# INFORMATION SHARING AND CREDIT RATIONING: EVIDENCE FROM THE INTRODUCTION OF A PUBLIC CREDIT REGISTRY

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# Information Sharing and Credit Rationing: Evidence from the Introduction of a Public Credit Registry

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## Abstract

We provide the first evidence on how the introduction of information sharing via a public credit registry affects banks' lending decisions. We employ a unique dataset containing detailed information on credit card applications and decisions from one of the leading banks in China. While we do not find that information sharing decreases credit rationing *on average*, the distribution of granted credit among borrowers with shared information has a unique pattern. In particular, compared to those with information reported only by this bank, borrowers with extra information shared by other banks receive higher credit card lines. While *positive* information shared by other banks augments lending of this bank, the effect of *negative* information shared by other banks is not significant. In addition, the availability of shared information through the Public Registry has mixed effects on how the bank utilizes internally produced information. Last, information sharing alleviates informational barriers in China's credit card market, but not completely.

Key Words: information sharing, credit availability, credit rationing, credit card
*Journal of Economic Literature* Classification Numbers: G21, G32

# I. Introduction

In the past decade, we experienced a tremendous expansion of information sharing institutions (World Bank (2006)). Information sharing is deemed to be crucial to improve credit market performance (Djankov et al. (2007) and Brown et. al. (2009)). While the impact of information sharing on reducing default rates is less debated (see e.g. Jappelli and Pagano (2002), and Brown and Zehnder (2007)), the impact of information sharing on credit availability and credit rationing is not clear.[1] Brown et al. (2009) report firm-level evidence showing improved access to finance in countries with information sharing institutions.[2] Others find that private credit bureaus, rather than public credit registries, are associated with lower perceived financing constraints and a higher share of bank financing (Love and Mylenko (2003)), or that the lowering of reporting thresholds of a public credit registry results in lower lending to firms that had multiple lending relationships (Hertzberg et. al (2008)). The diverging findings using borrower-level data on credit access calls for a deeper understanding on how information sharing shapes banks' lending decisions. In particular, does a bank adjust its lending to its clients whose information is shared *to* other financial institutions? How does a bank utilize borrower information shared *by* other banks? And which type of borrower information, *positive* or *negative*, matters? These questions are important for policy makers, for example, in the design and effectiveness of information sharing institutions.

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[1] Theories on the impact of information sharing on credit availability are mixed. Brown et al. (2009) summarize it as follows: "In the adverse selection model of Pagano and Jappelli (1993) the effect on lending is ambiguous, while it is positive in the hold-up model of Padilla and Pagano (1997) and in the multiple-bank lending model of Bennardo et al. (2009). The effect on lending also depends on the type of information being shared: in the model by Padilla and Pagano (2000), sharing only default information increases lending above the level reached when banks also share their data about borrowers' characteristics."

2  This finding is in line with cross-country aggregate-level evidence. For instance, Djankov et al. (2008) show that information sharing is positively associated with the private credit to GDP ratio. Jappelli and Pagano (2002) report that information sharing improves bank lending to private firms.

This paper provides the first evidence on the aforementioned questions. To this end, we utilize a unique bank-borrower dataset that gives us advantages compared to existing studies. As our dataset stems from a period where the public credit registry was introduced, we know which borrowers have already external information and which borrowers have not. External information refers to the information on borrowers' credit records filed at the Public Credit Registry. Furthermore, we also identify borrower information that was shared by this bank *to* the public credit registry and which information was shared *by* other banks to the public credit registry. Our dataset is drawn from the credit card center of one of the leading commercial banks in China. The Chinese setting is of interest for at least two reasons. First, information sharing should be particularly relevant for credit market performance in countries with weak company law and creditor rights (Djankov et al. (2007) and Brown et. al. (2009)). China, as the largest transition economy in the world, provides a good example. Second, China provides us with a natural experiment to study the effect of information sharing. The Public Credit Registry in China started to be accessible for all financial institutions in 2006. Our data come exactly from a time period where the public registry was gradually installed. This implies that at the time of gathering the data, some borrowers' information is shared in the registry whereas others' is not. Therefore, our dataset naturally contains two groups of borrowers, borrowers with and without shared information. The Public Credit Registry in China contains both *positive* (the amount of outstanding loans) and *negative* (delinquency history) information, allowing us to distinguish the effects of different types of shared information on credit rationing.

Our dataset further has two unique features. First, we observe both demand (credit card line application) and supply (bank's decision on the credit card line amount granted). This provides us with a direct and precise measure on credit availability and degree of credit rationing. Compared to our paper, existing studies, due to data limitations, use the loans carried by firms, or proxies for access to finance when addressing credit availability. These are the equilibrium outcome of credit demand and supply. As the credit demand tends also to be affected by information sharing, existing studies on the effect of information sharing on credit availability suffer from omitted variable problems which are hard to control for. A second unique feature of our dataset is that we know what the bank observed at the time of making the credit line decision. Therefore, we are able to examine the impact of information sharing under a broad framework of information production. In particular, we are able to examine whether information from a public credit registry plays a role next to a bank's internally produced information. We explore whether the bank's internally produced information has a differential impact when there is external information available or not. A bank's internally produced information includes proxies of the intensity of the bank-customer relationship as well as other internally observed borrower characteristics. In this way, we follow Agarwal et al (2009) who highlight the benefits of relationship lending for the retail credit market in general and the credit card market in particular (see e.g. Degryse, Kim and Ongena (2009) for a literature review on relationship lending).

To control for potential sample selection issues, we focus on borrowers asking for an augmentation of their credit card line. Using data on this augmentation controls for potential sample selection issues arising from the fact that borrowers do not have

external information because they would be new clients of the bank or newly active in the market. In addition, we match borrowers with and without externally shared information according to their propensity of being filed at the Public Credit Registry. This further alleviates concerns such as borrowers not having been included in the Public Credit Registry as they stem from less developed areas, or have modest borrowing habits only.

All the benefits of our sample come at a minor cost as the credit card rate in China has been regulated at approximately 18 percent annually since the early 1990s. Therefore, the demand and the supply in the credit card market are not necessarily endogenously determined through prices. However, the fixed price may be less of a concern in our study as typically the interest rates in the credit card market are persistently high and issuers would be less willing to compete using the price instrument (see e.g. Ausubel (1991), and Calem and Mester (1995)).

Our main findings can be summarised as follows. On average, we do not find that the credit card line availability for the group of borrowers with external information is statistically different from that of borrowers without external information. In addition, the bank does not tend to grant lower credit lines to the group of borrowers whose external information is provided to the Public Registry only by this bank than to those without external information. This suggests that sharing information *to* other banks does not decrease this bank's willingness to lend. However, the *distribution of granted credit* between different groups of borrowers with external information is significantly different. On average, borrowers with *extra* information, i.e. information shared *by* other financial institutions to this bank, received a higher credit card line

than the group of borrowers whose external information only comes from this bank. The higher credit line offer for borrowers with extra external information stems from the fact that the bank improves its knowledge about borrower quality by shared *positive* information. In addition, when the extra *positive* information of a borrower is shared to the bank, the extra *negative* information is not important anymore. We do not find evidence for the "publicity multiplier" of information as documented by Hertzberg et al. (2008) for Argentina; however, we find that the bank lowers its credit card supply to borrowers who carry greater credit card balances at other banks. Our results thus are in line with Bennardo et al. (2009) where multiple lending relationships induce banks to ration credit, for fear that the borrower's total exposure may become so large as to induce default; however, when banks share information about their seniority or/and about their loan sizes, lending becomes safer, and credit rationing is reduced.

We also find that the existence of external information alters the way the bank utilizes internally produced information. For instance, we do find that the bank depends less on the intensity of bank-borrowing relationships, when there is external information available. Moreover, the bank's credit line supply is increased when some internally observed information is confirmed by external information, such as the housing status.

Last, concerning the effectiveness of information sharing on alleviating information asymmetries in the credit market, we find that external information partly mitigates informational barriers. For instance, the negative impact of balances carried by borrowers on credit availability becomes economically less significant when there is external information available. This implies that the bank may not readily distinguish

the borrowers who need more credit for their future, from those who simply want to accumulate more debt. This result is in line with Calem and Mester (1995) where informational barriers lead high-balanced consumers to be rationed.

An emerging body of literature studies informational barriers and credit rationing in the credit card market, as credit cards are one of the most important financing channels for borrower.[3] We contribute to this literature by providing the first evidence of the degree of credit rationing in the credit card market. Moreover, we are the first the study the rationing in the credit card market under a broad framework of information production and information sharing.

The remainder of the paper is organized as follows. Section II outlines our empirical framework. Section III introduces our dataset. Section IV reports our results on credit card line demand, supply, and rationing. The last section concludes.

## II. Empirical Framework

Consider a representative individual borrower who asks to increase her credit card line to $D^*$ with this application. We define a set of variables that affect $D^*$. Typically they include individual risk measures, $R$, lending relationship with the bank, $L$, the

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[3] Calem and Mester (1995) were the first to document the phenomenon of credit rationing in the credit card market when studying the persistence of the high credit card loan rates in the US. Crook (2002) and Kerr and Dunn (2002) use data from the 1998 survey of consumer finance (SCF) and find little evidence that the high-balance borrowers intended to search less than others, while they do find that the consumers with high outstanding credit card loans were more likely to be turned down. Calem, Cordy and Mester (2006) revisit the question by investigating data of the 1998 and 2001 SCF and find that the probability of being turned down for a consumer was still highly correlated with the amount of loans she carried, and that the effect of informational barriers remained relevant but declined compared to that documented by Calem and Mester (1995). Other studies focus on *credit availability* in the credit card market, and find that the approved credit card line is highly correlated with the card holders' credit scores or risk profiles (Dunn and Kim (2002), Musto and Souleles (2005), and Dey and Mumy (2006)).

balances she carries, $B$, and personal characteristics, $P$. Therefore, $D^*$ can be expressed as,

$$D^* = g(R, L, B, P, ...) \qquad (1)$$

There are several reasons why the *real* demand, $D^*$, is determined by these variables. For instance, a borrower's personal characteristics may decide on her income level and thus the dependence on credit card loans. Individual risk measures as well as the balances carried by the consumer are plausibly associated with the borrower's spending behaviour and thus determine her expectation on future need for credit card loans. Also, the borrower's lending relationship with the bank may encourage or discourage her usage of the bank's credit card. For instance, the existing lending relationship may include the experience of past credit card line applications and thus shape the borrower's expectation of credit card line availability.

In China, the personal credit card line is subject to an upper bound. Therefore, the observed demand $D$ is likely to be censored. The *real* demand $D^*$ thus can be estimated by a censored model with the following set of conditions,

$$D = D^* \qquad if \ D^* \leq U$$
$$D = U \qquad if \ D^* > U$$

where $U$ is the upper bound of the personal credit card line.

The bank decides on the supply of the credit card line, $S^*$, based on a similar set of variables as mentioned above that determine the borrower's repayment ability and credit worthiness. Suppose $S^*$ is a function as follows,

$$S^* = h(R, L, B, P, ...) \qquad (2).$$

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It is likely that the observed supply $S$ is censored and therefore is different from the *real* supply, $S^*$. For instance, for strategic concerns or to avoid losing its customers, the bank may choose to keep the initial credit card line and reject the request of the borrower for a credit line increase, even if a bank would like to decrease it. On the other hand, the bank may find it too costly to hold regulatory capital for the extra line granted to customers if they anyway are not likely to spend more than they really need. This implies that the observed supply $S$ hinges plausibly on observed demand $D$. The observed supply $S$ is censored and thus estimating it by OLS would deliver biased results. Equation (2) therefore should be estimated by a censored model, with the following set of conditions imposed on $S^*$ and $S$,

$$S = D \quad \text{if } S^* \geq D$$

$$S = I \quad \text{if } S^* \leq I$$

$$S = S^* \quad \text{if } I \leq S^* \leq D.$$

where $I$ is the initial credit card line possessed by the borrower. Note here that the initial credit card line should not matter for $D^*$ and $S^*$ as all the information that determined $I$ is already included in $g(\cdot)$ and $h(\cdot)$.

To estimate the effects of information sharing on credit card line demand, supply, and degree of rationing, we rewrite equation (1) and (2) as follows,

$$\ln D^* = \alpha_0 + \alpha_1' IS + \alpha_2' R + \alpha_3' L + \alpha_4' B + \alpha_5' P + \alpha_6' Con_d + \varepsilon \tag{3}$$

$$\ln S^* = \beta_0 + \beta_1' IS + \beta_2' R + \beta_3' L + \beta_4' B + \beta_5' P + \beta_6' Con_s + \eta \tag{4}$$

$$R = \gamma_0 + \gamma_1' IS + \gamma_2' R + \gamma_3' L + \gamma_4' B + \gamma_5' P + \gamma_6' Con_r + \mu \tag{5}$$

where the credit card line demand and supply are in their log-transformed state, $R$, the degree of rationing, equals $\frac{D-S}{D}$ and is calculated by observed demand and supply, $IS$ is the vector of dummy variables capturing the existence of information sharing, $\alpha_0$, $\beta_0$, and $\gamma_0$ are constant terms, $\alpha_i'$, $\beta_i'$, and $\gamma_i'$ are vectors of parameters to estimate, $Con_d$, $Con_s$, and $Con_r$ are the conditioning sets of variables, and $\varepsilon$, $\eta$, and $\mu$ are error terms. A logarithmic transformation of the dependent variables is used to correct for the positively skewed distribution of $D^*$ and $S^*$. In addition, it allows us to deduce the relationship between degree of rationing and explanatory variables by differencing the demand coefficients and the corresponding supply coefficients. More specifically, the degree of rationing, $\frac{D^*-S^*}{D^*}$, can be approximated by

$-\ln(1+\frac{S^*-D^*}{D^*}) = \ln D^* - \ln S^*$. Therefore, the implied degree of rationing provides a comparison to $R$. $Con_s$ typically includes the time in between the last credit card line augmentation and the current application. This could capture some timing rule of the bank as suggested by Gross and Souleles (2002). In addition, industry dummies indicating in which industry the credit card holder works and thus capturing the potential risks associated with business cycles are also included into the set of controlling variables. A borrower's access to alternative financial resources serves as an indication for its quality or financial dependence and thus should be included as control variable in both demand and supply. Both the demand and the supply equation can be estimated by maximum likelihood (MLE), if we believe data censoring happens and assume that the error term is normally distributed and independent of censoring bounds, conditional on the set of explanatory variables. We therefore obtain consistent, approximately normal maximum likelihood estimators.

We treat the credit card loan rate as exogenous in order to take into account the specifics of the Chinese credit market. The reasoning is that the credit card loan rate is regulated and therefore is unlikely to be endogenously determined by supply and demand. Its effect will be absorbed by the constant term. This, however, does not jeopardize generalizing the inferences of our study. First, U.S. evidence shows that even without regulation, credit card issuers are less willing to charge a significantly lower loan rate than the prevailing market rate in order to avoid disproportionally attracting high-risk borrowers due to information asymmetries (Ausubel (1991) and Calem and Mester (1995)). Second, with fixed loan rates, banks are unable to use the price as instrument to distinguish *ex ante* the quality of borrowers. It is therefore more likely for the bank to rely on quantity rationing to maximize its expected returns. Last, the regulated price in China is not exceeding the market clearance interest rate and credit rationing prevails.

## III. Data

*The Chinese setting: the credit card market and the public credit registry*
Before describing our data, we briefly introduce the industry structure of the Chinese credit card market. China's credit card industry has experienced tremendous growth in the past years. The total number of credit cards reached 40 million in the beginning of 2006 compared to nearly no credit card in the early 1990s (Lin (2006)). The 15 largest commercial banks distributed most of the cards and all of them were domestic due to the regulatory restrictions on foreign entry. The leading card distributors such as the

Industrial and Commercial Bank of China and the China Construction Bank have a market share of nearly 40 percent[4]. A credit card in China sometimes is called a "double-currency card", because card holders may purchase not only in the Chinese currency (RMB) but also in foreign currencies if travelling abroad. Therefore for each credit card there are both RMB and U.S. dollar balances.[5] Credit cards play an important role in consumer transactions as well as spending. At the end of 2005, credit card transactions accounted for 27 percent of all point of sale (POS) transactions. The revolving balances on credit cards were approximately RMB 15 billion (about USD 1.9 billion), which accounted for roughly 10 percent of all personal consumer debt (Lin (2006)). However, credit card penetration is still low compared to international standards. At the end of 2005, one out of every 33 people in mainland China owned a credit card, compared to about one credit card per person in Hong Kong and Taiwan in 2006[6], and about one card for every 51 persons in India in 2007[7]. Credit card payments accounted for about 1 percent of total consumer spending in mainland China, compared to about 20 percent in the U.S. and 13 percent in South Korea (Chang (2004)).

The central bank of China started to collect borrowers' credit information for *geren zhengxin xitong*, the Public Credit Registry, in Shanghai in 1999, and from 2005 onwards, it started to gradually cover the whole country (Jentzsch (2008)). The China's Central Bank Public Credit Reference Center collects the personal credit history by electronically connecting to the headquarters of each bank through an inter-

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[4] Source: ICBC, CCB hold nearly 40 % of China's credit card market. *People's Daily Online*, December, 30, 2006.
[5] The foreign currency bills are normally settled in U.S. dollars.
[6] Source: Central Bank Urges Non-Cash Payment. *Shenzhen Daily/Agencies*, January 24, 2006.
[7] By January of 2007, the total number of credit cards in India is around 22 million and the population is about 1.12 billion. Source, India: Charge it, *Business India Intelligence*, April 17, 2007.

bank computer network. Through these headquarters, the Central Bank Public Credit Reference Center can monitor each loan officer's business activities. A consumer's borrowing and debt clearance information at a bank will be traced and reported to the Public Credit Registry in this way. The process of collecting all borrowers' credit information has been carried on till recently (Jentzsch (2008)). Although it had not covered all borrowers yet by the beginning of 2006, the Public Credit Registry started to be accessible for all financial institutions. By that time, the database of the Public Credit Registry included information on more than 40 million consumers, covering RMB 2.14 trillion (about USD 267.5 billion) personal loans (Lin (2006)). Personal information such as name, address, employment is also eligible to be reported. However, due to privacy protection reasons, the information of personal deposits is not shared. The recent report frequency is set to be every month, especially for frequently changed information such as granting, repayment, or default of loans, and expected to be accelerated in the future. However, in practice, the report frequency can be lower than designed due to some delays. Since there is no reporting threshold of consumer debt, the China's Public Credit Registry is claimed to provide continuous, complete, and accurate personal credit history. The personal credit records, including both *positive* and *negative* information from the Public Credit Registry, are called the "personal economic identification card". Therefore, if a consumer is not yet reported in the credit registry, it is because the consumer did not have loans from banks, or simply because the consumers are from inner-land regions or small cities which the Public Credit Registry did not yet cover. As access to personal credit records is for free, all financial institutions access the information when reviewing the individual application for loans, debit and credit cards, etc.

*Sample Description*

We randomly draw a sample of 3401 (arbitrarily assigned by the program drawing the sample) individual consumers who applied for increasing their credit card line from the database of the credit card center of one of the leading banks in China. In our sample, all applications for the augmentation of the personal credit card line happened at the beginning of 2006, right after the Public Credit Registry was put into use. Due to fact that the Public Credit Registry database did not cover yet all borrowers by that time, our dataset naturally contains two groups of borrowers: borrowers with and without their "personal economic idenfication card" filed at the Public Credit Registry. Using credit card line augmentation data controls for the potential sample selection issue arising from the fact that borrowers do not have external information because they are new clients of the bank. In addition, we match the borrowers with and without externally shared information according to their propensity of being filed at the Public Credit Registry, conditional on the provinces they are from, the initial credit line they had, and personal information such as gender, age, marital, housing, and employment status, and educational level[8]. Propensity score matching (PSM) alleviates further the concern of other potential sample selection issues, such as borrowers not having been reported to the Public Credit Registry because they are from relatively less developed areas or inner lands, or having modest borrowing habits[9]. Out of the matched 3077 borrowers, there are 1508 with credit records at the public credit registry, which therefore come with external information that is inquired by the bank. The remaining 1569 borrowers had at the time of the credit card line

[8]Since the consumer's personal credit card line is limited up to RMB 50,000 (about USD 6,250), we exclude the consumers who had an initial credit line of at least RMB 50,000, restricting our sample to 3364 observations. It is possible that these consumers hold business credit cards of the bank.
[9] Rosenbaum and Rubin (1983) propose the propensity score matching (PSM) estimator. Following Rosenbaum and Rubin (1983) which constructs a statistical comparison group by matching observations under treatment to controlling group with similar propensity of receiving treatment, we match the sample of borrowers have their credit records filed at the Public Credit Registry to those who do not.

application no credit records publicly available. The matched sample is representative for the whole market; for example, it covers all the 4 municipalities and the 5 autonomous regions, as well as 30 out of 31 provinces in mainland China[10].

Our data show that approximately 69 percent of all borrowers are from the most developed regions[11]. A large part of the borrowers in our sample come from richer provinces; this is in line with the current situation of the Chinese credit card market. As the credit card penetration is still low, most customers are from big cities where the network to use credit cards is better developed. The borrowers in our sample have a reasonable level of education. For instance, around 81 percent of borrowers hold a college degree or higher, suggesting that credit card usage is more easily acceptable among educated people in China. The average age of credit card holders in our sample is 34 years and 90 percent of them are in between 24 and 49. The youngest borrower is only 19 years. All the borrowers younger than 21, the average age of university graduation in China, are employees with stable income. There are 6 borrowers that are older than 65, 5 of whom are reported to hold a bachelor's degree and are still employed[12].

[Insert Figure 1 Here]

Our data show that on average borrowers held RMB 9,495 (about USD 1,187) as their initial credit card line. During this application for augmentation of their credit line, they asked for about RMB 19,185 (about USD 2,398) but were granted around RMB

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[10] Gansu province is omitted from our data.
[11] This development ranking is based on the per capita disposable income of urban residents reported by the National Bureau of Statistics of China. It is very common that the degree of development varies within one province: some of the cities are ranked as "the most developed" while others are ranked "relatively" or even "less developed".
[12] Most of them work for higher educational or state-owned research institutes.

12,685 (about USD 1,586). Figure 1 presents the relationship between borrowers'
initial credit card line and how much they applied for as new line, as well as the
approved amount. Although univariate analysis reveals that the initial line and the line
applied for are highly correlated (with rho=0.83 and significant at the 0.1% level),
figure 1 shows that the credit card line applied for converges to a max of RMB 50,000
in general. The approved credit card line seems to be correlated with the initial line,
i.e. the lower initial credit line, the lower the approved line.

*Borrowers without external information versus borrowers with external information*

[Insert Table 1 Here]

Our sample is naturally divided in two groups, borrowers *without* and *with* external
information available. The risk measures of the credit card line applicant are proxied
by PERMNT (a permanent credit line augmentation or not), VARIATION (credit card
spending variation), DELQ (internal record of current delinquency status), and
DELQ_E (external record of delinquency history from the Public Credit Registry).
Lending relationships between the bank (and in particular its credit card center) and
the customer are captured by variables such as DURATION (the length in hundreds of
days that the borrower has a credit card account in that bank), SPENDING (monthly
credit card spending), USD (credit card spending in foreign currencies), MAJOR (to
which extent the bank is the major credit card line provider for the borrower,
measured by the ratio of the borrower's credit card line provided by this bank to her
*total* credit card line) and ACCOUNT (total number of credit card accounts). The
balance carried is given by UTILIZATION (credit card line utilization ratio only

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known to the bank), UTILIZATION_E (credit card line utilization ratio filed at the Public Credit Registry). The public credit registry also provides information on BANKLOAN (the amount of bank loans the borrower carries as filed at the Public Credit Registry). The variables capturing personal characteristics are GENDER (female or not), AGE (age of the applicant), MARITAL (married or not), HOUSE (owner of house or not), RICH (the economic development level of the region that a borrower lives in), TITLE (having a senior, intermediate, junior or unrated position), and EDUCATION (the educational level). The control variables that may be relevant to the credit card line demand, supply, and rationing including the alternative financing sources the borrower has access to, such as OTHER_LINE (other credit card lines (in RMB 10,000) held by the borrower, self-reported to the bank), and OTHER_LINE_E (sum of all other credit lines (in RMB 10,000) as filed in the public credit registry). The other credit card lines a borrower has can also be treated as potential balances the borrower may carry in the future. We also control for the time between the last augmentation of the credit line at this bank and the current application (CYCLE), and industry dummies in which a borrower works. The definitions, means, and standard deviations of all variables for our two groups of credit line applicants are reported in Table 1.

Table 1 shows that borrowers with and without external information exhibit a similar average initial credit card line (I_LINE), credit card line demand (DEMAND) and supply (SUPPLY). However, the credit card line supply distribution may be different with and without external information. Figure 2 shows that the borrowers with external information were more likely to be approved when their initial line was low (upper left part of the graph).

[Insert Figure 2 Here]

Table 1 also reveals that borrowers without external information tend to have statistically more frequent delays (significant at 5%) in paying back their credit card loans than those who had their credit record filed in the public credit registry. This difference dismisses the concern that China's banks may have strategically reported bad-risk borrowers first, even when reporting is compulsory and monitored by the central bank. Borrowers without external information have on average shorter bank-borrower relationship (DURATION). Moreover, on average borrowers without external information are more likely to be married (MARITAL) and with better ranking of job positions (TITLE).

# IV. The Impact of Information Sharing on Credit Card Line Demand, Supply, and Rationing

*4.1 The Impact of Information Sharing: A First Glance*

To assess the impact of information sharing on credit card line demand, supply, and rationing, we can treat all borrowers as if they had a "thin–file" credit history. That is, we only take the internally produced information of each borrower into account, but include a dummy EXTERNAL which equals 1 if a borrower has external information and zero otherwise. Therefore, we estimate model (1), (2), and (3) with the pooled

sample. *IS*, the vector of information sharing dummies, here thus only includes the dummy variable EXTERNAL.

[Insert Table 2 here]

Column 2(a), 2(b), and 2(c) in Table 2 report the effects of the existence of external information on demand, supply, and the degree of rationing, respectively. The existence of external information only increases in a statistically significantly way credit card line demand (by 5.1 percent), but has no clear impact on the credit card line supply and degree of rationing. Therefore, we do not find supporting evidence that, on average, external information from the Public Credit Registry improves credit line availability.

The next step is to distinguish borrowers where external information is identical to the bank's information and borrowers where it is not. Recall that our sample only includes borrowers who asked for augmenting their credit card lines. Thus if a borrower is reported to have only one credit card account at the Public Credit Registry, this credit card account refers to the one granted by this bank. Therefore the credit history of this borrower filed at the Public Credit Registry stems from this bank only. On the other hand, when a borrower with external information has multiple credit card accounts, her credit history at the Public Credit Registry should contain extra information to our bank. To distinguish whether the existence of these two types of external information has distinct impacts on the credit card demand, supply, and rationing, we introduce two dummy variables, SAME and EXTRA. In particular, SAME equals 1 if a borrower has external information and is reported to have only

one credit card account from the Public Credit Registry, and 0 otherwise. EXTRA equals 1 if a borrower has external information and is reported to have more than one credit card account from the Public Credit Registry, and 0 otherwise. The results with SAME and EXTRA introduced into the specification are reported in columns 2(d), 2(e), and 2(f). We find that having similar external information to internal information (SAME) does not encourage the bank to grant more credit card loans, nor does it increase the degree of rationing compared to the group of borrowers with only internal information. One concern is that borrowers with only one credit card account reported at the Public Credit Registry may still have other financial services such as bank loans, implying that SAME may not properly capture the borrower with similar internal and external information. In our sample, out of the 553 borrowers who have only one credit card account at the Public Credit Registry, there are 136 borrowers who are reported to have also bank loans. We re-estimate the model by excluding these 136 borrowers, and our results remain robust.

We postpone the discussion of the economic and statistical significance of other explanatory variables to the next sub-sections.

*4.2 The Impact of Information Sharing: When External Information is Similar to Internal Information*

The previous sub-section showed that, for borrowers whose external information is contributed by this bank only, on average this bank is not likely to lower the credit card line. However, one question is whether the bank is particularly sensitive to some types of information that were known only to the bank but now are shared *to* other

financial institutions. To study this, we compare the group of borrowers with similar internal and external information to the group of borrowers with only internal information. In addition, we allow for interaction between SAME and DELQ, UTILIZATION, and OTHER_LINE, respectively. DELQ, UTILIZATION, and OTHER_LINE are the information that was known only to the bank but now are reported to the Public Credit Registry, i.e. to rival banks.

[Insert Table 3]

The left panel (Column 3(a), 3(b), and 3(c)), the middle panel (Column 3(d), 3(e), and 3(f)), and the right panel (Column 3(g), 3(h), and 3(i)) of Table 3 report the result for credit card line demand, supply, and rationing, respectively. Column 3(a), 3(d), and 3(g) report the results for the pooled sample of borrowers, where the interaction terms are introduced into the specification. Column 3(b), 3(e), and 3(h) report the results for the group of borrowers with similar external and internal information. Column 3 (c), 3(f), and 3(i) report the results for the group of borrowers with only internal information. Table 3 reports the results of the demand regression (3), and those of the supply regression (4). The implied degree of rationing thus can be derived by subtracting the estimated coefficients of the supply regression from those of the demand regression.

As Column 3(a) shows, having similar internal and external information does not explain the credit card line demand variation, neither do the interaction terms. Among the variables measuring personal risks, PERMNT measures whether the borrowers applied for a permanent increase of their credit card lines or not. In China, the credit

card line can be increased either temporarily or permanently, upon card holders' request. Permanent augmentation of a borrower's credit line entails uncertainty for the bank. VARIATION measures the variability of the credit card spending of a consumer. Risk measures also include DELQ, and DELQ_E, the internal delinquency status and external delinquency history, respectively. We find evidence that more risky borrowers tend to ask for more credit card line, as the coefficient of PERMNT is statistically significantly positive in Column 3(a), 3(b) and 3(c). The other risk measures have no significant impact on demand.

We introduce different measures of bank-borrower relationships to capture the bank's internally produced information. For instance, DURATION, which measures how long the credit card lending relationship had been formed between the borrower and the bank, in 100 days. SPENDING measures the RMB spending (in RMB 10,000) of the borrowers averaged over 12 months before application; it is treated as a proxy for the intensity of the credit card lending relationship. USD measures whether or not the borrower also used the credit card for purchasing in foreign currency, typically in US-dollars. USD therefore captures the width of financial services provides by the bank to the borrowers. Table 3 shows that having longer credit card lending relationships (DURATION) and enjoying more financial services (USD) tend to encourage the borrowers to demand more.

UTILIZATION measures the ratio of the outstanding credit card balance to the credit line, which is internal information to the bank. UTILIZATION_E is externally shared information, which measures the same ratio but for the sum of all credit card balances of a borrower. This relative measure controls for the heterogeneous nature of credit

card lines. For instance, carrying RMB 5,000 of credit card balances is much more of a concern to the bank when the borrower had a credit card line only of RMB 5,000 than that would be for one with a line of RMB 20,000. As information such as UTILIZATION_E of borrowers with similar internal and external information is reported by this bank and therefore tends to be the same as UTILIZATION, we include only UTILIZATION in order to avoid problems of multicollinearity. BANKLOAN measures how much bank loans a borrower carries. Our results show that, on the one hand, higher credit card balances (UTILIZATION) deter borrowers from asking for a higher credit card line. On the other hand, more bank loans (BANKLOAN) are associated with higher demand for credit card lines. Balances carried by borrowers have a mixed impact. Our speculation is that the credit card line utilization (UTILIZATION) may pick up some unobservable personal characterises that refrain the credit card line demand.

The borrower's gender (GENDER), age (AGE), marital status (MARITAL), and housing status (HOUSE) capture personal variations (we refer to Table 1 for the definitions and descriptive statistics of all variables used in the regression). We also include variables controlling for the borrowers' potential demand and their repayment ability. Examples are the economic development of the region where the borrower lives (RICH), the level of occupation of the borrower (TITLE), and its educational level (EDUC). Our results show that male (GENDER), older (AGE), married (MARITAL), and better educated (EDUC) borrowers tend to demand more. The other explanatory variables have no consistent impact across samples and specifications.

Last, the access to other credit card services (OTHER_LINE) does not correlate with the borrower's demand. Again, we also exclude OTHER_LINE_E as these are reported by this bank and would therefore induce multicollinearity.

Our results on the supply side show the following. On average, sharing information of its borrowers (SAME) has no significant impact for the bank's willingness to grant credit card loans, as Column 3(d) shows. Also, the bank tends not to be particularly sensitive to the information that becomes publicly available, as the coefficients of the interaction terms are not statistically significant. Our findings differ from predictions by recent theories that suggest that reducing bank's bargaining power in credit relationships by sharing information to other banks will increase (Padilla and Pagano (1997)), or decrease the lending (see e.g. Bouckaert and Degryse (2006) or Gehrig and Stenbacka (2007)). Our speculation is that while the existing theories assume that lending volumes may adjust to loan rates endogenously set by banks, it is typically not the case in the market for credit cards where the interest rate tends to be sticky. Comparison of results for the group of borrowers with similar internal and external information (Column 3(e)), and those with only internal information (Column 3(f)) shows the following. The bank is sensitive to the risk measures of a borrower. Greater credit card spending variation (VARIATION) discourages the bank to grant higher credit card lines, when there is no external information. The impact of VARIATION, however, becomes significantly positive on loan availability when the bank observes the borrowers' delinquency history from the Public Credit Registry (DELQ_E). Our interpretation is the following. Great borrower spending variation may lead to personal credit card debt. The debt, which generates interest income, can also be harmful to the bank if the borrower is risky. When such uncertainty is well captured

by repayment history (DELQ_E), VARIATION encourages the bank to grant higher credit card line. Delinquency history from the Public Credit Registry (DELQ_E) greatly lowers the credit card line supply, while internally observed current delinquency status (DELQ) has no significant impact. Bank-borrower lending relationships, especially the width (USD), encourage the bank to grant more loans. When there is external information available (Column 3(f)), the bank depends less on the lending relationships, as the intensity of such relationships (SPENDING) becomes insignificant. The balances carried by the borrower have mixed impacts on the credit card loan availability. The balance carried on the credit card account at the bank (UTILIZATION) shows to have a significant negative impact on the credit line availability. Such negative impact becomes less pronounced when more precise measure of borrowers' risk (e.g. DELQ_E) is available, as the comparison of Column 3(e) and 3(f) shows. One possible explanation for the significantly negative coefficient of UTILIZATION is that due to information asymmetries the bank cannot readily distinguish the borrowers who want to borrow more to meet their future needs from those who simply accumulate new debts. This result is in line with Calem and Mester (1995). The information on the bank loans carried by the borrower from the Public Credit Registry (BANKLOAN), however, seems to encourage the bank to grant larger credit lines. This result may stem from the fact that the approval of bank loans is a positive signal of individual repayment abilities. The same positive effect can also be observed for the information on other credit card lines (OTHER_LINE) carried by the borrower. Among all personal characteristics, only EDUC shows to have consistence statistically significant positive impact on credit card line supply. That is, the bank tends to grant larger credit lines to better-educated borrowers.  In the set of control variables, CYCLE measures the time in between the last credit card line

augmentation and the current application. Although Gross and Souleles (2002) suggest that the probability a borrower has her credit line increased is positively associated with CYCLE due to some timing rule, we do not find the same. It could be that in our case CYCLE *per se* is negatively associated with the quality of borrowers: bad borrowers might already have been rejected many times before this application.

The implied degree of rationing is obtained directly by subtracting the coefficients of the demand-side variables by those of the corresponding supply-side variables. Most of the implied degree of rationing is similar in the direction to the results of corresponding direct measure of degree of rationing (right panel of Table 3). However, some inconsistency exists. For instance, implied degree of rationing is supposed to be positive for borrowers with longer lending relationships (DURATION) as borrowers with longer lending relationships demand more. The difference of the coefficients of Column 3(c) and 3(f) suggests that the degree of rationing for a borrower with a 100-day-longer duration should receive a 2.9-percentage-point-higher degree of rationing. However, results of the left panel show that there is no significant impact of DURATION on the degree of rationing. This may be due to the fact that the direct measure of degree of rationing is calculated based on the observed rather than the real demand and supply. Comparing the right panel (rationing) to the left (demand) and the middle panel (supply) suggests that the degree of rationing may be a result of demand, supply, or both. For instance, sometimes degree of rationing is induced by solely greater or less demand (PERMNT, GENDER, and TITLE), sometimes it is merely induce by reduced supply (DELQ_E), and under most of the other circumstances it is jointly determined by demand and supply, effects which can be

magnified or offset by each other (VARIATION, SPENDING, USD, UTILIZATION, BANKLOAN, AGE, MARITAL, HOUSE, RICH, EDUC, OTHER_LINE).

*4.3 The Impact of Information Sharing: Does Extra External Information Matter?*

Shared individual credit history *by* other financial institutions adds to this bank's knowledge about its borrowers. In this section we first examine whether the existence of extra information matters for a bank's lending decisions. If so, which types of information that is extra to the bank matters most. To this end, we compare the group of borrowers with extra external information with those with similar internal and external information. To the extent that a bank knows about its borrowers, it is plausible to assume that the group of borrowers with similar internal and external information is close to those who have only internal information. Therefore we can pin down the effects of different types of information shared by introducing EXTRA and its interactions with these types of information into the specification. Finally, we study how differently a bank may depend on internal information, when external information is available or not.

[Insert Table 4 Here]

The left panel (Column 4(a), 4(b), and 4(c)), the middle panel (Column 4(d), 4(e), and 4(f)), and the right panel (Column 4(g), 4(h), and 4(i)) of Table 4 report the result for credit card line demand, supply, and rationing, respectively. Column 4(a), 4(d), and 4(g) report the results for the pooled sample of borrowers with extra external information, and borrowers with similar internal and external information, where the

dummy variable EXTRA is introduced into the specification. Column 4(b), 4(e), and 4(h) report the results for the specification where both EXTRA and its interactions with external information variables are introduced. To compare how differently the bank may depend on internal information, Column 4(c), 4(f), and 4(i) report the results for the group of borrowers with only internal information.

Borrowers with extra external information demand a higher credit card line, as the coefficient of EXTRA in column 4(a) shows. Such positive effect is likely to come from borrowers who depend more on the credit card financing from the bank (MAJOR) and those who have higher other credit card lines (OTHER_LINE_E), as the interaction terms in Column 4(b) shows. Borrowers needing permanent augmentation (PERMNT) ask for more. Greater lending relationships (DURATION, SPENDING, and USD) encourage borrowers to ask for more, which may stem from the fact that more frequent use of the bank's credit card makes borrowers depend more on this credit card, and thus lead to higher demand of credit card lines. Again, borrowers with higher utilization ratio of the credit card of the bank (UTILIZATION) ask less. Carrying more bank loans (BANKLOAN) stimulates borrowers to require a higher credit card line. So does the borrowers' access to alternative credit card loans (OTHER_LINE). Again, Male (GENDER), older (AGE), married (MARITAL), and better educated (EDUC) borrowers and borrowers from more developed regions (RICH) tend to demand more. The other explanatory variables have no consistent impact across samples.

Column 4(d) shows that, compared to those with similar internal and external information, borrowers with extra external information seem to receive higher credit

card lines. In particular, ceteris paribus, the bank tends to grant borrowers with extra information a credit card line which is approximately 16.4 percent higher than those with similar internal and external information. Further analysis shows that the positive impact is jointly driven by the effects from extra *positive* information on borrower credit history, especially the degree of a borrower's dependence on credit card services provided by the bank (MAJOR), the total credit card utilization ratio (UTILIZATION_E) and total other credit card lines (OTHER_LINE_E), as Column 4 (e) shows[13]. In particular, for a borrower with extra information, a 1 percentage point increase of the ratio of the credit card line provided by this bank to her total credit card lines (MAJOR), increases this bank to grant a credit card line which is approximately 1.28 percent higher. A 1 percentage point increase of the total credit card line utilization ratio (UTILIZATION_E) of a borrower with extra information decreases the credit card line approved by the bank by approximately 0.28 percent. A RMB 1,000 (about USD 125) increase in total other credit card lines (OTHER_LINE_E) increases the credit card line approved by the bank by approximately 0.76 percent. Other extra *positive* information such as the total bank loans carried by the borrower (BANKLOAN) has no significant impact on the bank's willingness to grand credit card loans. Column 4(e) also shows that, with extra *positive* information that signals the borrower's quality, the extra *negative* information, such as the delinquency history of borrowers (DELQ_E), does not affect the bank's lending decisions.

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[13] As the definition of OTHER_LINE_E illustrates, it equals 0 for consumers with the similar internal and external information. Therefore, the interaction term between EXTRA and OTHER_LINE_E will equal the latter itself. For reader's convenience, we report EXTRA X OTHER_LINE_E rather than OTHER_LINE_E and list it along with others in the section of "*Information Sharing Dummies*" in Table 4.

Focusing on the group of borrowers with external information (Column 4(d) and 4(e)), we find the following. The number of multiple banking relationships (ACCOUNT) has a significant negative impact on credit card line availability only in Column 4(d). On average, the extent borrowers depend on credit card services of the bank (MAJOR) has a significant positive impact on the credit availability, as Column 4(d) shows. However, Column 4(e) shows that the bank is more willing to grant higher credit card lines to borrowers with lower measure of MAJOR, when they have similar internal and external information. The rationale behind this is the following. MAJOR measures the ratio of the credit card line observed by the bank to the total credit card lines reported by the Public Credit Registry. For the group of borrowers with similar internal and external information, the information of total credit card lines at the Public Credit Registry consists only of the credit card line reported by the bank. But such information is likely to be lagged relative to the credit card line of a borrower the bank observes at the time the borrower applies for new credit card loans. Therefore a borrower who experienced a temporary credit card line augmentation before may still not find her external report of "total credit card lines" updated, and thus relatively higher to her current credit card line. This will lead to a measure of MAJOR lower than 1 if a borrower with similar internal and external information has experienced a previous credit card line augmentation, and MAJOR equal to 1 if she has not such an experience recently. Therefore, the negative coefficient in Column 4(e) may reflect the fact that for borrowers with similar internal and external information the bank prefers those who have experienced a temporary credit card line augmentation, as having experienced a credit card line augmentation implies that a borrower has passed the credit worthiness check. The total utilization ratio of credit card lines (UTILIZATION_E) shows to have positive impact for the group of borrowers with

similar internal and external information, while the current balances carried at the bank (UTILIZATION) decreases supply, as Column 4 (e) shows. Again, for borrowers with similar internal and external information, the external report of balances (UTILIZATION_E) is similar to the current balances (UTILIZATION) but with a time lag. In this sense, the bank cares only about the current balances carried (UTILIZATION) by a borrower, and thus her previous balances (UTILZATION_E) are rendered as good risks if being paid off. This is exactly why credit card balances carried by a borrower at other banks (EXTRAx UTILIZATION_E) have a significantly negative impact: the bank has no updated information on whether the borrower has paid off these balances or not.

When there is external information available, the bank tends to utilize internal information differently. On average, the bank is less willing to grant a higher credit card line to borrowers asking for a permanent augmentation (PERMNT). The bank is likely to grant lower credit card lines to borrowers with worse delinquency history (DELQ_E), though the current delinquency status (DELQ) doesn't matter. Although we find positive impact of spending variation (VARIATION) for the group of borrowers with similar internal and external information in the previous sub-section, for borrowers with external information, spending variation on average doesn't matters for the loan availability. While the impact of lending relationship duration (DURATION) becomes significantly positive on loan supply, lending relationship intensity (SPENDING) becomes much less pronounced. In particular, ceteris paribus, if monthly credit card spending of a borrower increases by RMB 1000 (about USD 125), the credit card line availability increase around 7.27 percent when there is no external information. When there is external information available, the positive

impact will only be approximately 1.63 percent (78 percent less pronounced). The width of lending relationships (USD) has comparable significantly positive impact on the bank's willingness to grant credit card loans when there is external information or not. Even when there is external information on a borrower's credit worthiness, the bank is still worried about the credit card balances carried at the bank (UTILIZATION). The negative impact of UTILIZATION on the credit card line availability, however, is less pronounced when there is external information available. This implies that information sharing may not yet completely alleviate problems of asymmetric information. When the housing status (HOUSE) and the economic development level of regions where a borrower is from (RICH) can be confirmed by external information, the bank tends to grant more credit card loans. The self-reported amount of other credit card lines (OTHER_LINE) only has significant positive impact on the bank's willingness of granting more loans when there is no external information.

The right panel of Table 4 reports the effects of information sharing on the degree of rationing. Most of the results are similar in terms of the direction of rationing, compared to the implied degree of rationing derived by the supply (the middle panel) and the demand (the left panel). The interaction between EXTRA and DELQ_E however shows to have negative impact to the degree of rationing. It may be because of DELQ_E has a non-linear impact on the degree of rationing. In unreported analysis, after controlling for non-linearity of DELQ_E, the coefficient of the interaction term is not significant any more. DELQ_E is shown to have a monotonic increasing impact on the degree of rationing within its whole interval in our sample. As argued in the previous sub-section, the degree of rationing constructed based on observed demand

and supply generates biased and sometimes inconsistent measures in term of direction and magnitude compared to the implied degree of rationing derived by real demand and supply.

## V. Conclusion

This paper is the first to provide a comprehensive empirical study on how the introduction of information sharing impacts banks' lending decisions. Different from previous empirical work on the effect of information sharing on credit availability using borrower-side data, our dataset allows to distinguish how the credit decisions of a bank react to the information shared *to* other banks, and the information shared *by* other banks. Also, we are able to pin down which types of shared information, *positive* or *negative*, matter.

We employ a unique dataset containing detailed information on credit card line applications (demand) and approvals (supply) from one of the leading Chinese banks. China allows for a natural experiment as it recently introduced information sharing about borrowers via a public credit registry, implying that some borrowers have external information available whereas others have not.

We find that on average borrowers with external information seem not to enjoy a statistically significantly higher credit line than those without external information. In comparison to credit availability for borrowers with internal information only, sharing information *to* other banks does not decrease a bank's willingness to lend. However,

on average, borrowers with extra information coming from other financial institutions received a higher credit card line than the group of borrowers whose external information only comes from this bank. The difference stems from the fact that the bank improves its knowledge about borrower quality from this shared *positive* information. In addition, when the extra *positive* information of a borrower is shared *by* other bank to this bank, the extra *negative* information does not show to be particularly important anymore.

We also find that the existence of external information alters the way the bank utilizes internally produced information. On the one hand, the bank depends less on the intensity of bank-borrowing relationships, when there is external information available. On the other hand, the bank grants more if some internally observed information is confirmed by external information, such as the housing status.

Last, we find that the negative impact of balances carried by borrowers on credit availability becomes less significant with external information available. This suggests that external information partly mitigates informational barriers.

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**Figure 1. Credit Card Line Applied for, the Approved Credit Card Line v.s. the Initial Credit Card Line**
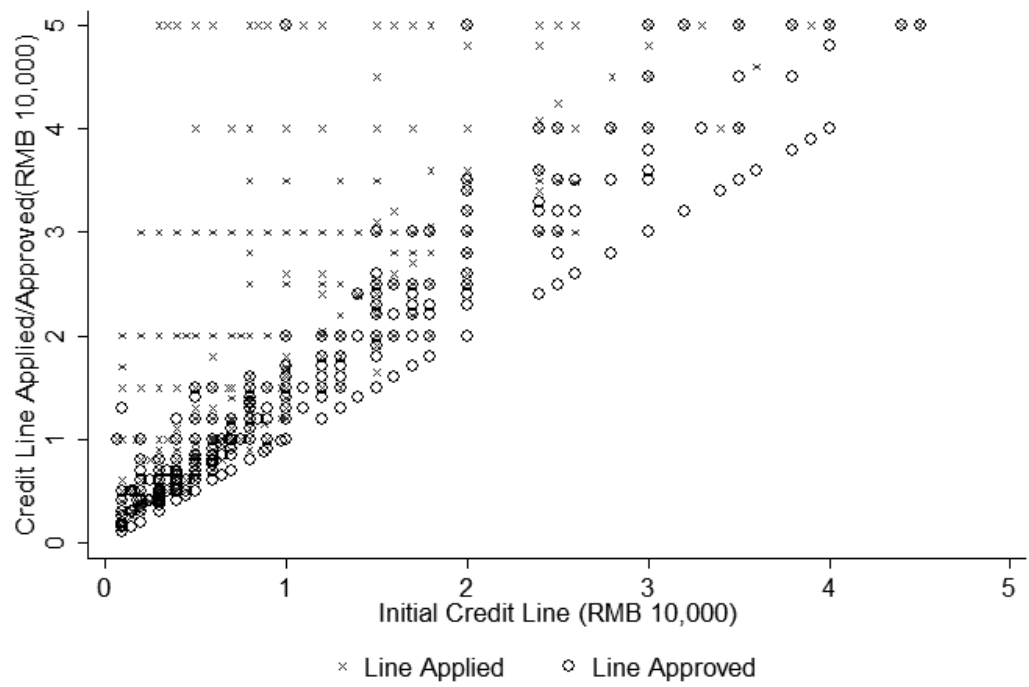


**Figure 2. Approved Credit Card Line: With External Info. v.s. Without External Info.**
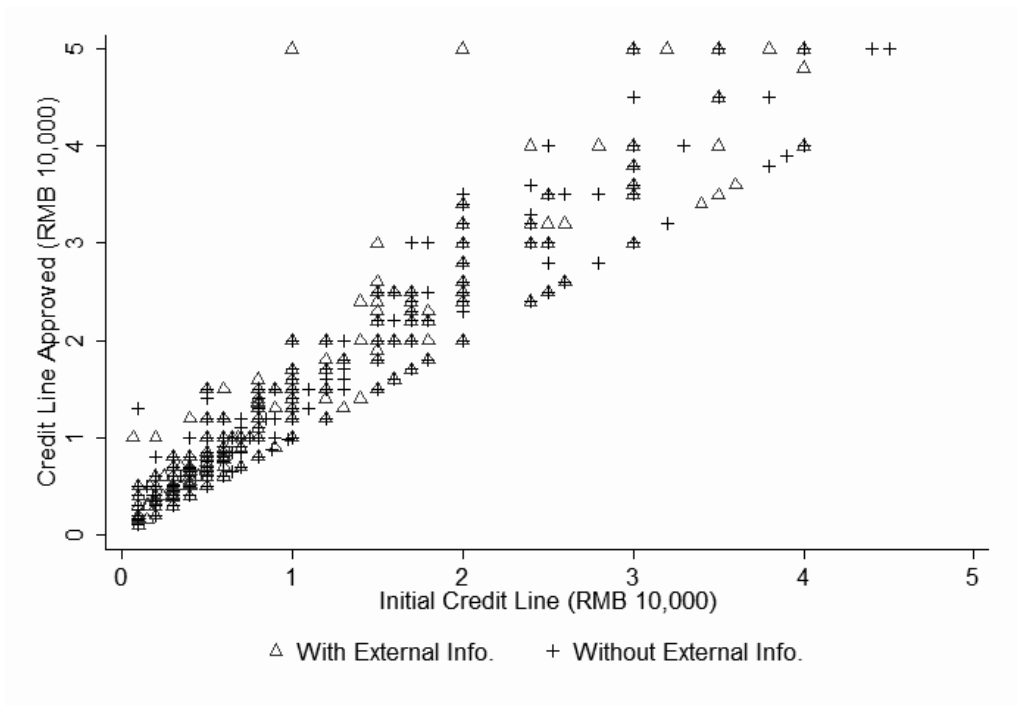
**Table 1.  Definitions and Summary Statistics of Major Variables**

| *VARIABLES* | *DEFINITION* | Without Ext. Info. Mean (s.d.) | With Ext. Info. Mean(s.d.) | t-Test |
|---|---|---|---|---|
| ***Demand and supply*** | | | | |
| I_LINE | $I$ , initial credit card line (in RMB 10,000) the borrower has before application | .939 (.753) | .960 (.753) | .430 |
| DEMAND | $D$ , the total credit card line (in RMB 10,000) the borrower applies for | 1.872 (1.395) | 1.967 (1.451) | .062 |
| SUPPLY | $S$ , approved new credit line (in RMB 10,000) by the bank | 1.253 (.912) | 1.285 (.898) | .316 |
| ***Information Sharing Dummies*** | | | | |
| EXTERNAL | 1 if a borrower has external information and 0 otherwise. | | | |
| SAME | 1 if a borrower has external information and is reported in the Public Credit Registry to have only one credit card account. | | | |
| EXTRA | 1 if a borrower has external information and is reported in the Public Credit Registry to have more than one credit card account. | | | |
| ***Measures for Risks*** | | | | |
| PERMNT | 1 if the borrower requested for a permanent line augmentation, 0 for a temporary augmentation for urgent needs | .666 (.472) | .679 (.467) | .442 |
| VARIATION | standard deviation (in RMB 10,000) of monthly credit card spending over 12 months before application | .519 (1.517) | .470 (.819) | .267 |
| DELQ | current number of times the borrower had delays in paying back credit card loans for 61 days up to 90 days for the bank, 12 months before application. | .006 (.076 | .001 (.026) | **.012** |
| DELQ_E[a] | historical number of times the consumer had delays in paying back *all* credit card loans for 61 days up to 90 days; 12 months before application | | .085 (.791) | |
| ***Characteristics of Lending Relationships*** | | | | |
| DURATION | number (in 100) of days the borrower has a credit card lending relationship with the bank | 5.678 (1.796) | 6.138 (1.816) | **.000** |
| SPENDING | monthly RMB spending (in RMB 10,000) of the credit card of the bank averaged over 12 months before application | .481 (.704) | .470 (.813) | .673 |
| USD | 1 if the  borrower has USD balance of the credit card 12 months before application | .194 (.395) | .212 (.409) | .203 |
| MAJOR[a] | ratio of the borrower's credit card line provided by this bank to her *total* credit card lines | | .569 (.337) | |
| ACCOUNT [a] | the total number of credit card issuers the borrower has cards from before application | | 2.279 (1.555) | |

**Table 1 (Cont'd). Definitions and Summary Statistics of Major Variables with Propensity-Score-Matched Sample**

| *VARIABLES* | *DEFINITION* | Without Ext. Info. Mean (s.d.) | With Ext. Info. Mean(s.d.) | t-Test |
|---|---|---|---|---|
| *Measures for Balances Carried* | | | | |
| UTILIZATION | the credit card balances to the credit card line ratio of the borrower from the bank before application | .438 (.426) | .413 (.394) | .081 |
| UTILIZATION_E [a] | the *total* credit card balances to the *total* credit card line ratio of the borrower from all bank before application | | .266 (.373) | |
| BANKLOAN[a] | All outstanding bank loans (in RMB 10,000) carried by the borrower before application | | 11.063 (38.543) | |
| *Other Relevant Variables* | | | | |
| CYCLE | number (in 100) of days in between last augmentation of credit line at this bank and current application | 1.907 (1.567) | 1.919 (1.787) | .835 |
| OTHER_LINE | other credit card lines (in RMB 10,000) held by the consumer, self-reported to the bank | .289 (.640) | .322 (.722) | .182 |
| OTHER_LINE_E[a] | sum of all other credit lines (in RMB 10,000) as filed in the Public Credit Registry | | 1.733 (3.363) | |
| *Measures for Personal Characteristics* | | | | |
| GENDER | 1 if the borrower is female, 0 otherwise | .361 (.480) | .360 (.480) | .969 |
| AGE | Borrower age in years | 34.2 (7.5) | 33.7 (8.0) | .086 |
| MARITAL | 1 if the borrower is married, 0 otherwise | .692 (.462) | .588 (.492) | **.000** |
| HOUSE | 1 if the borrower owns a house (with mortgage), 0 otherwise | .171 (.377) | .166 (.372) | .674 |
| RICH[b] | 4 if the borrower is from the most developed region, 3 from relatively developed region, 2 from less developed region and 1 from the least developed region. | 3.632 (.620) | 3.600 (.683) | .172 |
| TITLE | 4 if the borrower is ranked as senior for her occupation, 3 as intermediate, 2 as junior, and 1 as unrated | 1.942 (.935) | 1.777 (.951) | **.000** |
| EDUC | 5 if the borrower holds a graduate degree or above, 4 Bachelor's degree, 3 college degree, 2 secondary school degree, and 1 any other degrees | 3.315 (.893) | 3.345 (.900) | .353 |
| Obs | | 1569 | 1508 | |

a**:** External information provided by the public credit registry at the central bank of China.
b: The bank ranked the richness of a region according to the per capita disposable income of urban residents as reported by the National Bureau of Statistics of China.
t-Test reports the test for the hypothesis that the mean of the corresponding variable for the two groups of consumers is statistically the same.

### Table 2 Impact of the Existence of External Information: Pooled Analyses
### Censored Data Model with Propensity-Score-Matched Sample

This table reports the results from equation (3), (4), and (5), respectively. EXTERNAL equals 1 if a borrower actually has external information and 0 otherwise. SAME equals 1 if a borrower has external information and is reported to have only one credit card account from the Public Credit Registry. EXTRA equals 1 if a borrower has external information and is reported to have more than one credit card account from the Public Credit Registry. Definitions of other variables are summarized in Table 1. p-value is reported between brackets. ** stands for significance at 5 percent level, and * stands for significance at 10 percent level.

| | Demand | Supply | Rationing | Demand | Supply | Rationing |
|---|---|---|---|---|---|---|
| | 2(a) | 2(b) | 2(c) | 2(d) | 2(e) | (f) |
| *Information Sharing Dummies* | | | | | | |
| EXTERNAL | **.051**** | -.012 | .065 | | | |
| | **(.046)** | (.605) | (.101) | | | |
| EXTRA | | | | **.099**** | -.001 | **.082*** |
| | | | | **(.001)** | (.974) | **(.066)** |
| SAME | | | | -.030 | -.031 | .036 |
| | | | | (.382) | (.331) | (.521) |
| *Measures for Risks* | | | | | | |
| PERMNT | **.203**** | **-.067**** | **.617**** | **.202**** | **-.067**** | **.616**** |
| | **(.000)** | **(.011)** | **(.000)** | **(.000)** | **(.010)** | **(.000)** |
| VARIATION | **.059**** | **-.064**** | **.035*** | **.057**** | **-.064**** | **.035*** |
| | **(.031)** | **(.000)** | **(.056)** | **(.037)** | **(.000)** | **(.058)** |
| DELQ | -.218 | **-.336*** | .396 | -.208 | **-.333*** | .399 |
| | (.321) | **(.074)** | (.178) | (.342) | **(.076)** | (.176) |
| *Lending Relationships* | | | | | | |
| DURATION | **.037**** | **.021**** | .000 | **.037**** | **.021**** | .000 |
| | **(.000)** | **(.002)** | (.978) | **(.000)** | **(.002)** | (.980) |
| SPENDING | **.382**** | **.347**** | -.037 | **.381**** | **.347**** | -.038 |
| | **(.000)** | **(.000)** | (.351) | **(.000)** | **(.000)** | (.350) |
| USD | **.361**** | **.247**** | **.095*** | **.362**** | **.247**** | **.095*** |
| | **(.000)** | **(.000)** | **(.056)** | **(.000)** | **(.000)** | **(.055)** |
| *Balances Carried* | | | | | | |
| UTILIZATION | **-.330**** | **-.160**** | **-.099*** | **-.327**** | **-.160**** | **-.098*** |
| | **(.000)** | **(.000)** | **(.071)** | **(.000)** | **(.000)** | **(.074)** |
| *Personal Characteristics* | | | | | | |
| GENDER | **-.154**** | -.002 | **-.186**** | **-.153**** | -.002 | **-.185**** |
| | **(.000)** | (.929) | **(.000)** | **(.000)** | (.922) | **(.000)** |
| AGE | **.021**** | **.011**** | **.008**** | **.021**** | **.011**** | **.008**** |
| | **(.000)** | **(.000)** | **(.003)** | **(.000)** | **(.000)** | **(.003)** |
| MARITAL | **.156**** | **.068**** | **.153**** | **.157**** | **.068**** | **.152**** |
| | **(.000)** | **(.022)** | **(.002)** | **(.000)** | **(.022)** | **(.002)** |
| HOUSE | **.126**** | **.126**** | -.078 | **.127**** | **.126**** | -.078 |
| | **(.000)** | **(.000)** | (.130) | **(.000)** | **(.000)** | (.130) |
| RICH | **.093**** | **.090**** | -.049 | **.087**** | **.089**** | **-.051*** |
| | **(.000)** | **(.000)** | (.114) | **(.000)** | **(.000)** | **(.099)** |
| TITLE | **.024*** | .011 | .018 | **.024*** | .011 | .018 |
| | **(.081)** | (.399) | (.403) | **(.087)** | (.397) | (.409) |
| EDUC | **.145**** | **.097**** | **.057**** | **.144**** | **.097**** | **.057**** |
| | **(.000)** | **(.000)** | **(.017)** | **(.000)** | **(.000)** | **(.018)** |
| | | | | | | |
| OTHER_LINE | **.074**** | **.045**** | .039 | **.072**** | **.045**** | .038 |
| | **(.000)** | **(.008)** | (.134) | **(.000)** | **(.009)** | (.141) |
| CYCLE | | **-.228**** | **.150**** | | **-.228**** | **.149**** |
| | | **(.000)** | **(.000)** | | **(.000)** | **(.000)** |
| INDU_DUMMY | | YES | YES | | YES | YES |
| OBS | 3077 | 3077 | 3077 | 3077 | 3077 | 3077 |

**Table 3. Impact of the Existence of External Information: when External Information is similar to Internal Information**

**Censored Data Model with Propensity-Score-Matched Sample**

This table reports the results from equation (3), (4), and (5) with additional interactions, respectively. SAME equals 1 if a borrower has external information and is reported to have only one credit card account from the Public Credit Registry. Definitions of other variables are summarized in Table 1. Column 3(c), 3(f), and 3(i) report the results for the group of applicants with only internal information. Column 3(b), 3(e), and 3(h) report the results for the group of applicants whose external information is similar to internal information. Column 3(a), 3(d), and 3(g) report the results for the group of applicants merged by the above-mentioned two groups. p-value is reported between brackets. ** stands for significance at 5 percent level, and * stands for significance at 10 percent level.

| | Demand | Demand | Demand | Supply | Supply | Supply | Rationing | Rationing | Rationing |
|---|---|---|---|---|---|---|---|---|---|
| | 3(a) | 3(b) | 3(c) | 3(d) | 3(e) | 3(f) | 3(g) | 3(h) | 3(i) |
| ***Information Sharing Dummies*** | | | | | | | | | |
| SAME | -.007 | | | .020 | | | -.015 | | |
| | (.895) | | | (.682) | | | (.855) | | |
| SAME x DELQ | .237 | | | .118 | | | -.251 | | |
| | (.741) | | | (.843) | | | (.445) | | |
| SAME x UTILIZATION | -.057 | | | .001 | | | -.084 | | |
| | (.268) | | | (.983) | | | (.277) | | |
| SAME x OTHER_LINE | -.002 | | | -.119 | | | .200 | | |
| | (.982) | | | (.128) | | | (.172) | | |
| ***Measures for Risks*** | | | | | | | | | |
| PERMNT | **.211**** | **.208**** | **.203**** | -.026 | -.068 | -.023 | **.579**** | **.591**** | **.582**** |
| | **(.000)** | **(.001)** | **(.000)** | (.404) | (.217) | (.520) | **(.000)** | **(.000)** | **(.000)** |
| VARIATION | **.170**** | **.218**** | -.039 | **-.041**** | **.124**** | **-.188**** | **.027*** | **.161**** | **.059**** |
| | **(.000)** | **(.001)** | (.360) | **(.005)** | **(.017)** | **(.000)** | **(.097)** | **(.010)** | **(.023)** |
| DELQ | -.171 | -.378 | -.120 | -.286 | -.389 | -.224 | .414 | .028 | .393 |
| | (.458) | (.590) | (.582) | (.154) | (.448) | (.238) | (.185) | (.889) | (.221) |
| DELQ_E | | -.059 | | | **-.585**** | | | **.287*** | |
| | | (.739) | | | **(.040)** | | | **(.071)** | |
| ***Lending Relationships*** | | | | | | | | | |
| DURATION | **.265**** | **.034**** | **.029**** | **.018**** | .020 | .013 | .003 | .019 | -.002 |
| | **(.000)** | **(.042)** | **(.002)** | **(.032)** | (.166) | (.183) | (.837) | (.511) | (.890) |

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**Table 3. (Cont'd) Impact of the Existence of External Information: when External Information is similar to Internal Information**

**Censored Data Model with Propensity-Score-Matched Sample**

| | Demand 3(a) | Demand 3(b) | Demand 3(c) | Supply 3(d) | Supply 3(e) | Supply 3(f) | Rationing 3(g) | Rationing 3(h) | Rationing 3(i) |
|---|---|---|---|---|---|---|---|---|---|
| SPENDING | **.265\*\*** | .048 | **.737\*\*** | **.282\*\*** | .023 | **.727\*\*** | -.015 | -.028 | **-.130\*** |
| | **(.000)** | (.354) | **(.000)** | **(.000)** | (.562) | **(.000)** | (.658) | (.494) | **(.084)** |
| USD | **.306\*\*** | **.248\*\*** | **.325\*\*** | **.220\*\*** | **.213\*\*** | **.215\*\*** | .078 | -.041 | **.130\*** |
| | **(.000)** | **(.001)** | **(.000)** | **(.000)** | **(.001)** | **(.000)** | (.197) | (.740) | **(.065)** |
| *Balances Carried* | | | | | | | | | |
| UTILIZATION | **-.264\*\*** | **-.153\*** | **-.403\*\*** | **-.079\*** | **-.109\*** | **-.223\*\*** | -.114 | .010 | -.082 |
| | **(.000)** | **(.055)** | **(.000)** | **(.054)** | **(.096)** | **(.000)** | (.110) | (.942) | (.278) |
| BANKLOAN | | **.007\*\*** | | | **.003\*\*** | | | **.004\*\*** | |
| | | **(.001)** | | | **(.044)** | | | **(.034)** | |
| *Personal Characteristics* | | | | | | | | | |
| GENDER | **-.185\*\*** | **-.260\*\*** | **-.130\*\*** | .005 | -.053 | .036 | **-.271\*\*** | **-.267\*\*** | **-.281\*\*** |
| | **(.000)** | **(.000)** | **(.000)** | (.878) | (.327) | (.281) | **(.000)** | **(.017)** | **(.000)** |
| AGE | **.023\*\*** | **.017\*\*** | **.023\*\*** | **.011\*\*** | .005 | **.013\*\*** | **.009\*\*** | .009 | **.008\*** |
| | **(.000)** | **(.000)** | **(.000)** | **(.000)** | (.193) | **(.000)** | **(.016)** | (.144) | **(.073)** |
| MARITAL | **.160\*\*** | **.208\*\*** | **.133\*\*** | **.084\*\*** | **.161\*\*** | .035 | **.132\*\*** | .094 | **.185\*\*** |
| | **(.000)** | **(.007)** | **(.002)** | **(.021)** | **(.013)** | (.391) | **(.041)** | (.464) | **(.015)** |
| HOUSE | **.096\*\*** | .034 | **.096\*\*** | **.081\*\*** | .114 | .059 | -.072 | -.201 | -.034 |
| | **(.019)** | (.695) | **(.031)** | **(.033)** | (.104) | (.152) | (.243) | (.115) | (.628) |
| RICH | **.071\*\*** | **.180\*\*** | -.007 | **.060\*\*** | **.104\*\*** | .023 | -.021 | .058 | **-.071\*** |
| | **(.002)** | **(.000)** | (.794) | **(.005)** | **(.003)** | (.349) | (.573) | (.422) | **(.089)** |
| TITLE | **.031\*** | .040 | .026 | -.001 | -.009 | .009 | **.048\*** | **.110\*\*** | .022 |
| | **(.069)** | (.224) | (.174) | (.954) | (.731) | (.615) | **(.075)** | **(.031)** | (.487) |

**Table 3. (Cont'd) Impact of the Existence of External Information: when External Information is similar to Internal Information**

**Censored Data Model with Propensity-Score-Matched Sample**

| | Demand 3(a) | Demand 3(b) | Demand 3(c) | Supply 3(d) | Supply 3(e) | Supply 3(f) | Rationing 3(g) | Rationing 3(h) | Rationing 3(i) |
|---|---|---|---|---|---|---|---|---|---|
| EDUC | .154** | .133** | .148** | .118** | .068** | .127** | .044 | .111* | .019 |
| | (.000) | (.000) | (.000) | (.000) | (.020) | (.000) | (.120) | (.052) | (.558) |
| | | | | | | | | | |
| OTHER_LINE | .092** | .048 | .087** | .051* | .070** | .047* | .043 | -.062 | .044 |
| | (.001) | (.280) | (.001) | (.063) | (.048) | (.066) | (.291) | (.324) | (.288) |
| CYCLE | | | | -.218** | -.189** | -.201** | .161** | .137** | .167** |
| | | | | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) |
| INDU_DUMMY | | | | YES | YES | YES | YES | YES | YES |
| | | | | | | | | | |
| OBS | 2122 | 553 | 1569 | 2122 | 553 | 1569 | 2122 | 553 | 1569 |

**Table 4 Impact of the Existence of External Information: Does Extra External Information Matter?**
**Censored Data Model with Propensity-Score-Matched Sample**

This table reports the results from equation (3), (4), and (5) with additional interactions, respectively. EXTRA equals 1 if a borrower has external information and is reported to have more than one credit card account from the Public Credit Registry. Definitions of other variables are summarized in Table 1. Column 4(a), 4(b), 4(d), 4(e), 4(g), and 4(h) report the results for the group of applicants with external information. Column 4(c), 4(f), and 4(i) report the results for the group of applicants without external information. p-value is reported between brackets. ** stands for significance at 5 percent level, and * stands for significance at 10 percent level.

| | Demand | Demand | Demand | Supply | Supply | Supply | Rationing | Rationing | Rationing |
|---|---|---|---|---|---|---|---|---|---|
| | 4(a) | 4(b) | 4(c) | 4(d) | 4(e) | 4(f) | 4(g) | 4(h) | 4(i) |
| *Information Sharing Dummies* | | | | | | | | | |
| EXTRA | .318** | -.512** | | .164** | -.690** | | .077 | .486** | |
| | (.000) | (.000) | | (.001) | (.000) | | (.377) | (.049) | |
| EXTRAx DELQ_E | | .028 | | | .364 | | | -.348** | |
| | | (.868) | | | (.169) | | | (.040) | |
| EXTRAx MAJOR | | 1.207** | | | 1.276** | | | -.565* | |
| | | (.000) | | | (.000) | | | (.058) | |
| EXTRAx UTILIZATION_E | | -.143 | | | -.283** | | | .271 | |
| | | (.146) | | | (.006) | | | (.152) | |
| EXTRAx OTHER_LINE_E | .057** | .072** | | .055** | .076** | | -.000 | -.004 | |
| | (.000) | (.000) | | (.000) | (.000) | | (.991) | (.769) | |
| EXTRAx BANKLOAN | | -.003 | | | -.001 | | | -.005** | |
| | | (.201) | | | (.573) | | | (.007) | |
| *Measures for Risks* | | | | | | | | | |
| PERMNT | .175** | .179** | .203** | -.112** | -.106** | -.023 | .651** | .651** | .582** |
| | (.000) | (.000) | (.000) | (.001) | (.001) | (.520) | (.000) | (.000) | (.000) |
| VARIATION | .051 | .046 | -.039 | .003 | -.001 | -.188** | .072* | .074* | .059** |
| | (.145) | (.188) | (.360) | (.902) | (.965) | (.000) | (.055) | (.051) | (.023) |
| DELQ | -.324 | -.374 | -.120 | -.405 | -.368 | -.224 | .251** | -.025 | .393 |
| | (.626) | (.573) | (.582) | (.435) | (.463) | (.238) | (.036) | (.859) | (.221) |
| DELQ_E | -.025 | -.068 | | -.175** | -.510** | | .041 | .387** | |
| | (.288) | (.686) | | (.003) | (.050) | | (.130) | (.022) | |

**Table 4. (Cont'd) Impact of the Existence of External Information: Does Extra External Information Matter?**
**Censored Data Model with Propensity-Score-Matched Sample**

| | Demand | Demand | Demand | Supply | Supply | Supply | Rationing | Rationing | Rationing |
|---|---|---|---|---|---|---|---|---|---|
| | 4(a) | 4(b) | 4(c) | 4(d) | 4(e) | 4(f) | 4(g) | 4(h) | 4(i) |
| *Lending Relationships* | | | | | | | | | |
| DURATION | .042** | .034** | .029** | .024** | .019** | .013 | .000 | .004 | -.002 |
| | (.000) | (.001) | (.002) | (.007) | (.030) | (.183) | (.980) | (.801) | (.890) |
| SPENDING | .237** | .225** | .737** | .177** | .163** | .727** | -.022 | -.020 | -.130* |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) | (.539) | (.575) | (.084) |
| USD | .336** | .311** | .325** | .268** | .237** | .215** | .044 | .061 | .130* |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) | (.537) | (.393) | (.065) |
| ACCOUNT | -.019 | .007 | | -.039** | -.015 | | .015 | .002 | |
| | (.313) | (.722) | | (.029) | (.404) | | (.600) | (.943) | |
| MAJOR | .648** | -.025 | | .423** | -.253** | | .125 | .481** | |
| | (.000) | (.841) | | (.000) | (.021) | | (.372) | (.045) | |
| *Balances Carried* | | | | | | | | | |
| UTILIZATION | -.252** | -.243** | -.403** | -.136** | -.126** | -.223** | -.088 | -.094 | -.082 |
| | (.000) | (.000) | (.000) | (.001) | (.002) | (.000) | (.277) | (.241) | (.278) |
| UTILIZATION_E | -.084* | -.004 | | -.018 | .160* | | -.183** | -.359** | |
| | (.090) | (.961) | | (.717) | (.062) | | (.041) | (.018) | |
| BANKLOAN | .005** | .007** | | .002** | .002* | | .001 | .006** | |
| | (.000) | (.000) | | (.000) | (.062) | | (.195) | (.001) | |
| *Personal Characteristics* | | | | | | | | | |
| GENDER | -.143** | -.141** | -.130** | -.040 | -.041 | .036 | -.099 | -.089 | -.281** |
| | (.000) | (.000) | (.000) | (.211) | (.190) | (.281) | (.107) | (.147) | (.000) |
| AGE | .016** | .016** | .023** | .007** | .006** | .013** | .009** | .009** | .008* |
| | (.000) | (.000) | (.000) | (.006) | (.004) | (.000) | (.013) | (.013) | (.073) |
| MARITAL | .141** | .122** | .133** | .086** | .070* | .035 | .117* | .126* | .185** |
| | (.001) | (.005) | (.002) | (.025) | (.060) | (.391) | (.089) | (.066) | (.015) |

**Table 4. (Cont'd) Impact of the Existence of External Information: Does Extra External Information Matter?**

**Censored Data Model with Propensity-Score-Matched Sample**

| | Demand | Demand | Demand | Supply | Supply | Supply | Rationing | Rationing | Rationing |
|---|---|---|---|---|---|---|---|---|---|
| | 4(a) | 4(b) | 4(c) | 4(d) | 4(e) | 4(f) | 4(g) | 4(h) | 4(i) |
| HOUSE | .099** | .072 | .096** | .148** | .114** | .059 | -.128* | -.128* | -.034 |
| | (.044) | (.138) | (.031) | (.001) | (.005) | (.152) | (.095) | (.098) | (.628) |
| RICH | .147** | .133** | -.007 | .137** | .116** | .023 | -.066 | -.056 | -.071* |
| | (.000) | (.000) | (.794) | (.000) | (.000) | (.349) | (.167) | (.243) | (.089) |
| TITLE | .026 | .022 | .026 | .018 | .014 | .009 | .007 | .004 | .022 |
| | (.173) | (.254) | (.174) | (.280) | (.400) | (.615) | (.817) | (.899) | (.487) |
| EDUC | .111** | .106** | .148** | .041** | .040** | .127** | .091** | .094** | .019 |
| | (.000) | (.000) | (.000) | (.026) | (.025) | (.000) | (.009) | (.007) | (.558) |
| | | | | | | | | | |
| OTHER_LINE | .044* | .048** | .087** | .027 | .030 | .047* | .017 | .017 | .044 |
| | (.075) | (.048) | (.001) | (.194) | (.126) | (.066) | (.619) | (.614) | (.288) |
| CYCLE | | | | -.226** | -.217** | -.201** | .134** | .134** | .167** |
| | | | | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) |
| INDU_DUMMY | | | | YES | YES | YES | YES | YES | YES |
| | | | | | | | | | |
| OBS | 1508 | 1508 | 1569 | 1508 | 1508 | 1569 | 1508 | 1508 | 1569 |