Motivating Loan Officers: An Analysis of Salaries and Piece Rates Compensation [*]

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Abstract

Whether incentive contracts provide the right incentives to individuals in organizations is a central question in modern economic theory. We study loan officers' incentives for loan origination and their choice of effort to assess loan quality under fixed-wage salary and a piece-rate contract based on loan origination. We find that whether piece-rate contracts distort loan officers' incentive to search for bad credit depends crucially on the strength of the monetary incentive and the information asymmetry between the bank and the loan officers. We further examine the relationship between loan origination decisions, loan size and other loan characteristics under the two compensation schemes, and derive a number of predictions regarding these two types of remuneration. Using a unique dataset on loan officer compensation from a major commercial bank, we test these implications and find results that generally support the predictions of our model.

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1. Introduction

Providing incentives to individuals in organizations is a central question in the economics of the firm.[1] An underlying assumption to this literature is that individuals respond to contracts that reward performance. Such incentive scheme may, however, give rise to dysfunctional behavioral responses, where agents emphasize only those aspects of performance that are awarded (Baker, 1992, 2000, 2002). Many sophisticated models have been proposed, but they have gone largely untested because of the lack of data. In this paper, we develop a model of loan officers' incentives to assess loan quality and their loan origination decisions under different compensation schemes. We then test the model's implications by employing a unique data set from a major commercial bank on loan officer compensation. Specifically, the bank switched from fixed-salary compensation to a newly implemented incentive plan, or a piece-rate contract, based on loan origination for half of the loan officers. This provides a natural experiment for us to study many features of incentive compensations.

Such incentive contract creates a typical example of rewarding the agent along one dimension, namely, quantity, but not the other, quality. It gives loan officers no incentive to search for and book "good" loans. The dataset allows us to address many of the essential questions to this agency problem: (i) Do piece-rate contracts motivate loan officers to work harder? (ii) Do piece-rate contracts distort loan officers' risk-taking behavior? In addition, with detailed micro-level data on loan applications, subsequent performance of approved loans and loan officers demographic data, we are able to study the consequences of such incentive compensation on loan originations, and answer

[1] See Prendergast (1999) for an extensive survey.

questions such as (i) How do different compensation schemes affect subsequent loan quality? (ii) Are piece rate contracts eventually profitable for the bank?

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 contract 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.

To further examine the issue of compensation scheme on loan officers' performance and to analyze the loan origination process, we focus on the loan officers' effort to assess loan quality and their subsequent booking decisions under different compensation schemes. The loan origination process starts when a loan officer receives a loan application that contains observable information of a loan. 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 to reveal 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 or may not be concealed by the loan officer and be verifiable by the bank. One distinction between hard information and soft

information is that soft information is a signal that cannot be verified (Petersen (2004)). We study both cases when the loan officer makes the loan approval decision based on unverifiable information, or soft information, and when she makes booking decision based on verifiable information, or hard information.

We find that under fixed salary, the loan officer follows a simple lending standard of the bank and has no incentive to investigate loan quality. Incentive compensation based on loan origination, on the other hand, raises concerns that the loan officer may be motivated to write any loans and will not exert sufficient effort to search for bad credits. We show that the degree of the distortion of incentives depends on the strength of the monetary incentives given. With moderate amount of incentives, piece-rate contracts, although unrelated to the *ex-post* loan performance, motivate the loan officer to book more loans *and* to search out good credits. Her incentive to search for good credit, however, diminishes if monetary incentives exceed certain threshold. Monetary incentives may completely eliminate the loan officer's effort to assess loan quality when they are too large. This effort level reduces to zero, which is the same as that under fixed-salary compensation. Monetary bonus in this case is purely costly to the bank, since the loan officer will only book more loans of inferior quality.

Furthermore, we find that the incentive effect depends crucially on the information asymmetry between the loan officer and the bank. If the information revealed by the loan officer cannot be concealed and is verifiable by the bank *ex post*, incentive compensation perfectly aligns her incentive to search for good loans. The stronger the monetary incentive, the greater the effort, and thus, the more good loans written. If, however, this information can be concealed by the loan officer and is not verifiable by the

bank, the loan officer trades off monetary bonus with her career concern. In this case, incentive compensation may distort effort depending on the strength of the incentives given, as discussed above.

The loan officer's career concern, especially the interaction between her career concern and incentive compensation, also plays an interesting role in the loan officer's choice of effort and loan origination decisions. We find that when monetary incentive is moderate, for which the loan officer is motivated to write only good loans, career concern motives her to make more conservative booking decisions. Since even good loans may default with a small probability, the loan officer strategically decreases her effort to write loans. On the other hand, when monetary incentive is large such that the loan officer may take risks to write loans whose quality remain uncertain, her effort level increases with her career concern. The intuition is that when her career concern is large, writing a bad loan is costly to the loan officer. She will, therefore, put in more effort. Furthermore, we show that monetary incentives and career concern serve as compliments when information asymmetry between the bank and the loan officer is large.

The model allows us to derive a set of testable implications. We show that a switch to piece-rate pay increases the probability of booking a loan. In addition, loan officers will book larger and longer-maturity loans under the new incentive compensation. The default rate of booked loans will also be greater, and will increase with the requested loan amount and time-to-maturity of the loan. We test our model using a unique administrative data set from a large national bank that changed its compensation scheme. In January 2005, the management of the bank switched half of the loan officers from fixed-wage compensation contract to a new incentive compensation

package. The goal of this program was to "recognize and reward those associates whose performance most aggressively contributes to the overall success of Business Credit Services," and "to attract and retain outstanding talent." The data set includes micro-level data on loan applications, loan performance, and loan officers from 12 months before the compensation change to 12 months after. This allows us to study the effect of incentive compensation on the loan officers before and after the treatment without the usual endogeneity problem. Since the incentive compensation scheme was implemented on half of the loan officers, the other half whose salary remains fixed-wage constitute a control group. In addition, we have the default status of the approved loans for two years after their originations.

In the context of compensation contract, 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). Such compensation structure is usually compared to fixed-wage compensation. 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 awarded (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 towards those that are directly rewarded and away from the uncompensated activities.

We contribute to the incentive contract literature by demonstrating that information asymmetry and the agent's individual career concern affects the degree of distortion of incentive contracts. This is also consistent with the view that the size of the incentives given should depend on the noisiness of performance measures.

Due to 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 effect and the worker selection effects of piece-rate contracts. Paarsch and Shearer (1996) provide similar evidence using Canadian tree planters data. It is important to bear in mind that these studies document cases that the jobs carried out are "simple," in the sense that 1) performance is easily measured and 2) the quality is easily observed. Loan officer's job in our paper is much more complicated than those in the previous papers. Most importantly, the quality of 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 effect of incentive contracts on multi-tasking behavior of the agents. In addition to providing empirical evidence to the existing theories, we add to the banking literature by studying how loan officer's incentives affect the subsequent loans booked.

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. We conclude in Section 5.

2. Model Description

The primary motivation behind the incentive scheme is to increase worker efforts. In the context of loan officers, a central role that they play in the process of loan origination is to assess loan quality. 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 under different compensation schemes and information structure.

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.

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 decision to approve a loan application. The probability θ that the loan officer reveals the loan type depends on her effort *e*. With probability 1- θ, the loan type remains uncertain. We assume that $\partial\theta / \partial e > 0$, $\theta(0)=0$ and $\theta(\infty)=1$.[2] We also assume that $e'(\theta) \in [0,\infty)$ and $e''(\theta) > 0$.[3] In addition, we assume that the bank sets an approval policy such that all applications with sufficiently high ex-ante score $q > q0$ will be approved.

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 amount of the loan originated. Assume that $b(Y) >=$

[2] Assume that θ is continuous. Then the inverse function $e(.)$ is continuous and $\partial e/\partial\theta > 0$.
[3] One such example of the functional form of $e(.)$ would be $e(\theta)= \tan(\theta*\pi/2)$.

0, and $\partial b / \partial Y > 0$. Under the fixed salary contract, *b(Y)* = 0. For notional simplicity, we normalize *a* to zero.[4]

It is easy to see that under fixed salary contract, that is, the loan officer's salary does not depend on the amount of loan originated, she has no incentive to exert costly effort to assess loan quality. In this case, she approves a loan if its ex-ante quality *q* is greater than *q0*, and rejects the loan otherwise. The ex-ante probability that a loan will be approved is $\overline{B}_s = 1 - q0$. The expected default probability of all booked loans under this compensation scheme, $\overline{D}_s$, is given by

$$\overline{D}_s = \frac{\int_{q_0}^{1} (1 - pq) dq}{1 - q_0} = 1 - \tfrac{1}{2} p - \tfrac{1}{2} p q_0 .$$

We study a loan officer's decision to assess loan quality under an incentive scheme that compensates her for loan originations. The basic game proceeds as follows: a loan officer reviews a loan application characterized by (*Y, T, q*). If *q* > *q0*, the loan will be booked. If *q* <= *q0*, the loan officer exerts costly effort *e*, and reveals the loan type with probability *θ(e).* Depending on the information structure, the loan officer can or cannot conceal the information she reveals. She then makes an approval decision and receives payoffs that depend on the compensation contract and her career concern.

We study variations of the basic game above to analyze the effects of the incentive compensation scheme under different information structures. We first study the case when the loan officer cannot conceal the information she reveals and that this information is verifiable by the bank – we call this the "verifiable information problem." We then study the case when the revealed loan quality is the loan officer's private

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

information and that this information is unverifiable by the bank – we call this the "unverifiable information problem."

2.1 The verifiable information problem

Suppose that the loan officer exerts costly effort to reveal a loan type. The information she reveals cannot be concealed and is verifiable by the bank. Assume that good loans are profitable for the bank and should be booked. Thus, the loan officer books a loan if $q > q0$, or if the loan is revealed to be of the good type with probability θ in the case of $q <= q0$. With probability 1-θ, nothing will be revealed. The loan officer does not update her prior belief that the loan is good with probability q. Therefore, the loan is not qualified to be booked if its type is not revealed. Since the loan officer books loans based on verifiable information, she suffers no negative consequences should a loan default. If $q > q0$, the loan officer books the loan without exerting effort. She receives payoff $b(Y)$. If $q <= q0$, the loan officer will book the loan only if it is revealed to be of the good type. The loan officer chooses the probability of detection, θ, that maximizes her payoff given by

$$q\theta b(Y) - e(\theta),$$

yielding a first-order-condition (FOC):

$$qb(Y) = \frac{\partial e}{\partial \theta}.$$

The probability of loan origination, B_v is given by

$$B_v = \begin{cases} 1 & q \geq q_0 \\ q\theta(e^*) & q < q_0 \end{cases},$$

where e^* is the effort chosen by the loan officer. The loan officer's effort increases the probability that a loan is booked. The ex-ante probability of loan origination for all loans is given by $\overline{B}_v = 1 - q_0 + \int_0^{q_0} q\theta(e^*)dq$.

The expected default probability of all booked loans, $\overline{D}_v$, is given by

$$\overline{D}_v = \frac{\int_{q_0}^{1}(1-pq)dq + \int_0^{q_0} q\theta(e^*)(1-p)dq}{1 - q_0 + \int_0^{q_0} q\theta(e^*)dq}.$$

Compared to the fixed compensation case, the default probability is smaller. The intuition is straightforward: since the loan officer can only book good loans if the ex-ante score is low, more good loans will be booked, thus lowering the overall default probability. We summarize these results in the following proposition.

Proposition 1 *If the loan officer cannot conceal the information she reveals and this information is verifiable by the bank, then*

1. An incentive plan motivates the loan officer to book more loans compared to fixed-wage salary.

2. The expected default rate of booked loans is lower under the incentive plan than under fixed-wage salary.

Since $e''(\theta)>0$, we see from the FOC that if $qb(Y) <= e'(0)$, then the loan officer's maximum payoff is achieved at $\theta^*=0$, or $e^*=0$. That is, with verifiable information, if the monetary incentive is too weak, or if it unlikely that a loan is good, the loan officer will not exert any costly effort. Otherwise, if $qb(Y) > e'(0)$, there is always a

unique interior solution to the maximization problem, as we assume is the case in the following discussion.

Proposition 2 *Under an incentive compensation plan, if the loan officer cannot conceal the information she reveals and this information is verifiable by the bank, then*

1. The loan officer's optimal effort increases with the loan amount, and the ex-ante score of the loan, q (for $q < q0$).

2. *The likelihood of loan origination increases with the loan officer's effort level, and the ex-ante score of the loan, q (for $q < q0$).*

We see that with non-concealable and verifiable information, incentive scheme strictly improves the loan officer's effort to assess loan quality and the overall quality of booked loans. In addition, the loan officer has more incentive to exert effort for intermediate quality loans, which do not meet the simple standard of loan approval. These loans are likely to be good, and thus monetary incentives motivate further investigation.

2.2 The unverifiable problem

As we see in the previous section, when information cannot be concealed and is verifiable by the bank, incentive compensation based on loan origination works well to motivate loan officers to search for good loans. In this section, we study the case when the information revealed to the loan officer can be concealed by the loan officer and is not verifiable. We show that loan officers now have incentives to write "bad" loans, motivated by monetary benefits. Unlike the verifiable information case, since good loans

may also default and the information the loan officer reveals cannot be verified by the bank, the loan officer cannot justify her approval decision when a loan defaults. In this case, the loan officer's career concern plays an important role as a disciplinary mechanism. We assume that the loan officer suffers a negative career consequence should a loan default.

The model is similar to the basic game. The loan officer observes loan characteristics *(Y, T, q)*. She exerts effort *e* and the loan type will be revealed with probability θ. The loan officer makes a loan origination decision and receives her payoff. If a loan is booked, she receives

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

where ρ is the probability that a loan will default. *c(T)* is the negative career consequences of a defaulted loan. We assume that $c(T) >= 0$ and $\partial c / \partial T < 0$. Specifically, we assume that *c(T)* takes the functional form $c(T) = Ke^{-\delta T}$. We assume that the cost of a defaulted loan decreases with the time to maturity of the loan to capture the idea that the longer the maturity, the more likely it is that the loan will default years later when the loan officer may no longer be on the job, and therefore the smaller the negative impact on her career concern.

It is reasonable to conjecture that greater monetary incentives for loan origination will distort the loan officer's incentive to book riskier loans. We investigate this question in three cases based on the information revealed to the loan officer: the loan type is good (*G*), bad (*B*), or no information is revealed, that is the loan type remains unknown (*U*). If the loan is booked, the loan officer gets the following payoffs based on revealed types:

$$P(G) = b(Y) - (1-p)c(T) - e(\theta),$$
$$P(B) = b(Y) - c(T) - e(\theta),$$
$$P(U) = b(Y) - (q(1-p) + (1-q))c(T) - e(\theta).$$

Case 1: Only good loans are booked

If the following constraints are satisfied, then the loan officer has incentive to book only good loans.

$$b(Y) - (1-p)c(T) \geq 0,$$
$$b(Y) - c(T) < 0,$$
$$b(Y) - (q(1-p) + (1-q))c(T) < 0.$$

Notice that the second inequality is redundant in this case: if the loan officer has no incentive to book uncertain loans, she has no incentive to write bad loans.

The loan officer chooses an optimal effort level based the loan characteristics, *(Y, T, q)*, and the associated monetary bonus. If the monetary incentive is relatively small, or the loan officer's career concern is very strong, she will not book the loan unless it is revealed to be good, which happens with probability $q\theta$. In this case, the loan officer receives expected payoff

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

yielding a FOC: $q[b(Y) - (1-p)c(T)] = \dfrac{\partial e}{\partial \theta}$.

From the FOC, if $q[b(Y) - (1-p)c(T)] \leq e'(0)$, then $\theta^* = 0$. Otherwise, there is an interior solution to the maximization problem. Since the probability that a good loan will default, *1-p*, is small, we assume that the latter is true.

The probability that a loan with a score q is booked is given by

$$B_u^G = \begin{cases} 1 & q \geq q_0 \\ q\theta(e^*) & q < q_0 \end{cases},$$

where e^* is the effort chosen by the loan officer satisfying the FOC. As in the verifiable information problem, the loan officer's effort increases the probability that a loan is booked. The ex-ante probability of loan origination for all loans is given by

$$\overline{B}_u^G = 1 - q_0 + \int_0^{q_0} q\theta(e^*)dq.$$

The expected default probability of all booked loans, $\overline{D}_u^G$, is given by

$$\overline{D}_u^G = \frac{\int_{q_0}^1 (1 - pq)dq + \int_0^{q_0} q\theta(e^*)(1-p)dq}{1 - q_0 + \int_0^{q_0} q\theta(e^*)dq}.$$

The default probability of any given booked loan, D_u^G, is given by $D_u^G = 1 - p$, since the loan officers are motivated to book only good loans.

Proposition 3 *If the monetary incentive is small or the loan officer's career concern is large, the loan officer will book a loan if it is revealed to be good. In this case,*

1. The loan officer's effort level to investigate loan quality 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.

2. The probability of loan origination increases with the loan officer's effort to assess loan quality.

Notice that the monetary incentive works exactly the same as that in the verifiable problem. The loan officer's choice of effort, thus, detection probability, increases with the requested loan amount, monetary incentive, and the likelihood that the loan is good, and decreases with her career concern *c(T)*. Since the loan officer books a loan only when it is revealed to be good, and she suffers a negative, albeit small, career consequence even when a good loan defaults, she makes conservative booking decision and strategically decreases her effort to reveal loan quality compared to the verifiable information case. On the other hand, although monetary incentive motivates the loan officer to increase her effort to search for good loans, as it gets larger, she may have incentive to book not only the loans that are revealed to be good, but also those whose quality remains uncertain. We analyze this next.

Case 2: Good loans and uncertain loans are booked.

Recall that when the loan officer exerts costly effort *e*, with probability θ the loan type will be revealed, and with probability 1- θ its type remains uncertain, 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 uncertain ones if the monetary incentive is larger or when her career concern is weaker than in the previous case. That is, when the following constraints are satisfied:

$$b(Y) - (1-p)c(T) \geq 0,$$
$$b(Y) - c(T) < 0,$$
$$b(Y) - (q(1-p) + (1-q))c(T) \geq 0.$$

In this case, the first inequality is redundant. The loan officer gets payoff

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

yielding a FOC:

$$q[b(Y) - (1-p)c(T)] - [b(Y) - (q(1-p) + 1 - q)c(T)] = \frac{\partial e}{\partial \theta}$$

$$\Rightarrow$$

$$-(1-q)b(Y) + (1-q)c(T) = \frac{\partial e}{\partial \theta}.$$

We see from the FOC that if $-(1-q)(b(Y) - c(T)) \le e'(0)$, then the loan officer achieves maximum payoff by choosing $\theta^*=0$. That is, too large a monetary incentive completely destroys the loan officer's incentive to exert effort. Moreover, we see that this distortion of incentive is more severe for ex-ante risky loans, that is, those with low ex-ante score q.

The probability that a loan is booked is given by

$$B_u^{GU} = \begin{cases} 1 & q \ge q_0 \\ 1 - (1-q)\theta(e^*) & q < q_0 \end{cases},$$

where e^* is the effort chosen by the loan officer. Unlike the previous case, the loan officer's effort decreases the probability that a loan is booked.

The ex-ante probability of loan origination is given by

$$\overline{B}_u^{GU} = 1 - q_0 + \int_0^{q_0} 1 - (1-q)\theta(e^*)dq\,.$$

The expected default probability of all booked loans, $\overline{D}_u^{GU}$, is given by

$$\overline{D}_u^{GU} = \frac{\int_{q_0}^{1}(1-pq)dq + \int_0^{q_0}\theta(e^*)q(1-p)+(1-\theta(e^*))(1-pq)dq}{1-q_0+\int_0^{q_0}1-(1-q)\theta(e^*)dq}.$$

The default probability of any given booked loan, D_u^{GU} is given by

$$D_u^{GU} = \frac{\theta(e^*)q(1-p)+(1-\theta(e^*))(1-pq)}{1-(1-q)\theta(e^*)} = 1-\frac{pq}{1-(1-q)\theta(e^*)}.$$

In this case, the loan officer's effort increases the likelihood of revealing a bad loan which will be denied. Therefore, the default probability decreases with the loan officer's effort.

Proposition 4 *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.

Monetary incentives and the loan officer's career concern work in the opposite direction as in the previous case. Monetary incentive in this case decreases 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 "uncertain" ones are booked, her effort to investigate loan quality only affects her booking decision of bad loans, which she is discouraged from booking. In other words, the loan officer's effort decreases the likelihood that she will book a loan and receive the monetary bonus. Monetary incentives, in this case, discourage the loan officer to investigate loan quality. On the other hand, career concern 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, motivated by her strong career concern. 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.

Case 3: All types of loans are booked.

If monetary incentives are sufficiently large and the loan officer's career concern is small, the loan officer will book a loan regardless of its quality, that is, if the following constraint is satisfied:

$b(Y) - c(T) \geq 0.$

In this case, it is easy to see that the loan officer has no incentives to exert costly effort.

2.3 Empirical Implications:

As we show in the previous section, under fixed salary compensation, loan officers have no incentive to investigate loan quality. A loan will be booked if it meets the simple approval qualification based on primarily ex-ante observable information. Incentive compensation, on the other hand, motivates loan officers to work harder to assess the loan quality. Loan officers' effort levels, however, vary with the strength of monetary incentive and career concerns. It follows that there will be greater variation in the total amount of loans booked, internal risk rating, and ex-ante scores of booked loans.

Prediction 1 *The total amount of loans booked, the internal risk rating of booked loans, and the ex-ante scores of booked loans display greater variance by loan officers under the incentive compensation contract than under fixed-wage salary.*

Summarizing propositions 1-4 above, we have the following predictions.

Prediction 2 *Loan officers book more loans under incentive compensation than under fixed-wage salary.*

Prediction 3 *The default rate of booked loans is greater under the incentive compensation than under fixed-wage salary.*

Prediction 4 *Under an 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 5 *Under an 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 6 *The likelihood of booking a loan decreases with the loan officer's career concern.*

One distinction between hard information and soft information is that soft information is unverifiable (Petersen (2004)). Our analysis on information verifiability and compensation scheme, therefore, sheds lights on how incentives affect the subsequence loan performance based on the amount of soft information used in the loan origination process. We show above that with verifiable information, incentive compensation promotes loan officers to investigate loan quality and to avoid booking bad loans. Only when information becomes unverifiable does a monetary bonus distorts incentives.

Prediction 7 *Both the likelihood of loan origination and the default probability is higher for more informationally opaque loans under the incentive compensation.*

3. Description of the Market

3.1 The Loan Officer's Job Function

Loan officers play a central role in the process of loan origination. The process begins from the loan officers initiating 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.

3.2 Data

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 to half of the Business Credit Services approval officers. The incentive package provides a "pay for performance" bonus opportunity based on individual results. Before that, all loan officers were paid 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, 2, and Figure 1.

The goal of this program is to "recognize and reward those associates whose performance most aggressively contributes to the overall success of Business Credit Services," and "to attract and retain outstanding talent."

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

The data covers 12 months before the compensation change and 12 months after. To study the effect of incentive compensation on loan officer's incentives and its 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 (henceforth referred to as the treated group), and data from the other half of the loan officers whose salary remained fixed-wage (henceforth referred to as the control group) covering the same period. Data from the control group allows us to better control for macro economic fluctuations over this time 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. Preliminary Result

Not surprisingly, loan officers are motivated to book more loans under the incentive pay. 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. A month by month break-down of the status of loan applications reveals that a structural change in the percentage of approved loans takes place in January, 2005. See Table 8 and Figure 2.

In addition to booking more loans, loan officers in the treated group are booking larger loans, as it is motivated by the incentive pay. Table 3 shows that the average dollar amount of booked loans increases by $96.470, a 44.7% increase. The average percentage of loan applications that are approved increases from 32% to 47%. Figure 3 shows that

both the average dollar amount of booked loans and the percentage of loans booked increase since January 2005.

Moreover, as the model predicted, Table 9 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. This is partly driven by the fact that loan officers are usually on the job for a relatively short period of time. When a longer term loan defaults, chances are the officers who originated the loan will no longer be on the job.

It is apparent from above that loan officers in the treated group are booking more loans, both in terms of the number of loan applications and the dollar amount of the loans. We measure loan officer's efficiency in input by the number of days spent on each loan application. Not only is it part of the incentive plan (the overall goal is 68.5% of the decision made in time according to the guideline. See Table 1.), it also affects how many loans can be reviewed in a given month. Table 3 shows that the average number of days spent on each loan application goes down from 1.35 to 1.06 since the compensation change, a 21% drop. Figure 4 shows that the structural change takes place in January, 2005.

As predicted by the model, the difference in loan officers' career concerns and cost of effort will drive a greater variance in the effort level by loan officers under the incentive compensation. It follows that there will be greater variation in the total amount of loans booked, and ex-ante scores of booked loans. Table 6 shows that the number of loans reviewed, the number of loan applications booked, the amount of loans booked and

the percentage of loans booked all have a larger increase in standard deviation in the treated group from year 2004 to 2005.

As suggested in the literature, incentive compensation may have a sorting effect of attracting more able workers (Lazear (2000)). Table 5 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.

Interestingly, Table 4 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.

Are loan officer booking riskier loans?

One potential concern of paying piece rates is that quality may deteriorate. In our case, does piece rate contract distort incentives in a way that loan officers book riskier loans? The model suggests that loan officers have stronger incentives to investigate 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 3 shows that while the average LTV of loan applications slightly decreased from year 2004 to year 2005 in the treated group, the LTV of booked loans increased from 76.24 to 84.10, a 10.32% increase, suggesting that loan officers are

booking riskier loans. Figure 5 shows that there is a structural change in the average LTV ratios in January 2005.

It is also noticeable that more of the booked loans are secured by collateral after year 2005 in the treated group. The average percentage of booked loans without collateral went 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 3 shows that the average business scores and personal scores of approved loans go up in year 2005, and the internal risk ratings go down. Figure 6 shows a decrease in internal risk rating since January 2005. Since the internal risk ratings reflect large amount of soft information possessed by loan officers, these imply that loan officers are identifying less risky borrowers since the plan implementation.

In conclusion, our univariate statistics, while largely consistent with our predictions, are not conclusive. We provide further evidence with a multivariate analysis.

Further Evidence: Multivariate analysis

Next, we estimate the impact of the treatment on the treated for a series of outcome variables. Namely, we determine if the treated loan officers during the treatment period are more likely to, (i) approve as opposed to decline loan applications; (ii) are the loans approved more likely to be withdrawn; and (iii) are the booked loans 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 collaterals are important for loan officers' approval decisions. Table 11 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 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 larger risk and are less likely to be approved on average, the implementation of the incentive plan encourages loan officers to book larger loans, as we see in Table 11 that log(loan amount requested)*treated*2005 is significantly positive. Similarly, Loan maturity*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. We confirm that internal risk ratings, LTV of the loan, loan amount requested and loan maturity are good risk factors that predict loan defaults, as seen in Table 12. The higher the internal risk ratings, the higher the LTV, the larger the loan amount requested and the longer the loan maturity, the more likely that a loan will default. Collateral requirements on the other hand decrease the probability that a loan defaults, consistent with the moral hazard views 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 loan officer's effort to investigate loan quality. The harder the loan officer works, the less likely 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 are more likely to default. Both Loan-to-Value of the Loan * treated * 2005 and Loan maturity * treated * 2005 are significantly positive.

Table 10 summarizes 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 allow us to study questions such as how the incentive plan interacts with loan officers' career concern. Our model indicates that loan officers' career concern serves as a power 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 10. Using loan officers' ages and number of years on the job (tenure) as proxies for career concern, we see that loan officers' career concern becomes significant after the implementation of the incentive plan in year 2005. These are insignificant on their own, but become significant after interacting with the treated dummy and the year 2005 dummy. 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 less the number of 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 less the career concern, and thus, the more likely that the loan officer books riskier loans motivated by the 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%, which is much larger than the other two, confirming that loan officers' tenure is an important factor to loan approval decisions after the implementation of the incentive package. We interpret this as the 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 loan officer's effort to assess loan quality.

We see that the longer the number of days 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.

5. Conclusion

A central question addressed by much research on incentive compensation has been whether incentive contracts provide the right incentives. Our model demonstrates that with the right amount of monetary incentives, incentive compensation motivates loan officers to work harder at assessing loan quality, although the monetary incentives are provided along the quantity dimension. Too large a monetary incentive, however, does distort loan officer's incentives to search for bad credits. They will be induced to book riskier loans.

We show that career concerns serve as a good disciplinary device to mitigate the incentive problems. Loan officers with greater career concerns will be more conservative at booking loans and will exert more effort to search for bad credits.

We find that the loan officer's choice of effort and loan origination decision depends crucially on the strength of the monetary incentives, the information asymmetry between the bank and the loan officer, and the loan officer's career concern. Hardening the soft information that loan officers use to make approval decisions will reduce distortion of incentives of piece-rate contracts.

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Table 1: Performance measure

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:

- Score + (all products) = 1 point
- S/L – basic (term $500M - $1MM) = 2 points
- S/L (term $1 - $3MM, lines of credit < $750M) = 3 points
- S/L – complex (term > $3MM, lines of credit > $750M) = 5 points
- Letters of credit (S/L) = 2 points
- Commercial card (S/L) = 2 points

*Decision time guidelines are as follows:

- Score + guideline is 3 days
- 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

Figure 1: Incentive Plan

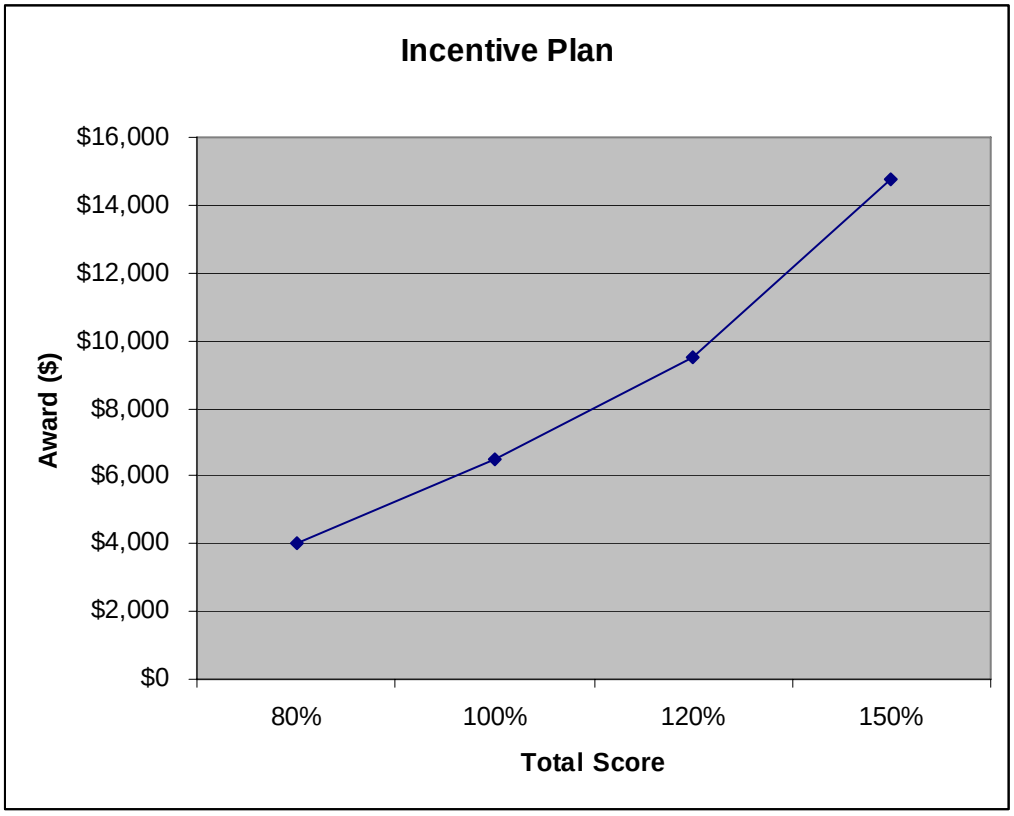


Table 3: Summary statistics of loan applications

Variable	2004 (January - December)				2005 (January - December)			
	Control Group		Treated Group		Control Group		Treated Group	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
Avg $ Loan Requested	$ 455,240	$ 336,805	$ 426,480	$ 378,698	$ 454,141	$ 369,635	$ 444,137	$ 381,829
Avg $ Loans Booked	$ 224,614	$ 279,361	$ 216,048	$ 229,403	$ 253,219	$ 257,801	$ 312,518	$ 404,976
Avg % of Loans Booked	31%	46%	32%	47%	36%	50%	47%	48%
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
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%
APR Booked Loans	9.91	5.02	9.85	4.89	9.58	4.88	9.65	4.93
Days Spent/Loan Requested	1.38	0.85	1.35	0.70	1.32	0.75	1.06	0.53
Number of Loan Requests	6920		7996		7564		7788	
Number of Loans Booked	2192		2548		2744		3680	
Number of Defaults	91		107		119		192	

Table 4: Summary Statistics of Loan Officers

	2004		2005	
Variable	Control Group Mean	Treated Group Mean	Control Group Mean	Treated Group Mean
Total Number of Loan Officers	63	70	65	65
Age	43	41	43	37
Gender - Male	58	61	59	72
Income	$42,363	$42,422	$42,976	$49,019

Table 5: Demographics of Loan Officers in the Treated Group

2004		2005	
Loan Officer Age	% of Loan Officers	Loan Officer Age	% of Loan Officers
25-34	26.92	25-34	33.04
35-44	29.07	35-44	37.58
45-55	24.66	45-55	21.04
55+	19.35	55+	8.34

2004		2005	
Loan Officer Gender	% of Loan Officers	Loan Officer Gender	% of Loan Officers
Male	68.04	Male	74.28
Female	31.96	Female	25.72

Table 6: Summary Statistics of Loans Reviewed by Loan Officers

Variable	2004 (January - December)				2005 (January - December)			
	Control		Treated		Control		Treated	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
# of loans reviewed	109.84	77.70	114.23	34.93	116.37	75.64	119.82	52.13
# of loans booked	34.79	30.37	36.40	20.38	42.22	33.18	56.62	40.63
% of loans booked	41%	38%	32%	16%	41%	24%	45%	21%
amount of loans booked	$225,134.00	$74,040.80	$225,397.31	$113,290.16	$257,949.08	$72,452.48	$331,931.22	$116,835.69

Table 7: Percentage bookings in the treated group by income level

2004			2005		
Loan Officer Income	% of Loan Officers	Percentage Bookings	Loan Officer Income	% of Loan Officers	Percentage Bookings
0-20K	8.04	4.95	0-20K	12.81	15.05
20K-30K	14.44	9.89	20K-30K	15.03	15.9
30K-40K	26.82	19.11	30K-40K	16.05	13.05
40K-50K	24.05	29.02	40K-50K	21.05	17.93
50K+	26.64	37.01	50K+	35.04	38.05

Table 8: Monthly Loan Approval Status

	Number of Loans in the Treated Group							Number of Loans in the Control Group						
Months	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 9: Loan Approval Status

	Treated Group in 2004			Treated Group in 2005			
Loan Size / Type	% approval	% rejection	% walk away	% approval	% rejection	% walk away	Freq
Big loan (> $700K)	35%	57%	8%	55%	36%	8%	23%
Medium loan ($250K-$700K)	31%	56%	13%	49%	40%	11%	53%
Small loan (< $250K)	27%	55%	18%	33%	51%	16%	24%
Long term loan (Larger than One Year)	32%	55%	13%	52%	36%	12%	63%
Short term loan (One Year)	29%	58%	13%	37%	51%	12%	37%

Table 10: Loan approval decisions and defaults

	Acceptance				Default			
Variable	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%	
Loan Officer Dummy	Yes				Yes			
SIC 2 Digit Dummies	Yes				Yes			

Table 11: 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			

Table 12: 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				

Figure 2: Monthly Loan Approval Status

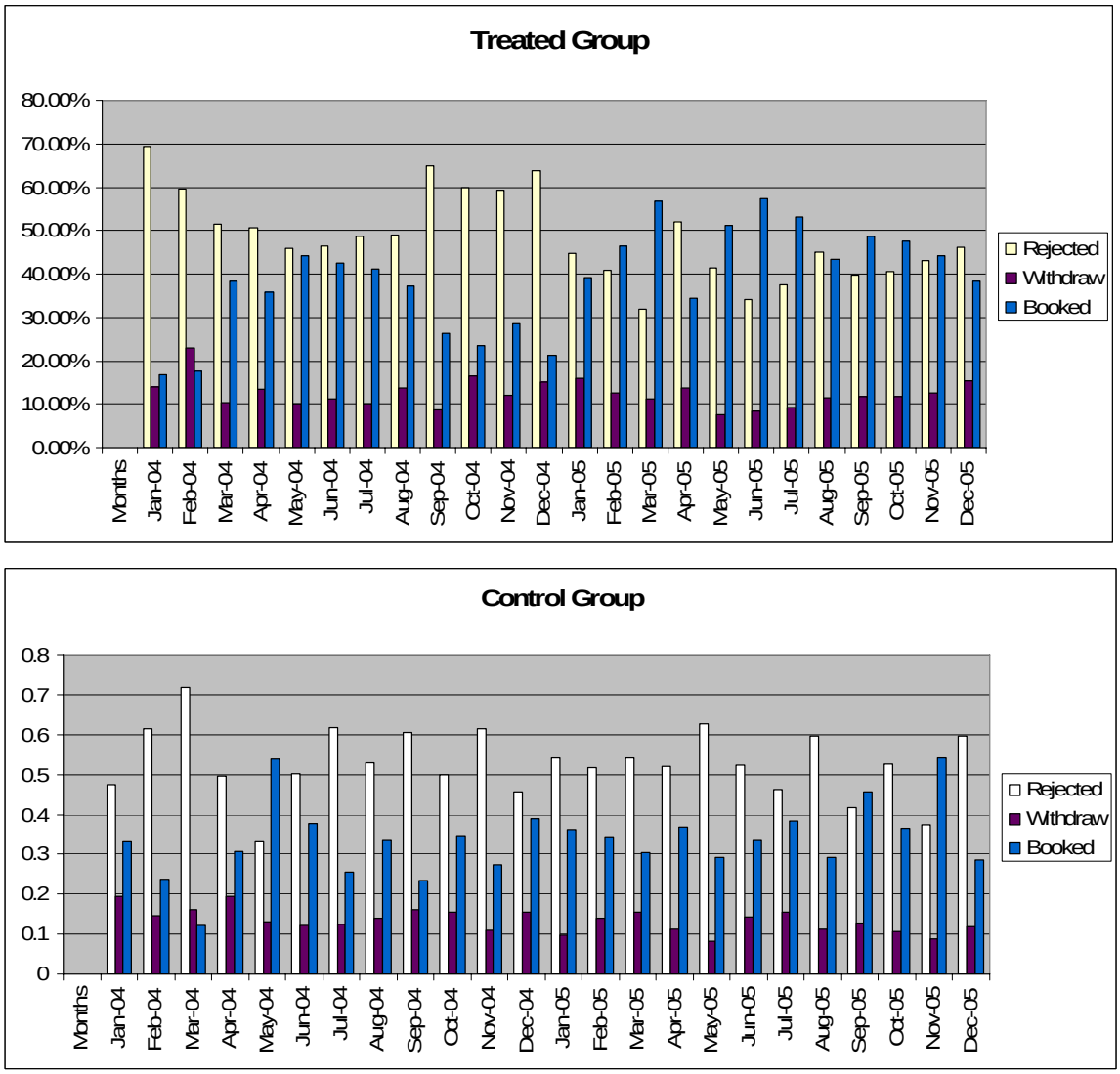


Figure 3: Loan Applications Booked in the Treated Group

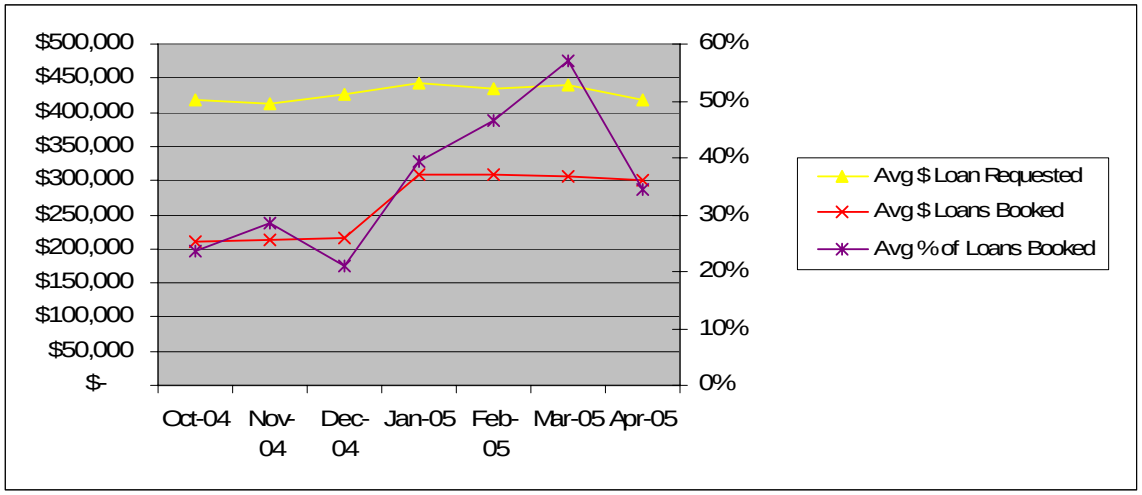


Figure 4: Days Spent on Loan Requested in the Treated Group

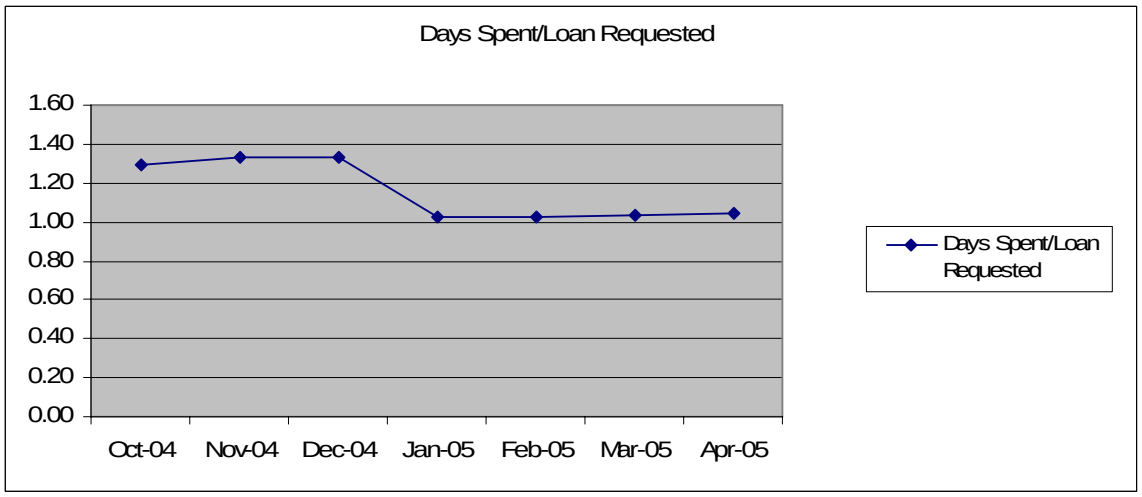


Figure 5: Loan-to-Value Ratios

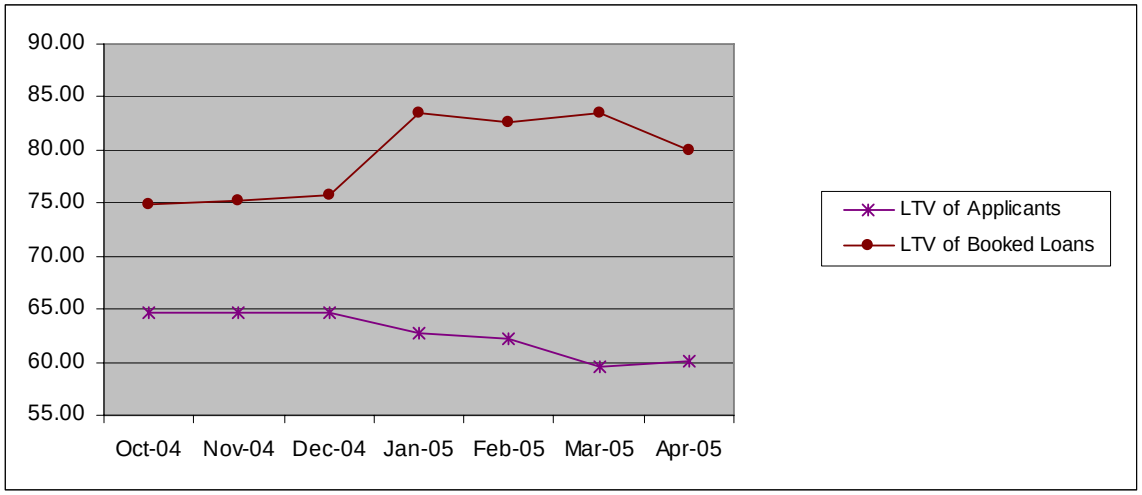
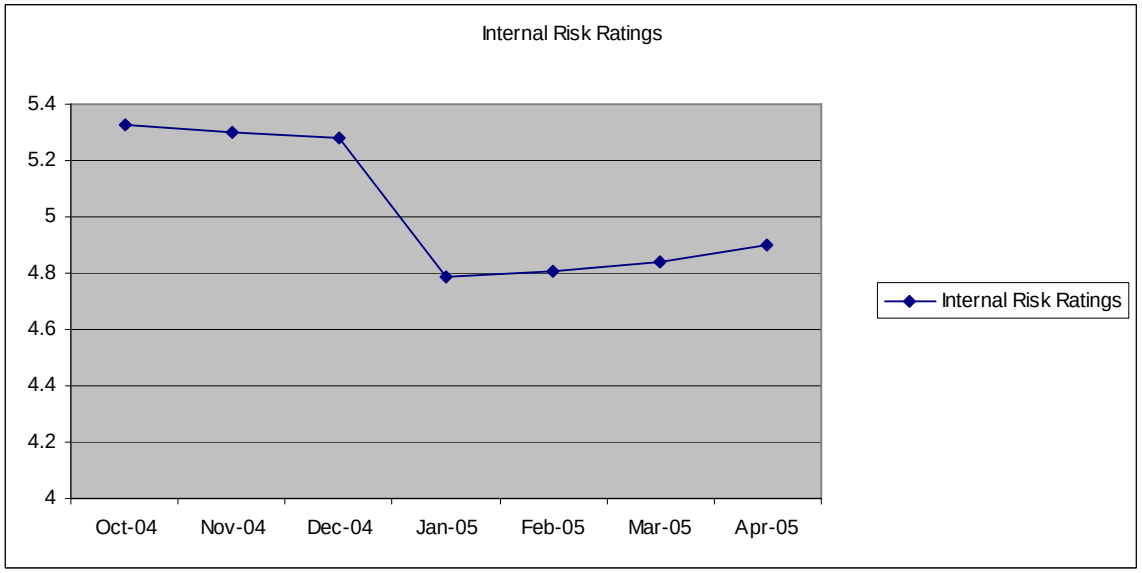


Figure 6: Internal Risk Rating



APPENDIX

Proof of Proposition 1:

1. $\bar{B}_v = 1 - q_0 + \int_0^{q_0} q\theta(e^*)dq > \bar{B}_s = 1 - q_0$.

2. We wish to show that $D_v < D_s$. That is,

$$\begin{aligned} D_v - D_s &= \frac{\int_{q_0}^1 (1-pq)dq + \int_0^{q_0} q\theta^*(1-p)dq}{1 - q_0 + \int_0^{q_0} q\theta^* dq} - \frac{\int_{q_0}^1 (1-pq)dq}{1-q_0} < 0 \\ &\Leftrightarrow (1-q_0)\int_0^{q_0} q\theta^*(1-p)dq - \int_{q_0}^1 (1-pq)dq \int_0^{q_0} q\theta^* dq \\ &= [(1-q_0)(1-p) - \int_{q_0}^1 (1-pq)dq] \int_0^{q_0} q\theta^* dq \\ &= -\frac{1}{2}p(1-q_0)^2 \int_0^{q_0} q\theta^* dq < 0. \end{aligned}$$

Proof of Proposition 2:

1. Define $f(\theta) = q\theta b(Y) - e(\theta)$. Assume that there is an interior maximum, that is, $qb(Y) > e'(0)$. Then the maximum θ^* satisfies $f'(\theta) = qb(Y) - e'(\theta^*) = 0$.

   Taking derivatives w.r.t. Y, we have $qb'(Y) = e''(\theta^*)\partial\theta^*/\partial Y$. Since $q > 0$, $b'(Y) > 0$ and $e''(\theta^*) > 0$, we have $\partial\theta^*/\partial Y > 0$.

   Similarly, taking derivatives w.r.t. q, we have $b(Y) = e''(\theta^*)\partial\theta^*/\partial q \Rightarrow \partial\theta^*/\partial q > 0$.

2. $\partial B_v/\partial q = \theta^* + q\partial\theta^*/\partial q > 0$.

Proof of Proposition 3:

1. Define $f(\theta) = q\theta(b(Y)-(1-p)c(T))-e(\theta)$. Assume that there is an interior maximum, that is, q(b(Y)-(1-p)c(T))¿e'(0). Then the maximum θ^* is achieved at $f'(\theta) = q(b(Y) - (1-p)c(T)) - e''(\theta^*) = 0$.

   Taking derivatives w.r.t. Y, we have $qb'(Y) = e''(\theta^*)\partial\theta^*/\partial Y$. Since $q > 0$, $b'(Y) > 0$ and $e''(\theta^*) > 0$, we have $\partial\theta^*/\partial Y > 0$.

   Similarly, taking derivatives w.r.t. q, we have $b(Y) - (1-p)c(T) = e''(\theta^*)\partial\theta^*/\partial q \Rightarrow \partial\theta^*/\partial q \geq 0$, since $b(Y) - (1-p)c(T) \geq 0$.

   Taking derivatives w.r.t. T, we have $-q(1-p)c'(T) = e''(\theta^*)\partial\theta^*/\partial T$. Since $c'(T) < 0$, $\partial\theta^*/\partial T > 0$.

   Taking derivatives w.r.t. K, we have $-q(1-p)e^{-\delta T} = e''(\theta^*)\partial\theta^*/\partial K \Rightarrow \partial\theta^*/\partial K < 0$.

2. $\partial B_u^G/\partial e^* = q\partial\theta/\partial e^* > 0$.

Proof of Proposition 4:

1. Define $f(\theta) = q\theta[b(Y) - (1-p)c(T)] + (1-\theta)[b(Y) - (q(1-p) + 1 - q)c(T)] - e(\theta)$. Therefore, $f'(\theta) = -(1-q)b(Y) + (1-q)c(T) - e'(\theta)$. Assume that there is an interior maximum, that is, -(1-q)(b(Y)-c(T))¿e'(0). Then the maximum θ^* is achieved at $f'(\theta) = -(1-q)(b(Y) - c(T)) - e''(\theta^*) = 0$.

   Taking derivatives w.r.t. Y, we have $-(1-q)b'(Y) = e''(\theta^*)\partial\theta^*/\partial Y$. Since $(1-q) > 0$, $b'(Y) > 0$ and $e''(\theta^*) > 0$, we have $\partial\theta^*/\partial Y < 0$.

   Similarly, taking derivatives w.r.t. q, we have $b(Y)-c(T) = e''(\theta^*)\partial\theta^*/\partial q \Rightarrow \partial\theta^*/\partial q < 0$, since $b(Y) - c(T) < 0$.

Taking derivatives w.r.t. T, we have $(1-q)c'(T) = e''(\theta^*)\partial\theta^*/\partial T$. Since $c'(T) < 0$, $\partial\theta^*/\partial T < 0$.

Taking derivatives w.r.t. K, we have $(1-q)e^{-\delta T} = e''(\theta^*)\partial\theta^*/\partial K \Rightarrow \partial\theta^*/\partial K > 0$.

2. $\partial B_u^{GU}/\partial e^* = -(1-q)\partial\theta/\partial e^* < 0$. $\partial B_u^{GU}/\partial q = \theta^* - (1-q)\partial\theta^*/\partial q > 0$.

3. $D_u^{GU} = 1 - \frac{pq}{1-(1-q)\theta^*}$ decreases with θ^*, therefore, increases with Y, T, and decreases with K.