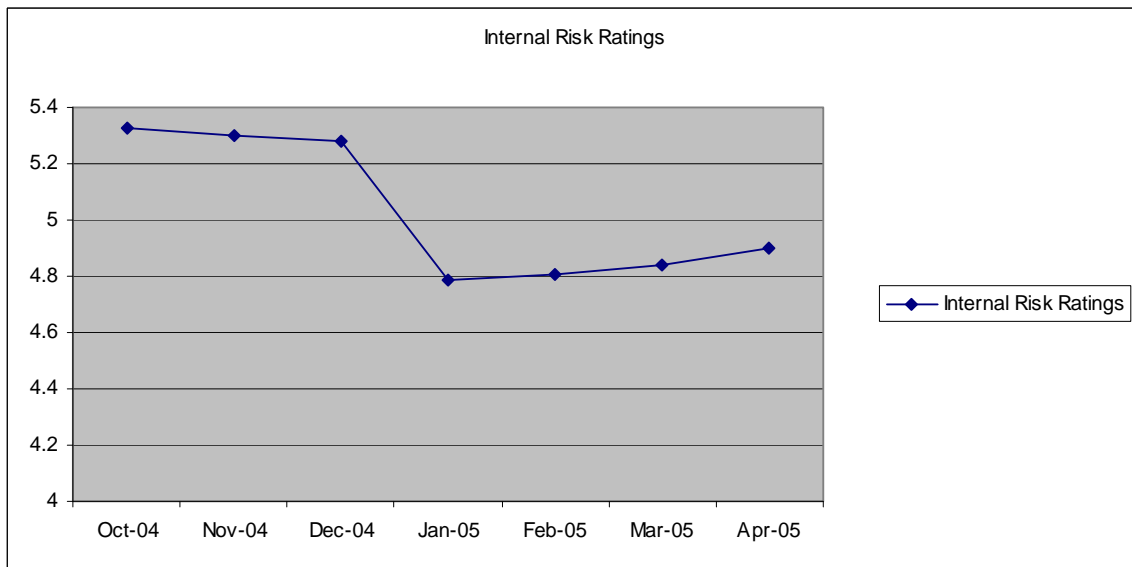


Figure 5: Internal Risk Rating



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