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Credit-Rationing for Bad Companies in Bad Years
–Evidence from Bank Loan Transaction Data–

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Abstract

This paper examines whether or not there is equilibrium credit rationing using Taiwan banks loans' transaction data. Our transaction data are unique since they help us to identify the exact lenders and borrowers, thus reducing the aggregation bias. This paper raises three hypotheses to test equilibrium credit rationing. First, we argue that the loan supply should bend backward to be consistent with equilibrium credit rationing. Second, credit rationing is expected to be more severe in bad years than in good years, suggesting stronger asymmetric information during turbulent days. Third, the asymmetric information is more severe for bad companies than for good companies. Our results support almost all hypotheses except when a bad company is similarly credit rationed as a good company in bad years.

Keywords: equilibrium credit rationing, backward bend loan supply, bank loan transaction dat disequilibrium model

JEL classification: G2, E5

1 Introduction

Theoretical and empirical analysis of credit rationing has advanced significantly in recent years. One reason for this interest is the potentially important role that credit rationing may play in the transmission of monetary policy. Advocates suggest that monetary policy may operate through a rationing channel rather than interest channel. Another reason offered is the exploration of bank screening device. Owing to asymmetric information, lenders may screen customers not just through quantity, but also through the interest rate.

The theoretical model of Keeton (1979), Stiglitz and Weiss (1981), and Devinney (1983) provides supply-side equilibrium explanations of credit rationing. In this framework, those who are willing to pay high interest rates may, on average, be a worse risk. They are willing to borrow at high interest rates because they perceive their probability of repaying the loan to be low. Banks, alternatively, do not know which projects are less risky, but know a safe project will drop out when the interest rate goes up. Thus, only a risky project which could pay at a high interest rate stays but it defaults more often. Under this circumstance, rational profit-maximizing banks are reluctant to accept the offered high interest rate due to the adverse selection. Thus, the expected return of banks become quadratic: the rise in the interest rate first increases the expected profit, but further increase of the interest rate decreases the profit. Since the profit-maximizing behavior and the excess demand coexist, the model is typically referred to as the equi-

librium credit rationing. This model's unique feature is its backward bent loan supply curve, in contrast to the conventional positive-sloped supply curve.

Let ρ denote the expected return of bank lending. Stiglitz and Weiss (1981) argue that ρ is an increasing function of the loan rate (r) before the optimal rate (r^*), but becomes decreasing function after it. Hence, ρ is a quadratic curve against loan rate, where r^* corresponds to the maximum expected return (ρ^*). See Figure 1 (a) for their quadratic relationship. The quadratic expected return curve implies that a backward-bent supply curve as shown in Figure 1 (b). This backward-bent supply curve also implies an adverse selection phenomenon exists and the loan rate functions as a screen device. Thus, even some borrowers would like to pay higher rates, banks are unwilling to accept it. These borrowers are credit rationed.

Despite many theoretical efforts, empirical studies fail to reach a consensus of the existence of credit rationing.[1] Two types of criticisms can be levelled against them. First, the macro time series data is ill-suited for identifying the sources of credit shrinking (Favero, Giavazzi and Flabbi, 1999). It is often found that the macro evidence contradicts the micro fact. For example, Calomiris, Himmelberg and Wachtel (1995), in a similar study, point out that while commercial paper issuance is countercyclical at the aggregate level, it is procyclical at the firm level. The use of aggregate data thus makes it difficult to distinguish whether the reduced credit is supply- or demand-constrained.

[1]For example, see King (1986), Kugler (1987), Pazarbaşoğlu (1997) and Kim (1999). They use macro time series data to explore the credit rationing problem in their home countries and obtain different answers. See the next section for details.

Second, the existence of an excess demand for loans does not necessarily indicate the equilibrium credit rationing. Empirical studies focus mainly on the existence of excess demand to demonstrate the existence of credit rationing. However, excess demand may reflect more on the sluggish adjustment of the interest rate in the conventional supply and demand framework than on the equilibrium credit rationing *á la* Stiglitz and Weiss (1981). In other words, excess demand can be inferred not only from equilibrium credit rationing behavior, but also from conventional disequilibrium model. In the latter case, banks have not optimized their profit since they can still gain more by increasing the interest rate. By contrast, banks' profits are maximized in an equilibrium credit rationing model since increasing the interest rate will not bring additional profit. Hence, excess demand *per se* tells us little about bank lending behaviors, nor does the adverse selection in the information-theoretical model.[2] The preferable way to investigate the equilibrium credit rationing model is through testing its backward bent loan supply curve.

In this paper, we use individual loan "transaction" data from Taiwan to examine banks' lending behavior in terms of the equilibrium credit rationing model. Our unique transaction data is able to avoid the above aggregation bias.[3] The data is collected from (Taiwan) Security Exchange Council (SEC). In Taiwan listed corporates send their balance sheet and income statement to the SEC with details of how they compile these financial statements. These details, which are called "long format of financial statement".[4]

[2]Similarly, the sluggish adjustment of the interest rate tells us little about equilibrium credit rationing.

[3]Berger and Udell (1992) is the only paper we find in the literature that also uses transaction data. However, their focus is on the roles played by the stickiness of loan rates and collateral.

[4]The long in Chinese here also means "detail". Hence, it is the detailed information of financial

includes each loan transaction between the bank and corporate. The transaction records loan amounts, loan rates, loan periods, collaterals and bank's names etc. Since both borrowers' and lenders' names are known, we can also collect their financial statements if they are listed companies. Hence, not only is loan contract information collected, but also financial statements of both lenders and borrowers are taken. Equipped with these individual transaction data set, we avoid the aggregation bias and expect to obtain more convincing evidences.

To further extend the issue of equilibrium credit rationing, we also classify the sample into the bad and good borrowers. During the Asian financial crisis, the press in Taiwan created a new term to describe high-risk and/or default companies. The literal translation for these risky companies are "land-mine companies" (LMC, hereafter) or bomb companies,[5] which sound superficially, but their loans likely will become non-performing. Banks making loans to these companies are just like stepping on a mine that will explode and destroy the banks at any time. The detailed discussion on LMC is in the next section and is taken from Shen and Deng (2000). In this paper, bomb companies are referred to as "bad" companies and the remaining companies are "good" companies.

The sample is also classified into bad year and good year according to the macro economic environment. We select August 10, 1997 to divide our sample, ranging from December 1994 to June 1998, into two subperiods. This dividing date is chosen because it was the time that Taiwan became involved in the Asian crisis, though the Thailand

statements.

[5]We use LMC or bomb companies interchangeably to describe these high-risk companies.

Baht had been speculatively attacked earlier on July 2, 1997. The first period (before the Asian crisis) is referred to as the "good" period and the second period (during the Asian crisis) is the "bad" period.[6]

With the two defined separations, our sample includes good company in good year, bad company in good year, and good company in bad year. It is worth noting that we do not consider bad company in bad year since their low repayment probabilities are known,[7] whereas bad companies are unknown to have low repayment probabilities in good year. Our hypothesis can be better examined step-by-step by checking the following three hypotheses.

Our first hypothesis, as stated above, argues that banks should have backward-bent loan supply curve to prove adverse selection and equilibrium credit rationing.

The second hypothesis regards the riskiness of project. In contrast to the theoretical augment that banks know nothing about a project's riskiness, we suggest that there is outside information which banks can utilize to evaluate the borrowers. In practice, it is common for banks to ask a borrower's peers about the borrower's risk preference when a loan is requested. This is especially true when banks are unfamiliar with the borrower. Typically, the peer is a rival company who knows all bad things about the borrower, such as the borrower is planning to take on a risky project. Thus, we particularly wonder whether or not the bomb companies, which were known during the Asian crisis but not

[6]All the good and the bad are relative concepts in this paper.

[7]The lendings still exist for bad companies during bad days owing to government's supports, the purpose of which is to avoid enterprise crisis.

before the crisis, are credit rationed. That is, asymmetric information is expected to be more severe for bad companies than for good companies

The third hypothesis relates to the macro environment. During mayhem years, such as the Asian financial crisis period, the "fly to quality" is common for all market participants (Bernanke, Gertler and Gilchrist, 1996), with no exception for banks. Since banks know this, their lending turns cautious. The behavior is observationally equivalent to stronger credit rationing. Hence, the loan supplies bend backward faster during the bad years than during the good years. That is, asymmetric information is more severe in bad year than in good year.

Six sections are contained in this paper. The next section is the literature survey. Section three briefly introduces the selection of bad bank and bad year with the collection. The fourth section is the disequilibrium econometric model and the fifth section contains the empirical results. Section six concludes.

2 Literature Survey

Credit rationing stresses that the shrinking credit results from an inward shift of the loan supply, given the loan demand. However, because of the difficulty in determining whether the observed slow credit growth is a demand or supply phenomenon, convincing evidence of the practical importance of credit rationing remains elusive.

Two main approaches are often used to distinguish the loan demand from supply. The first is the disequilibrium econometric method of Maddala and Nelson (1974). In this

model two equations, demand and supply, are built and quantity equals the short side of supply and demand without any assumption about price adjustment. Employing this disequilibrium model, the estimation results are mixed for different sample periods and different countries. King (1986) finds that there is little evidence that banks credit-ration loans in the U.S. Kugler (1987) finds the same results using U.S. data, but significantly opposite results for four European countries.[8] Pazarbaśioĝlu (1997) finds little credit rationing in Finland. Kim (1999), however, finds positive evidence in the Korean market.

The second approach uses an event-then-econometric concept. This study focuses only on one particular period or episodes, when (or where) a demand shock has been controlled. This study's rationale of this study is thus clear: since one side is known, the shifts of loans or deposits must come from another side. Peek and Rosengren (1995) find evidence of a capital crunch in New England banks in 1990-1991, when (and where) banks are under the same demand shock. Favero, Giavazzi and Flabbi (1999), in a similar but slightly different topic,[9] study the responses of the European countries' bank loans to bank reserves in 1992. The period is well-known as a tightening monetary policy period and hence shrinking bank reserves are not contaminated by other demand shocks.[10]

While both methodologies are appealing, they have drawbacks. We discuss these in a reverse order since the weakness of the second one may be minor. Since the methodology

[8]Kugler's (1987) model considers price adjustment, making his econometric model slightly different from the described disequilibrium model.

[9]In fact, their focus is not on the issue of credit rationing, but on the credit channel of monetary policy. The two arguments are similar, but are not completely the same.

[10]There may have a third approach, which uses a reduced-form equation. Bernanke and Lown (1991) and Berger and Udell (1992) may be the representative papers for this approach. This approach does not distinguish the loan supply from loan demand and the focus is slight different from ours here.

has assumed only one side moves during the event period, it provides no rigorous testing about this. However, the identification may still be a potential problem. For example, adopting a tightening monetary policy is rarely endogenous. If the policy is induced by a fear of economic growth that is too fast, businessmen also know it. They lessen their investment when the tightening policy is announced. The loan demand and loan supply are both thus also affected.

While the econometric method *per se* is sound in the first method, its drawback is in its use of aggregation data. The macro time series date has the advantage of being easily obtained, but suffers the aggregation bias stated above. The use of panel data from banks' balance sheet relieves the aggregation problem to some extent, however, the aggregation bias problem remains. For example, loans in a bank's balance sheet are still aggregated from all individual loans. Hence, it is uneasy to distinguish the loan demand from supply. Therefore, while Baba (1996) has made progress in employing panel data on Japanese individual banks, which enriches him to discuss the issue of credit rationing as well as using the loan rate as a screening device by Japanese banks, more detailed data may be preferable to answer the question.

Our paper employs the first methodology to study credit rationing. The transaction data taken in this paper can overcome the above difficulty. Because we identify exactly the lenders from borrowers, the results are more convincing.

3 Bad Companies, Bad Years, and Data Collection

3.1 Bad Companies (Bomb Companies, Land Mine Companies)

The reasons that LMC are sound at first glance but in fact are not, can be categorized into three reasons.[11] The underlining factor is that a company's and its subsidiaries' financial statements are separately reported to the authority. It then becomes easy to window dressing financial ratios without revealing the deteriorating balance sheets. Three type of LMCs are found.

The first, and also the worst case, is the **zombie company**. It occurs when a company sets up a subsidiary and asks the subsidiary to buy back the mother company's stock from the market. The big shareholders of the mother company sell stock at the same time to match the purchasing order, and hence money goes into their pockets. The big shareholders usually buy back the stock before the next meeting of the board of directors so that they can still control the company. During the interim, the big shareholders hold no shares but control the company, making the company a zombie.

The second case is the **bluffing sales**. When the products of a company are not sold out, the company sells the products to its subsidiaries, which are not listed in the stock market and hence are not responsible to the public. The fake increase in sale of the mother company stimulates its stock price. The company then uses the high price of stock as collateral to borrow more money from banks. Revenue from the product sale is recorded as "accounts receivable" in the company's balance sheet, but the cash will

[11] See Shen and Deng (2000) for details.

never come in. The growing sales generates no profit.

The last case is the **phony low debt/equity ratio**. The trick is played in both the numerator and denominator of the DE (debt/equity) ratio. A company endorses a loan borrowed by its subsidiaries from banks. Once the loan is approved, the money goes to the mother company instead of the subsidiaries. This endorsement is the contingent liability and hence is recorded on the off-balance sheet. Hence, little "debt" is found on the balance sheet, making the debt/equity ratio low. The appearing strong balance sheet allows the companies to borrow more money from banks. The true fact of the high debt/equity ratio can be only found in the joint financial statements.

A company can also have a low debt/equity ratio by repeatedly using the same capital. For example, a company and its subsidiaries can buy each other's newly issued stock using the same capital. The capital is thus double counted.[12] Joint reports of the financial statement can avoid these tricks. However, many companies are strongly against passing the law of joining reports due to the high compiling costs, according to them.[13] Thus, the argument continues.

Shen and Wang (2000) adjust the phony low debt equity/ratio problem and examine financial constrained in the investment function. Shen and Deng (2000) compare the financial ratios between normal and bomb companies. In this paper, we take the banks' view to examine whether banks credit ration them or not.

[12]This case also occurs in Japan and is called cross-linked companies or affiliations. When one company's stock price drops, it affects the net worth of another company and the collateral values drop.

[13]Based on their arguments, a company which has 50 subsidiaries needs to take a year to finish the joint reports.

3.2 Bad Years

Our sample period covers from December 1994 to June 1998. The starting period is chosen because of financial deregulations, which started in 1989 when the interest rate was lifted first and then by allowing sixteen new banks to be established in 1992.[14] Before 1992, most banks were state-owned and hence only some of them are listed in SEC. After 1994, some new banks decided to be listed on the stock exchange and their financial statements are now available to the public. Accordingly, more transaction data are thus available after 1994.

The good and bad years in our sample are separated by August 10, 1997. During bad years, values of financial assets drop, making the net worth of companies decline. Thus, asymmetric information increases due to the rising uncertainty of the ability to repay a loan back. The opposite argument holds true for good years. Thus, credit rationing is expected to be more severe in a bad year than in a good year.

3.3 Data Collection

Our data are collected from the warehouse of the SEC laboriously. As discussed in the introduction, when listed corporates send their balance sheets and income statements to the SEC, they need to send the long format of the financial statement simultaneously. These documents record the borrowers' names, loan rates, loan period ranges, and collaterals, etc. The loan rates include fixed and flexible rates. With respect to the latter,

[14]See Shen (2001) for details of Taiwan financial deregulations.

we only take the initially-negotiated loan rate without tracing the new rate when there is a change. The collateral is usually recorded in a vague term, such as a land number in one particular area, without mentioning its book or market values. Thus, while collateral is an important factor when banks determine lendings, we cannot but ignore it.

Once we have banks' and companies' names, we download their balance sheets and income statements from a private data company (Taiwan Economic Journal). Our data are thus restricted in the listed banks and companies.

Because there are more than ten thousand transactions during the study period, we focus on transactions with bomb companies and collect two extra non-bomb (or normal) companies with the equivalent assets in the same industry. In our sample, 24 bomb companies and 48 normal companies (which will also be referred to as good companies) are found.

Since a company can borrow more than once from the same bank, the actual numbers of loan contracts are unknown *ex ante* and need to be counted. There are a total of 2,268 transactions for bomb companies and 2,810 for good companies. Among the bomb companies, 1,879 transactions occurred in the good years and 859 in the bad years. Alternatively, among good companies, there are 931 companies in the good years and 1,409 in the bad years. Because the numbers of transactions for bomb companies substantially fall from a good to the Asian crisis, simply reading these numbers would support the flight to quality issue: banks may be more willing to lend loans to good companies than to bad companies during the mayhem period.

4 Equilibrium Credit Rationing Model and Backward Bent Supply Curve

4.1 Equilibrium Credit Rationing Model

Equilibrium credit rationing in Stiglitz and Weiss (1981) argues that loan rates are not presumed to adjust in each period to clear the market. The basic idea is that there are "safe" borrowers, whose investment projects have a low risk but low rate of return, and "risky" borrowers, whose projects have a high risk but high rate of return. However, only borrowers know that the projects are safe or risky; banks do not. When the interest rate increases, only risky projects have the ability to pay back, but they default more frequently. While banks do not know the riskiness of borrowers, banks know that an increase in the loan rate will cause a safe borrower to drop out of the market. Banks also know that the repayment probability of the staying project is low. This makes the probability of repayment to be endogenous, and the resulting expected profit becomes non-monotonic.

Waller and Lewarne (1994) provide a simple model to show how to derive the backward bent loan supply curve. Banks are assumed to maximize their profit Π as

$$\max \quad \Pi = p \cdot L \cdot r_L - D \cdot r_D - (q/2)L^2,$$

where L is the loan amount, r_L is the loan rate, r_D is the deposit rate, q is the cost parameter of servicing the loan, b is the deposit to loan ratio, p is the probability of loan repayment, and a_i are the parameters. A bank's profit is equal to the interest

revenue payment minus the interest payment and the overhead cost. The constraint is the relation between the loan and deposit. The probability of repayment is not fixed, but is a decreasing function of r_L, that is, $\partial p/\partial r_L = a_2 < 0$. The expected profit thus becomes quadratic: a rise in the loan rate increases the profit only before the optimal loan rate, but a further rise decreases the profit.

Substituting the constraints into the profit equation and maximizing with respect to L yield the loan supply curve

$$L^s = (a_1 r_L + a_2 r_L^2 - b r_D)/q. \tag{1}$$

Because a_1 is positive and a_2 is negative, the supply curve bends backward to the negative slope after the loan rate exceeds a turning point, which is the optimal loan rate. The loan supply thus decreases even as the rate increases.

4.2 Simultaneous-equations Models With Truncation

Our estimation of loan supply and demand relies on the simultaneous-equations model with truncation. According to the theoretical model suggested above, a squared loan rate is put in the loan supply equation (see equation (1)). The feature of the simultaneous-equations model with truncation is that the loan transaction takes place if the equilibrium interest rate is less than the optimal interest rate r^*. Otherwise, the loan amount is

determined by the loan supply.

$$
\begin{aligned}
L_i^s &= \alpha_0 + \alpha_1 r_i + \alpha_2 r_i^2 + \alpha_3 TDrate_i + \alpha_4 IntCash_i + \alpha_5 BadLoan_i + \alpha_6 UnSecu_i + \alpha_7 DumAsia_i \\
&\quad + \alpha_8 DumBank_i + \alpha_9 DumTerm_i + \alpha_{10} DumColl_i + \mu_{si} && (2) \\
L_i^d &= \beta_0 + \beta_1 r_i + \beta_2 EBIT_i + \beta_3 GDP_i + \mu_{di} && (3) \\
L_i &= \min(L_i^s, L_i^d) \qquad i = 1, \ldots, N && (4) \\
&\begin{bmatrix} \mu_{si} \\ \mu_{di} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_s^2, & g \\ \cdot, & \sigma_d^2 \end{bmatrix} \right)
\end{aligned}
$$

where L_i^s, L_i^d and L_i are loan supply, loan demand, and actual loan for the ith transaction, respectively, and loans are divided by company sales to adjust the heteroscedasticity. Coefficients α_i and β_i are the unknown coefficients. ν_{si} and ν_{di} are the residual from each loan supply and loan demand equations with mean zero and variances σ_s^2 and σ_d^2 respectively, g is the correlation coefficient between two errors, and N is the number of loan contracts. The subscript i, which denotes the ith loan contract between lender and borrower, is occasionally omitted for simplicity.

Model (2) contains loan demand and loan supply. The loan supply function is affected mainly through three different categories. The first is the contract information, including the loan rate (r), the square of the loan rate (r^2), a dummy of a short-term loan versus a long-term loan ($DumTerm$), the ratio of an unsecured loan/total loan ($UnSec$) and a dummy of collaterals ($DumColl$). The second category is the perspective of the borrowing companies, which is proxied by a credit rating ($TCRI$) provided by a data

collection company.[15] The last one is the bank's health, which includes funding cost and percentage of bad loans to total loans ($BadLoan$). The funding cost is proxied by the one-year time deposit rate ($TDrate$) and the total interest payment over total cash flow ($IntCash$). Bank dummies are also included ($DumBank$).

The loan demand equation considers the contract information (the loan rate) and the soundness of corporation. The later is proxied by earnings before interest and tax ($EBIT$), credit rating ($TCRI$), and macro condition (GDP).

Equation (4) lets supply side determine the quantity based on the equilibrium credit rationing model. The systems (2) to (4) can be written in a matrix form and the subscripts i are eliminated without losing generality.

$$L^s = \alpha_1 r + \theta_1 X_1 + \nu_1.$$

As shown by Maddala (1983), the likelihood function can be written as

$$L_i = \Pi_{r<r^*} f(L_i, r_i) \cdot \Pi_{r \geq r^*} \int_{r^*}^{\infty} g(r_i) dr_i, \tag{5}$$

where the first term on the right-hand side is the bivariate density $f(L_i, r_i)$, which is

$$f(L_i, r_i) = \frac{1}{\Pi} \frac{1}{2\Lambda^{/2}} \exp(-\frac{1}{2} V' \Lambda^{-1} V) \cdot \text{Abs}(|J|).$$

The second term on the right-hand side depends on the marginal density of r_i, $g(r_i)$. We first solve for the reduced form of R_i and get

$$r = \frac{1}{\alpha_1 - \beta_1} (\theta_1' X_1 - \theta_2' X_2) + \nu_r, \tag{6}$$

[15]The company's name is Taiwan Economic Journal. Since this credit rating information is free, the company has less incentive to provide the best reliable results. However, this is the only source of ratings available in Taiwan.

where $\nu_r = (\nu_1 - \nu_2)/(\beta_1 - \alpha_1)$ is the random term distributed as $N(\mu_r, \sigma_r^2)$, and where

$$\mu_r = (\theta_1' X_1 - \theta_2' X_2)/(\beta_1 - \alpha_1).$$

Hence,

$$\int_{r^*}^{\infty} g(r_i) dr_i = 1 - \Phi(r^* - \mu_r)/\sigma_r) = 1 - \Phi(W).$$

In the absence of information concerning the price adjustment process and assuming that the errors are normally distributed random variables, the model itself allows the determination of the probabilities with each observation belonging to the demand or supply equation. The log likelihood function is defined as follows.

$$f_1(L_i) = \frac{1}{\sqrt{2\pi}\sigma_1} \exp\left[-\frac{1}{2\sigma_1^2}(L_i - \alpha X_{1i})^2\right],$$

where αX_{1i} and βX_{2i} are the short hand of the right hand of equations (2) and (3), respectively. See Appendix B for the estimation techniques.

4.3 Empirical Hypothesis

Our three hypothesis are suggested as follows.

Hypothesis 1: The existence of equilibrium credit rationing and adverse selection suggests a backward-bent loan supply curve, where the coefficients on loan supply expect to have the following relationship.

$$\alpha_1 > 0, \alpha_2 < 0 \text{ and } |\alpha_1| > |\alpha_2|.$$

The estimated optimal loan rate is also

$$r^* = -\alpha_1/2\alpha_2,$$

by setting the partial derivative, $\partial L_i/\partial r_i = \alpha_1 + \alpha_2 r_i$, to be zero.

Hypothesis 2: A bad company is more severely credit rationed than a good company. The loan supply curve of a bad company is expected to turn backward faster than that of a good company. In addition to the first hypothesis holding true, the relation between optimal loan rates of a bad company and a good company is then

$$r^*(\text{Bad Company}) < r^*(\text{Good Company}),$$

where r^* (Bad Company) and r^* (Good Company) denote the optimal loan rate for a bad company and good company, respectively.

Hypothesis 3: A company is more severely credit rationed during a turbulent period than in a peaceful period. The loan supply in a bad year turns backward faster than that in a good year. In addition to the first hypothesis holding true, the relation of banks' optimal loan rates is then

$$r^*(\text{Bad Year}) < r^*(\text{Good Year}),$$

where r^* (Bad Year) and r^* (Good Year) denote the optimal loan rate for a bad year and a good year, respectively.

5 Empirical Results

5.1 Basic Statistics

In Table 1 the basic statistics for each variables are discussed. The average loan amount is larger for bad companies than for good companies, regardless of macro economic environments. The explanations can be taken from borrowers' view. Good borrowers borrow

less because they have either sufficient internal funds or can be directly financed through financial markets. In contrast, bad borrowers borrow more since they are either short of internal funds or are unable to borrow directly from the market and cannot but resort to banks.

The average loan rate (r) is higher for bomb companies than for good companies owing to the risk premiums. Loan rates are also higher during the good years than the bad years since high economic growth usually accompanies a high interest rate. It is thus sensible to find that the bad companies in a good year have the highest average loan rate.

Good companies have higher average earning (EBIT), regardless of macroeconomic environments. Moreover, the average earning turned negative during the Asian financial crisis. Sales (*Sale*) display a similar pattern as that of EBIT. With respect to the credit rating, TCRI for good companies are low (where 1 is the best, 9 is the worst), but it is high for bad companies.

It is interesting to find out whether or not good banks tend to lend more to the good companies while bad banks tend to lend more to bomb companies. We use the percentage of banks' bad loans (*Bad*) as a simple criterion to assess bad banks and good bands. However, evidence seems not to support this conjecture. Bad loans seem to be affected more by macro economic environments than by firms' natures. In bad years, the average bad loans are higher than that in good years irrespective of companies. It is an interesting issue worth pursuing in the future.

Banks' funding cost is also affected by the macro economic environment. For ex-

ample, the one-year time deposit rate ($TDrate$) is affected more by macro economic environments than by the nature of companies. The fundamental of banks' financial ratios is thus related more to macro economic conditions and less to the micro companies' condition.

Unsecured loan ratio ($Unsecu$) is higher for good companies than for bad companies since banks are irreluctant to accept an unsecured loan for good companies while needing collaterals from bomb companies. Furthermore, the percentage of requesting collateral ($DumColl$) is highest for bomb companies during bad years.

Figures 2 to 4 plot the histograms of the above variables from different views. Figure 2 views the distribution of the loan rate from four different angles. Bad companies' distribution is slightly on the right hand side versus that of good companies, regardless of the years, suggesting the existence of risk premiums. The loan rates are also usually higher for good years versus bad years, which seems counter-intuitive at the first glance. However, it is still acceptable since a booming economy is often accompanied by high interest rates.

Figure 3 plots the histograms of company conditions. Not surprisingly, the distributions of EBIT and Sales shift slightly on the right-hand side than those of bad companies. Figure 4 plots the banking information showing time deposit rate's distribution during a good year is higher. Distributions for bad loans, unsecured loan ratio and interest payments for the two periods seem to overlap.

5.2 Econometric Estimation Results

The equilibrium credit rationing requires the coefficients r and r^2 in the loan supply curve to be positive and negative, respectively. Once these requirements are met, the absolute size of the coefficient on r should be larger than that on r^2 to ensure a larger-than-unity optimal loan rate. Moreover, the coefficient on r in the loan demand curve is thus expected to be negative.

Our estimation results using the three subsamples are reported in Table 2 (OLS estimation) and Table 3 (disequilibrium model). In Table 2, except for the third column, the good company in the bad years, estimated coefficients on the interest rate, and on the interest rate square in the loan supply equation are all inconsistent with our conjecture. Coefficients on r in these cases become negative, suggesting wrong slopes. Negative coefficients on r in the loan demand curve are only found in the last two columns, but turn to be positive for the first two columns. Hence, OLS estimated results are less satisfactory.

Table 3 reports the disequilibrium estimation results and they are highlighted as follows. Recall that the requirements of backward bent loan supply curve are positive coefficient on interest rate and negative one on interest rate square, with the former greater than the latter. Hence, the coefficients on r and r^2 in the loan supply curves in the three quadrants are (16.124, −0.417), (10.623, −0.868) and (9.307, −1.042), respectively, which are consistent with the hypothesis of a backward-bent loan supply curve. Also, all coefficients of r and r^2 are all significantly different from zero. Our first hypothesis of

adverse selection is thus strongly supported.

The condition of good companies in the good years should be the least credit rationed, implying the highest optimal loan rate r^*. As can be seen, its optimal loan rate moves up to 38.68%, suggesting that credit rationing is impossible to occur for good companies during good years. This high optimal loan rate can be also found in the top panel of Figure 5 where the plots are generated by the estimated coefficients listed in Table 3. The plotted loan supply curve appears positively sloped with little trend toward turning backward. The curve shifts outward or inward when exogenous variables change, causing a positive zone area. The turning point is too high to have credit rationing (Figure 5, bottom panel).

The second hypothesis argues that there is more severe credit rationing for bad companies than for good companies. This issue is interesting since bomb companies appeared only during the Asian crisis.[16] Before the crisis, bad companies were non-existent, at least superficially. Hence, the related issue of the second hypothesis is whether or not banks know some borrowers are more risky than others before the Asian crisis. Only if banks know this, can they then ration the borrowers. This also implies that banks are not totally ignorant about borrowers.

The optimal loan rate for bad borrowers in good years is 12.23%, which is smaller than that of good borrowers in good years, suggesting that the second argument is supported. The risky borrowers are probably known and hence they are more severely rationed.

[16]As we stated above, the term bomb company is created during the Asian crisis.

The loan supply curve of bad borrowers in good years are plotted in the upper panel in Figure 6. which displays strong backward bending around the optimal loan rate. When the loan demand and loan supply are considered simultaneously, as shown in the bottom panel in Figure 6. some demands are not met around the turning points, implying credit rationing.

The third hypothesis argues that companies are more severely credit rationed for bad years than for good years. This hypothesis is supported by comparing the optimal loan rates for good borrowers in good years and bad years. The rate for the former is 38.68% stated above and is 9.09 for the latter. As the latter is substantially lower than the former, the difference is significant even though we does not test it. The results implies that good companies are more severely credit rationed in a bad year than in good year.

Figure 7, the top panel, shows loan supply curves for good companies during bad years. The curve bends backward substantially, implying that banks know the companies are risky. In this case, it seems common for unfulfilled demands to exist, creating excess demand.

The implications of the above results suggest that the degree of adverse selection may be better classified by the macro economic environment than by a company's riskiness. In bad years, the declining net worth of companies and their reduced repayment abilities are well-known, and banks therefore become more cautious towards lending. Furthermore, it is uneasy to identify good borrowers from bad borrowers *ex ante* during good periods. This problem is not solved by requesting collaterals since the values of most collaterals

are high during the periods. Given these two reasons, the lending is thus substantially cut during bad periods, yielding the strong credit rationing, whereas lending is less cut for bad borrowers during good periods.

We now turn our attention to the model's excess demand, which requires both a backward bent loan supply and negative-sloped loan demand curve in our model. Since the former has been demonstrated, we examine the latter. In Table 2 again, coefficients of r in the loan demand curve are overwhelmingly negative, suggesting a negative-sloped loan demand curve. As can be seen in the bottom panel of Figures 6 and 7, these negative demand curves intersect the supply curve at rates which are higher than the respective optimal loan rates. Hence, excess demand exists.

The borrowers also respond more strongly to GDP growth than lenders by observing the higher coefficients of GDP in demand than in supply equations. The positive coefficient on EBIT implies that borrowers' earnings affect their investment toward the same direction.

While we do not discuss too much about the model specification, some evidences may suggest that our model improves from the OLS model. For example, the standard deviations in both supply and demand equations (σ_1 and σ_2) in each case are overwhelmingly smaller in the disequilibrium model than in the OLS model. Correlation coefficients, which are ignored in OLS, of the two equation errors are significantly positive and are around 0.221 0.395. In addition, more coefficients become significant based on our specification.

6 Conclusion

This paper examines whether or not there is equilibrium credit rationing using Taiwanese banks loan transaction data. Our transaction data is unique since it helps to identify the exact lenders and borrowers, reducing the aggregation bias.

Equilibrium credit rationing is derived from asymmetric information, and hence lenders are unwilling to lend even when borrowers want to pay high a interest rate. The resulting loan supply curve is quadratic against the loan rate, differing from the conventional positive-sloped loan supply curve.

We extend the hypothesis to divide the sample into three quadrants using the riskiness of borrower and the macro economic environment as the horizontal and vertical axes. That is, good borrowers in good and bad years, and bad borrowers in good years. We do not consider bad borrowers in bad years since their low probability of repayment is known, and hence few banks will lend to them.

There are thus three hypotheses raised in this paper. First, the coefficients on the loan rate and its squared rate should be positive and negative, respectively. Moreover, the former should have a larger size than the latter in absolute values. These requirements ensure a backward-bent loan supply curve. Second, more severe credit rationing is expected during bad years than during good years, suggesting asymmetric information becomes more common during turbulent times. Third, asymmetric information is also more severe for bad companies than for good companies.

Our results almost support all hypothesis. Hence, the credit rationings overwhelmingly exist for all conditions, and the resulting adverse selection indeed exists for Taiwan's banks. Furthermore, the backward-bent supply curve cannot be rejected for all the cases, however, to a lesser extent for good companies during a good year.

The evidence additionally suggests that the macro economic environment may be a better criterion to divide the sample to evaluate credit rationing than the riskiness of borrowers. There may be two simple reasons. One, during the mayhem period, the ability to repay back is weak for everyone, and hence banks are reluctant to lend to the same borrowers even though they had strong financial conditions before. Two, banks have difficulty in identifying the riskiness of borrowers during good periods, weakening the effect of adverse selection.

Finally, the loan demand curve is found to be negative for three quadrants under study, creating excess demand in the presence of profit-maximizing behavior.

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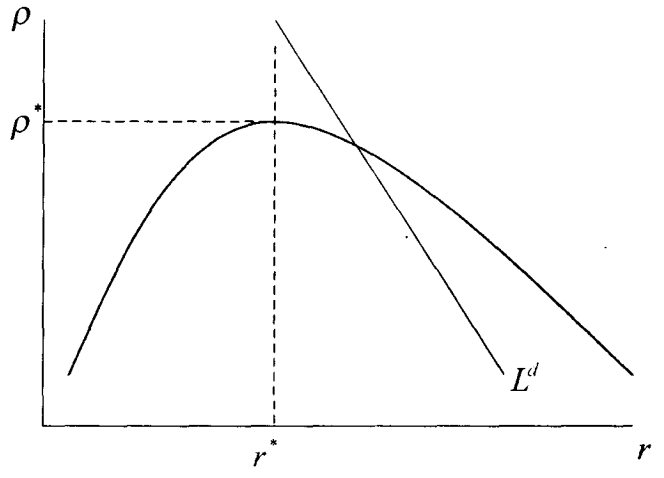
Appendix A: Data Appendix

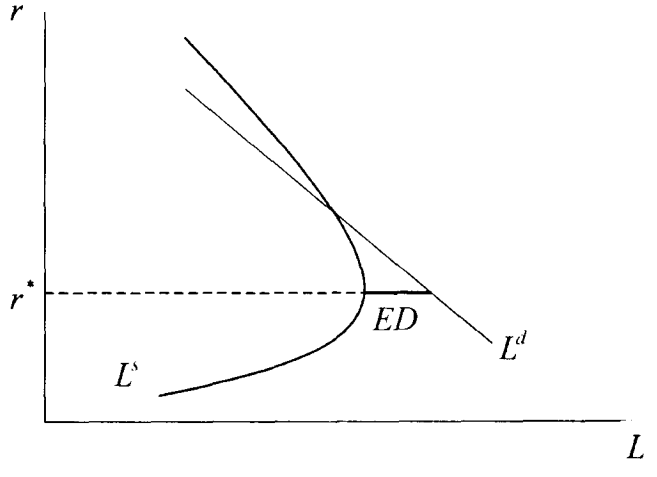
Details of the data used in this paper are as follows.

L_i:	Loan amount, unit in millions.
r_i:	interest on loan
$TDrate$:	one year time deposit
$IntCash$:	each bank and interest payment over the cash flow.

(a) Equilibrium Credit Rationing



(b) Backward Bend: Loan Supply



ED: excess demand

Figure 2: Histograms of Loan Rates

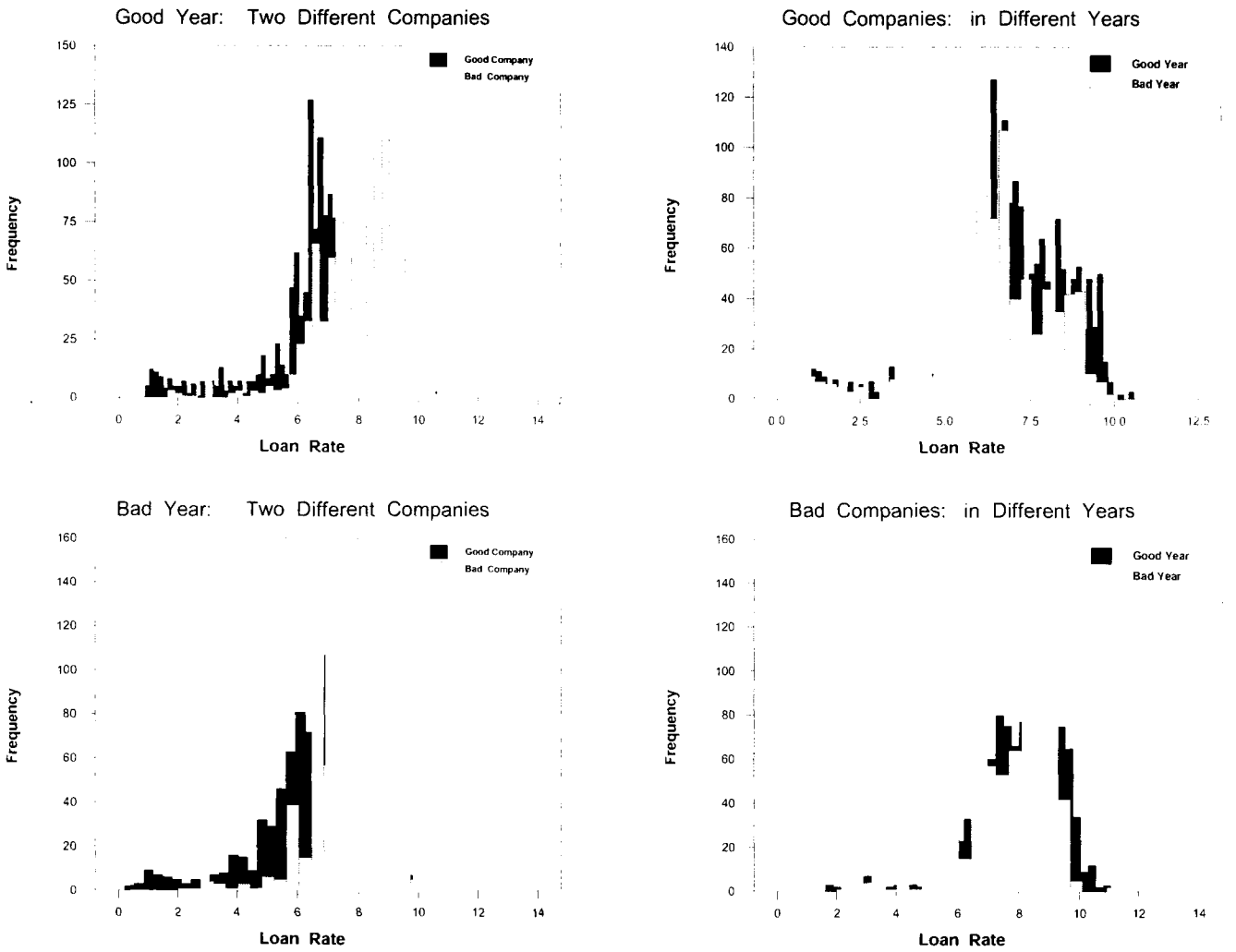


Figure 3: Histograms of EBIT and SALES

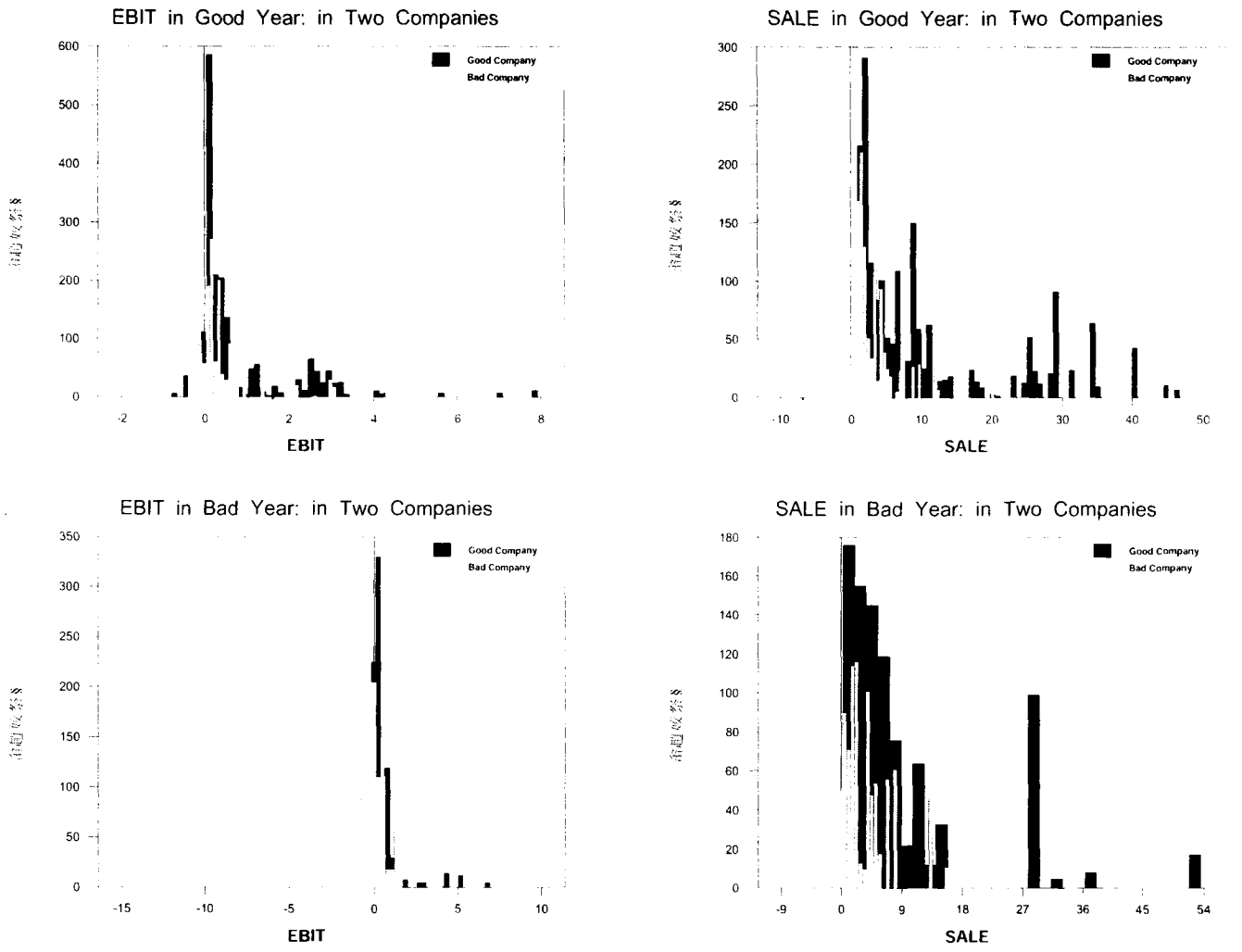


Figure 4: Histograms of Banking Financial Information

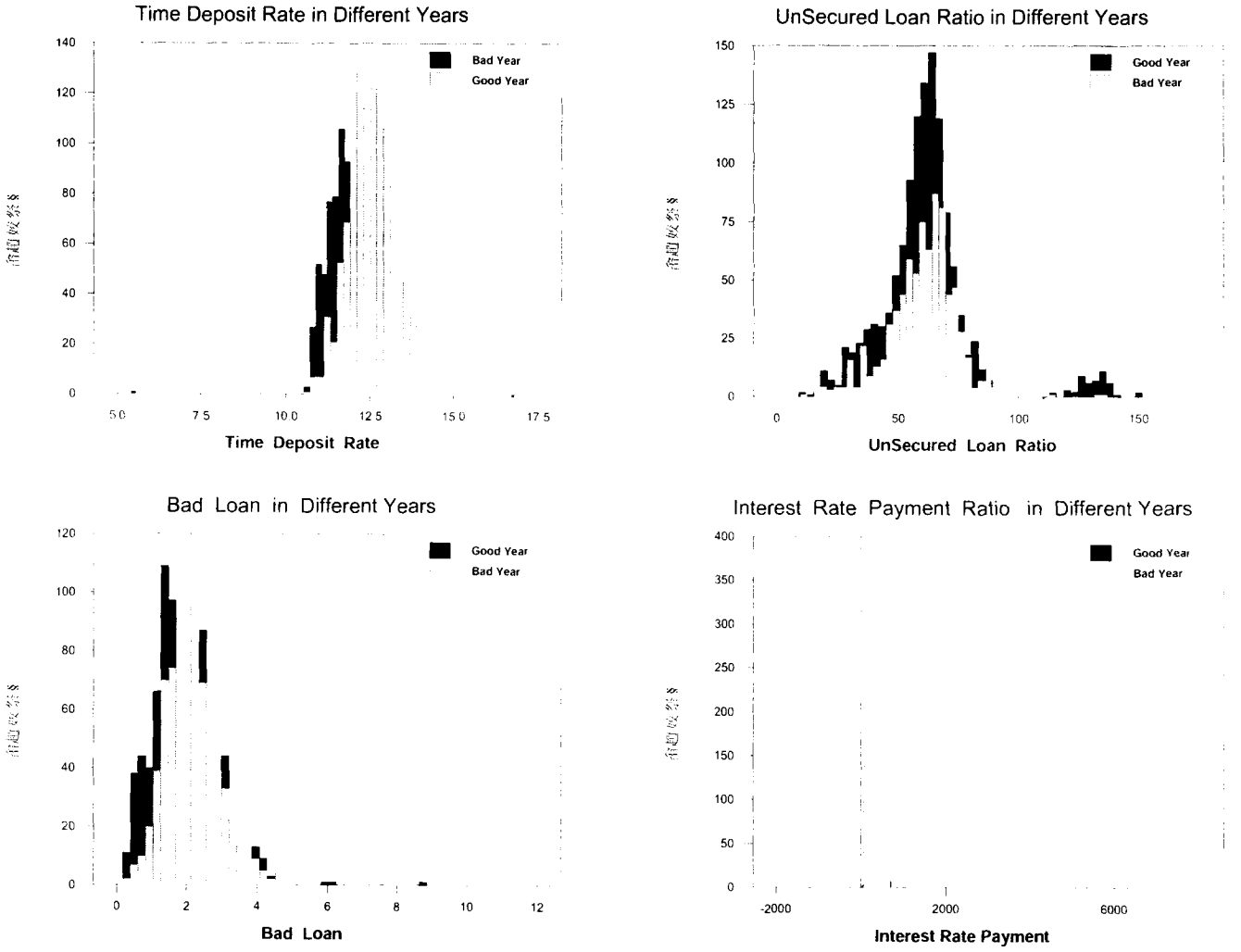
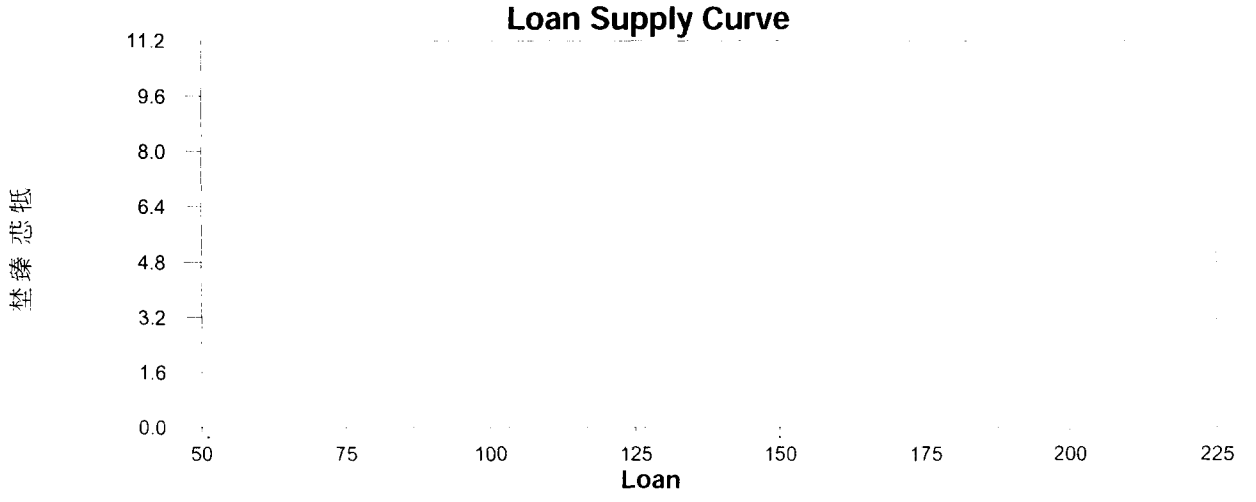


Figure 5 Credit Rationing For Good Company in Good Year



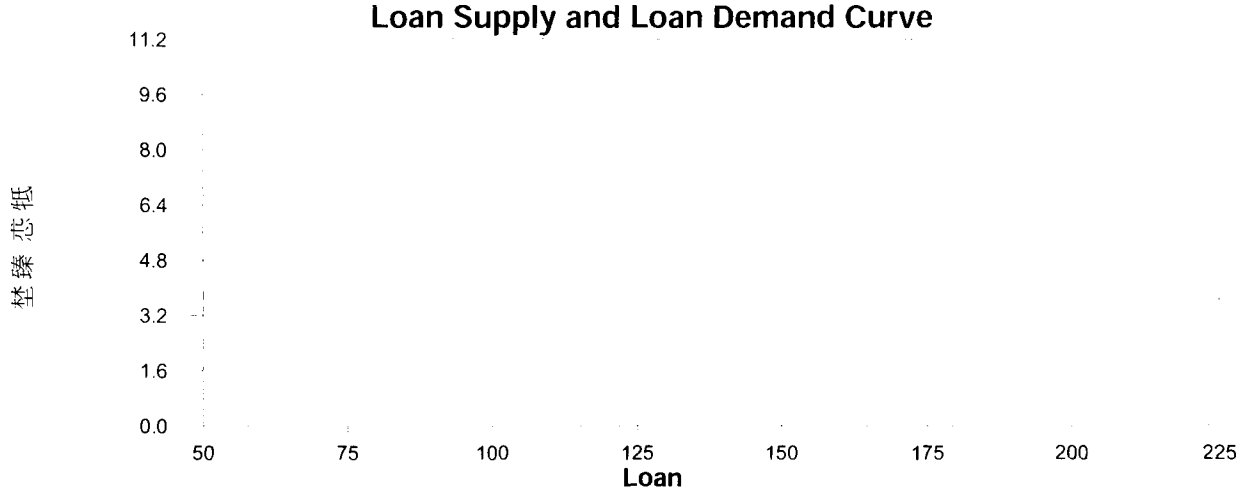
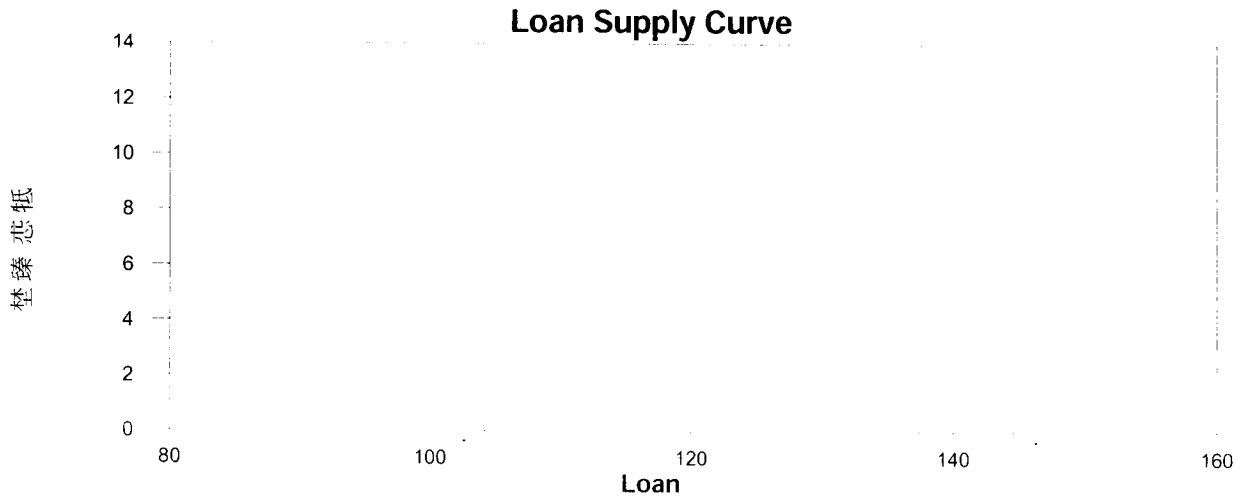


Figure 6 Credit Rationing For Bomb Company in Good Year



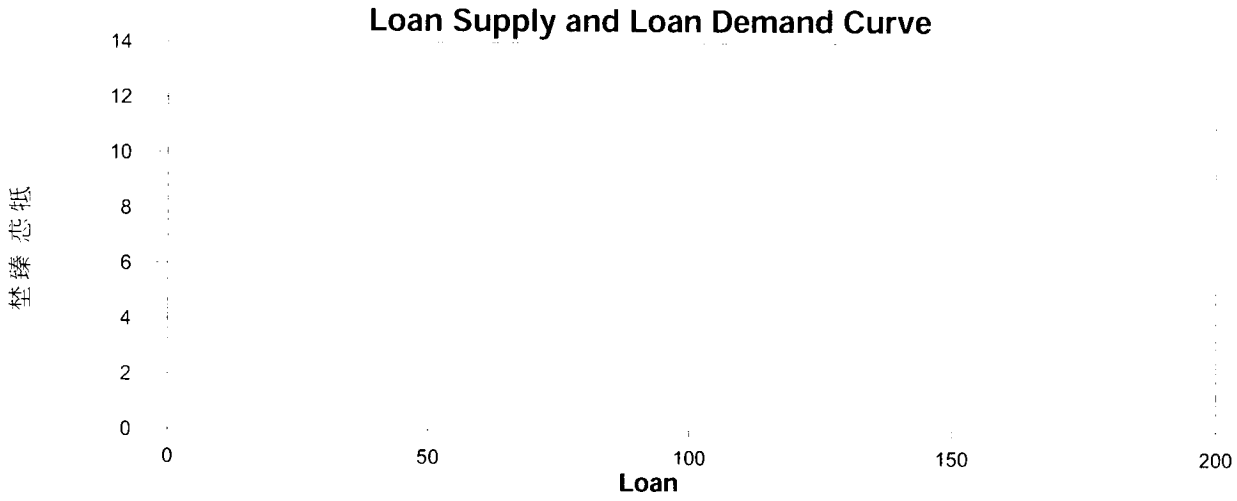
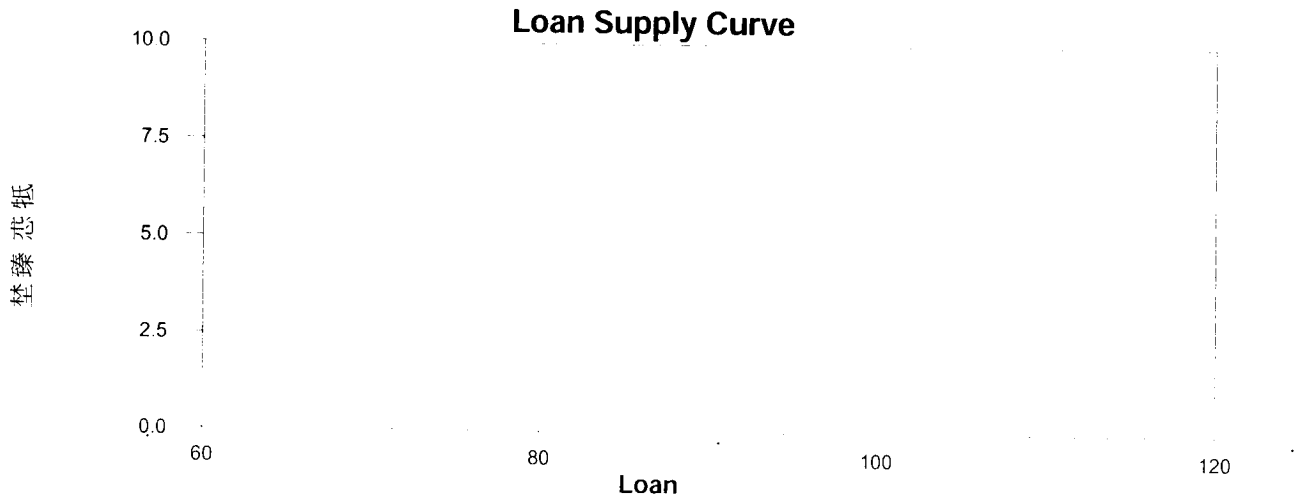
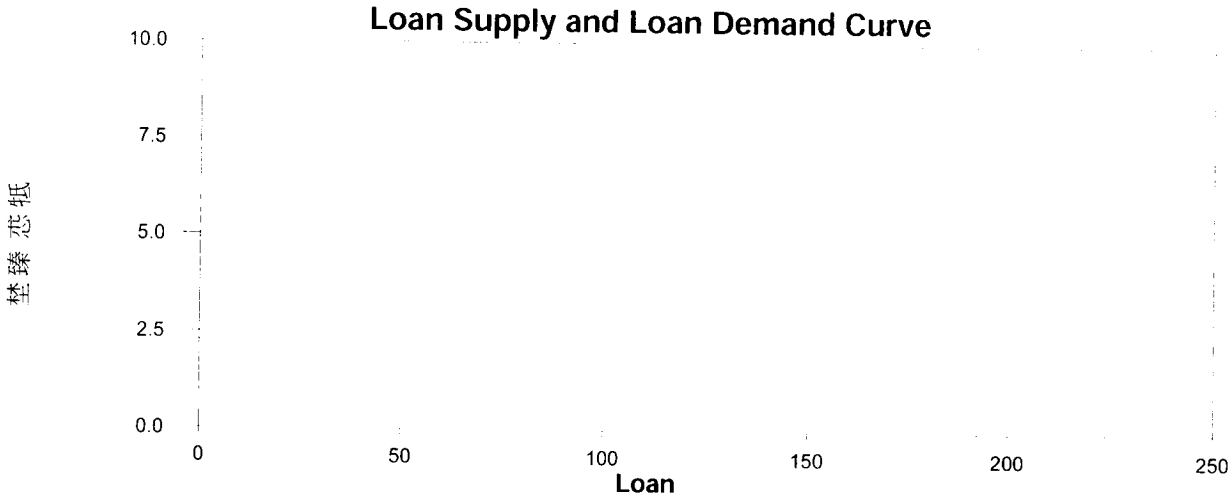


Figure 7 Credit Rationing For Good Company in Bad Year





Appendix B: Disequilibrium Econometric Model

The $\acute{U}_1$ and $\acute{U}_2$ can be written as

$$\acute{U}_1(\hat{O}.) = 1 \quad \Phi \left[\frac{\hat{O} \quad {}^{0}\grave{E}_{1\cdot} \quad {}^{1}(\text{▒}_1 \quad {}_2)(\hat{O} \quad \text{▒}^{0}\grave{E}_{2\cdot})}{\text{▒}_1(1 \quad {}^{12})^{1\tilde{a}2}} \right]$$

$$\acute{U}_2(\hat{O}.) = 1 \quad \Phi \left[\frac{\hat{O} \quad \text{▒}^{0}\grave{E}_{2\cdot} \quad {}^{1}(\text{▒}_2 \quad {}_1)(\hat{O} \quad \text{▒}^{0}\grave{E}_{1\cdot})}{\text{▒}_2(1 \quad {}^{12})^{1\tilde{a}2}} \right]$$

where Φ is the cdf of the standard normal distribution and ¹ is the correlation coefficient. Taking °. and $\acute{U}.(\cdot = 1\mathring{a}2)$ together, we use BHHH method in RATS to maximize the likelihood function of (??) with respect to all unknown parameters.

Table 1: Basic Statistics of Variables

Variable	Statis-tics	Good Company Good Year	Bad Company Good Year	Good Company Bad Year	Bad Company Bad Year
Loan	mean	111.359	142.067	141.246	162.389
	std	189.139	312.695	206.993	300.355
	max	2300.0	4996.00	1621.0	4300.0
	min	0.002	0.001	0.077	0.089
®	mean	6.988	8.175	6.440	7.935
(Loan Rate)	std	1.794	1.299	1.757	1.233
	max	10.500	13.250	10.00	13.250
	min	3.340	3.640	4.200	4.260
EBIT	mean	0.795	0.329	0.345	-1.572
	std	1.252	0.675	1.066	2.863
	max	7.847	3.070	6.839	1.552
	min	-0.789	-0.933	-1.531	-12.926
Sale	mean	10.843	5.352	9.024	3.778
	std	11.292	5.619	10.464	3.544
	max	46.298	20.177	53.044	15.697
	min	0.279	-0.452	0.315	-0.365
Bad Loan	mean	1.024	0.948	1.258	1.147
	std	0.640	0.741	0.593	0.957
	max	9.196	9.196	9.809	9.809
	min	0.080	0.087	0.067	0.067
TDrate	mean	6.287	6.349	5.902	5.981
	std	0.523	0.515	0.463	0.490
	max	8.590	8.590	7.440	7.440
	min	4.820	5.310	5.320	4.950
UnSecu	mean	31.672	29.5700	29.570	30.230
	std	14.486	12.0842	12.084	11.207
	max	100.0	100.00	100.000	72.717
	min	0.000	0.0000	0.000	0.014
IntPay	mean	180.660	154.898	162.992	171.366
	std	105.095	94.363	80.267	368.392
	max	518.270	518.270	421.801	7451.024
	min	0.233	0.016	0.042	0.042
GDP	mean	6.106	6.095	4.908	4.903
	std	0.593	0.632	0.099	0.100
	max	6.770	6.770	5.000	5.000
	min	4.800	4.800	4.800	4.800

(continue...) Basic Statistics of Variables

TCRI	mean	5.174	6.611	5.818	7.647
	std	2.124	1.438	2.233	0.902
	max	9.000	9.000	9.000	9.000
	min	1.000	2.000	2.000	6.000
DumTerm	mean	0.416	0.400	0.392	0.380
	std	0.493	0.490	0.488	0.485
	max	1.000	1.000	1.000	1.000
	min	0.000	0.000	0.000	0.000
DumColl	mean	0.663	0.689	0.580	0.721
	std	0.472	0.462	0.493	0.448
	max	1.000	1.000	1.000	1.000
	min	0.000	0.000	0.000	0.000

Mean in dummy variable denotes the percentage of observations to be 1.

Table 2: OLS Estimation of Loan Supply and Loan Demand Equations

	Good Company Good Year		Bad Company Good Year		Good Company Bad Year	
Variable	Supply	Demand	Supply	Demand	Supply	Demand
Constant	8.986	10.639	184.73	205.33	-33.60	-70.627
	(0.42)	(0.95)	(2.60)	(5.02)	(0.30)	(0.64)
RATE	-6.478	2.955	-28.767	5.956	6.501	-3.971
	(2.60)	(5.96)	(2.22)	(2.52)	(1.29)	(3.11)
RATE2	0.829		2.387		-0.858	
	(4.09)		(2.73)		(1.95)	
DUMTERM	9.262		2.157		44.146	
	(3.92)		(0.35)		(8.95)	
TDRATE	2.532		6.925		-1.397	
	(1.29)		(1.32)		(0.30)	
BADLOAN	0.833		6.064		-0.245	
	(0.49)		(1.29)		(0.06)	
DUMCOLL	11.167		16.349		-20.209	
	(4.88)		(2.53)		(4.10)	
UNSECU	-0.035		0.391		0.113	
	(0.51)		(1.60)		(0.56)	
EBIT		-4.261		24.291		6.784
		(6.22)		(5.57)		(3.36)
GDP	-2.282	-1.456	-25.232	-37.856	13.011	25.904
	(1.12)	(0.80)	(4.41)	(6.10)	(0.56)	(1.16)
σ_1 σ_2	36.54	34.94	94.60	107.8	59.50	62.14

¬ value in parenthesis.

σ_1 σ_2 is the standard deviation of supply and demand equations, respectively.

Table 3: Disequilibrium Estimation of Loan Supply and Loan Demand Equations

	Good Company Good Year		Bad Company Good Year		Good Company Bad Year	
Variable	Supply	Demand	Supply	Demand	Supply	Demand
Constant	-43.92	-43.87	-42.527	-11.464	33.96	37.57
	(68.18)	(2.48)	(6.85)	(0.45)	(32.27)	(0.31)
RATE	16.124	-1.350	10.623	-16.208	9.307	-12.198
	(6.61)	(0.17)	(2.70)	(1.32)	(4.03)	(0.33)
RATE2	-0.417		-0.868		-1.024	
	(1.75)		(2.62)		(3.95)	
DUMTERM	-0.227		-1.201		3.420	
	(0.12)		(0.40)		(0.93)	
TDRATE	-0.249		-0.0595		-0.235	
	(0.17)		(0.023		(0.08)	
BADLOAN	-0.084		0.3058		4.453	
	(0.04)		(0.11)		(1.56)	
DUMCOLL	-2.284		2.116		-0.754	
	(0.78)		(0.43)		(0.23)	
UNSECU	0.031		0.102		0.243	
	(0.52)		(0.98)		(3.19)	
EBIT		9.328		21.207		14.83
		(2.83)		(2.55)		(0.28)
GDP	20.465	30.044	23.207	36.425	6.331	21.467
	(8.62)	(5.73)	(6.32)	(5.88)	(1.61)	(2.18)
σ_1 σ_2	22.091	33.171	30.605	40.949	23.043	28.17
	(10.25)	(11.70)	(12.46)	(24.62)	(16.44)	(16.84)
ρ	0.395		0.370		0.393	
	(8.25)		(3.84)		(6.90)	
Optimal Lending Rate	38.68%		12.23%		9.09%	

¬ value in parenthesis, ρ is the correlation coefficient between supply and demand errors. The estimation method is maximum likelihood estimation.