Collateral, Market Structure and Relationship Lending —Identification through IPO[1]

Bing Xu
(University Carlos III of Madrid)

Honglin Wang
(Hong Kong Institute for Monetary Research)

Adrian Van Rixtel
Bank for International Settlements

December 2014

Abstract

Concentrated market structure allows consolidation of information and higher incentive to extract proprietary information. Relationship lending also facilitates accumulation of proprietary information. This article empirically investigates if concentrated market structure and relationship intensity allow banks to extract informational rent through collateral. Our identification strategy hinges on the notion that informational equalization shocks could erode both concentrated market structure and relationship lenders' information monopoly. We employ borrowers' initial public offering (IPO) as such informational equalization shock. Applying this identification strategy to a unique hand-collect database of Chinese lending market, we find the incidence of collateral is positively related to market concentration and relationship intensity, while their effects are moderated after IPOs. Our results are robust to alternative sample selection and relationship measure, and firm fixed effect estimation. Other determinants of collateral are also investigated, and we discover private firms in China are financially discriminated in terms of collateral pledging.

JEL Classification: G21, L11
Key Words: asymmetric information, collateral, market structure, relationship lending, IPOs

[1] We thank Dong He, Hongyi Chen, Charles Calomiris, Jun Qian, and participants in the seminar at Hong Kong Institutes for Monetary Research for very constructive comments and helpful suggestions.

1. Introduction

Banks accumulate proprietary information about borrowers through screening and monitoring. This informational advantage over outside lenders increases the cost of switching banks for borrowers, allowing incumbent banks to charge higher prices. This article investigates whether banks with informational advantage can charge informational rent in terms of collateral using a unique loan-level dataset from China. In other words, we want to test if banks with superior information comparing to competitors are more likely to request collateral. Drawing from literature, we identify that both bank market structure and relationship lending lead to consolidation of proprietary information about borrowers, therefore informational advantage resulted from both factors can induce rent extraction through collateral.

A natural question is whether banks with superior information have incentives to request higher collateral. Collateral is valuable for banks because it can signal the quality of borrowers, reduce moral hazard problem, and reduce loan loss at default. Collateral is not without costs for banks on the other hand, but particularly in emerging markets, the degree of collateral measured as percentage of loan size is usually quite high, sometimes exceeding 100% in some cases, which suggests the benefits side of collateral in emerging market may prevail.

In the context of relationship lending literature, this argument is similar to the hold-up theory of Sharpe (1990), but differs in the method of hold-up, i.e. through higher likelihood of collateral instead of higher lending rates. Empirical findings of the hold-up through collateralization are plenty. For instance, Degryse and Van Cayseele (2000) finds for European market, the incidence of collateral increases if the lender is the Main Bank. They argue the hold-up resulted from informational monopoly is more prevalent in Europe than the U.S. because the banking market in Europe is more consolidated, and fewer credit alternatives exist for borrowers. In emerging markets, Menkhoff et al., (2006) investigates Thailand and finds the incidence of collateral increases if borrows from housebank, and concludes this hold-up effect is stronger comparing to findings in other industrialized countries.

The impact of market structure on information consolidation and on the incidence of collateral is less studied. To develop our hypotheses, we rely on theoretical developments that focus on the relationship between information asymmetry, market structure and competition over lending prices. These models highlight that concentration market structure gives banks more incentive to accumulate proprietary information due to higher rents from their lending (Hauswald and Marquez, 2006), and it also allows this information to be consolidated in smaller groups of banks (Marquez, 2002). Furthermore, if proprietary information is quickly spilled over to competitors, the ability of informational rent extraction through collateral is greatly reduced (Hauswald and Marquez, 2003). This argument reveals an important channel that market structure could affect bank's ability to charge informational rent, i.e., market structure affects the level of information spill-over.

Banks that possess the major share of the market have higher incentive or capacity to protect this proprietary information from leaking to competitors, because they have more to lose if this informational advantage vanishes.

Drawing from these theoretical works, a natural implication is that informational advantage of concentrated market structure gives banks more market power to charge collateral. Informational advantage is also possessed by relationship lenders, therefore rent extraction through collateral is more likely for these lenders. The above arguments hinge on crucially the fact that information asymmetry among lenders, either resulted from concentrated market structure or high intensity of relationship lending, gives banks the informational market power to charge informational rent through collateral. A natural prediction is the impact market structure and relation lending on collateral should be moderated or become irrelevant in a market where information about borrowers are symmetrically distributed.

To test these hypotheses, we follow Schenone (2010) and introduce Initial Public Offerings (IPO) as our key identification strategy. To the best of our knowledge, our paper is the first to apply IPO to identify whether banks charge informational rent through collateral. IPO is a significant information releasing event that levels playing field of information among banks. Prior to IPO, firms are not required to release information to the public, which gives incumbent banks informational advantage over outsiders, and allows for rent extraction by requiring more likelihood of collateral. After IPO, constant releasing of information through financial reports, market research and stock prices greatly erodes incumbent banks informational advantage, hence charging informational rent through collateral becomes more difficult. By investigating the difference in collateral requirement before and after IPO, we can test if the ability of concentrated market structure and relationship lenders to charge collateral is eroded when information become more symmetrically distributed among lenders.

Another advantage of using IPO as the identification strategy in the particular case of China is that IPO is strictly exogenous to both borrowers and lenders, which we will discuss further in later section. We argue the difference in the likelihood of collateral before and after IPO should be more pronounced in concentrated banking market and for relationship borrowers. This is because information asymmetry among banks is more severe in both concentrated market structure and for relationship borrowers, hence IPO generates larger scale of information equalization effect, therefore more reduction to banks to charge informational rent through collateral.

The Chinese banking market offers an ideal testing ground for informational rent through collateral, because China is a bank-based economy and the authority imposes strict price regulations on lending and deposit rates, which suggests banks have less discretion in setting prices comparing to their counterparties in mature markets. This makes rent extraction through collateralization an attractive alternative.

Furthermore, the banking market in China is relatively concentrated, and rent extraction through collateral is more likely to happen. We test our hypotheses by developing a unique loan-level dataset that lend to Chinese listed firms before and after their initial public offerings.

This article reports three main findings. First, prior to IPO, both concentrated market structure and higher relation intensity cause higher incidence of collateral. Second, after IPOs, the likelihood of pledging collateral reduces, that is the higher the market concentration or the higher the relationship intensity, the larger the reductions in the probability of pledging collateral, but the overall impacts of both factors on collateral remain positive. These findings confirm that both concentrated market structure and high relationship intensity allows banks to charge informational rent through collateralization, and shocks that levels information asymmetry among banks reduces informational rent. Our results are robust to controls for firm characteristics, macroeconomic variables, endogeneity issues of loan contract terms, sample selection issues. They are also robust to controls to firm fixed effects.

Third, we further test other determinants of collateral. Our results show firms with higher credit risks are associated with more likelihood of pledging collateral, confirming the prediction that collateral mainly solves moral hazard problem. Other loan contract terms, in particular short loan maturity, constitutes an alternative mechanism to collateral to reduce risks of lending. The particular important factor that determines the incidence of collateral in the context of China is firm ownership. Private ownership is associated with much higher probability of pledging collateral, which confirms that the soft budget constraint or implicit guarantee from the state provides an alternative mechanism to collateral for state-owned firms. Besides higher lending rates, higher collateral requirements constitute another obstacle for private firms to access bank financing.

Very few studies have investigated the determinants of collateral in the context of China. Firth et al.,(2012) investigates the role of collateral as governance mechanism in mitigating investment distortions, and determinants of collateral, using a sample of firm-level data from Chinese listed firms. They confirm collateral in China mainly solves moral hazard problem and state ownership reduces the collateral requirement. Pan and Tian (2013) also use a firm-level data to investigate if corruption facilitates firms to obtain loans with lower collateral requirement. Chen et al., (2011) study the relationship between collateral and accounting conservatism for a sample of Chinese firms. However, none of above three studies investigated the determinants of collateral at *loan-level* in China and paid attention to the role of market structure and relationship lending on the incidence of collateral, as well as how changes in information asymmetry among lenders can affect the impact of those factors on collateral.

The remainder of this article is organized as follows. Section 2 reviews

literature on the determinants of collateral. In particular, section 2.1 develops hypotheses on market structure and collateral based on existing theoretical work. Section 2.2 reviews literature on relationship lending and collateral and develops hypotheses. Section 3 develops identification strategy. Section 4 describes the sample, variable definitions and summary statistics. Results are reported in Section 5. Section 6 reports results of various robustness tests, and Section 7 concludes.

2. Literature Review and Theoretical Predictions

2.1. Bank Market Structure and Collateral

The relationship between bank competition and collateral requirement is both theoretically and empirically ambiguous. Very few theoretically works address this issue formally, and most of the empirical studies investigate this topic on the sideline. The following section provides a brief literature review and develops hypotheses.

Manove, Padilla and Pagano (2001) proposed a lazy bank model in which banks choose between screening the borrower or ask for collateral. They assume that screening provides banks with perfect signal about firm's creditworthiness, and collateral reduces banks' incentive to perform screening. In their model, intensified competition would favor bank laziness by reducing screening and asking for more collateral. Based on the model of Manove, Padilla and Pagano (2001), Hainz (2003) draw an opposite conclusion on competition and collateral. The crucial assumption he made is that greater competition results in a better information extraction for the bank and a more efficient screening signal. Therefore increased competition in the banking industry makes screening a more attractive choice compare to requiring collateral. Moreover, Hainz (2003) proposes that banks with monopoly power have incentive to use collateral to extract rents. In Hainz et al., (2013), banks employ either screening or collateralization to solve adverse selection problem, depending on cost efficiency of those two alternative instruments. Screening becomes more efficient if market is more competitive, because increasing number of banks reduces the distance between lenders and borrowers, which lowers the cost of screening and improves quality of screening signal. Competition is therefore negatively correlated with collateral.

Berlin and Butler (2002) develop a model following the observations that competitive pressure in loan markets often compels banks to soften contract terms, in particular to lower or waive collateral requirements. Their theory is based on the possibility of renegotiation between the bank and the borrower. They support the view that bank competition leads to lower collateral requirements, which results from the incentives of the bank to proceed to renegotiation. Inderst and Muller (2007) developed a lender based model of collateral which does not assume borrower side information asymmetry. Collateral is valuable because it increases banks' payoff in time of default. Local (or informed) lenders use collateral to exploit the informational advantage relative to distant ones (or uninformed). They predict incidence of collateral is higher in competitive market. Jimenez et al., (2009) provides empirical validation of this hypothesis using a sample of Spanish banks.

We develop our hypotheses from a sequence of theoretical papers that address the relationship between information asymmetry, market structure and competition over lending rates (e.g. Hausewald and Marquez, 2006; Marquez, 2002; Dell'Ariccia and Marquez, 2006; Dell'Ariccia, 2001). Most of these theoretical works do not focus on collateral, but these models offer some important insights. The first general conclusion of these models is banks that have proprietary information can charge informational rent by requiring higher interest rate. For instance, Hauswald and Marquez (2006) demonstrates that banks located closer to borrower can charge higher rates, because banks obtain more accurate information about the borrower comparing to a distant bank. Similar results are predicted and validated by many others. (Degryse and Ongena, 2005; Degryse and Van Cayseele, 2000).

The second insight is that bank market structure affects informational distribution among lenders. Concentrated market structure not only consolidates market share of lending, but also the proprietary information of borrowers (Marquez, 2002). Thirdly, different market structure also determines the incentive of banks to accumulate proprietary information. Hauswald and Marquez (2006) shows that banks acquire proprietary information to soften lending competition and to extend market share. Increased competition reduces the banks rents and decreases incentives to generate information through credit evaluation (screening). Lastly, the distribution of information among lenders further affects the market structure and actual competition the borrower is facing. Dell'Ariccia, Friedman, and Marquez (1999) and Dell'Ariccia (2001) show that information asymmetries between lenders can be a prime determinant of the market structure of the banking industry. Information monopoly deters entry of new banks.

Most of the theoretical works mentioned above do not explicitly consider the role of collateral. Notable exception is Dell'Ariccia and Marquez (2006). They model collateral as signal device of credit quality and show how the informational structure of loan markets interacts with banks' strategic behavior in determining lending standards (collateral). They demonstrate banks may loosen lending standards (collateral) when informational asymmetries vis-a-vis other banks are low, such as when the proportion of borrowers with unknown projects in the market increases. In this model, increasing proportion of unknown projects levels information asymmetries among lenders and reduces adverse selection problem for each bank, therefore banks have incentive to reduce collateral requirement to exchange extra market share.

These theoretical models reveal two possible channels that market structure can increase the incidence of collateral: through information monopoly and through pure market power. The first channel hinges on the difference in the effectiveness of information extraction and informational distribution among lenders between different market structures. Marquez (2002) suggests information extraction is less effective in market composed of many small banks comparing to the one with a few large banks.

Competitive market structure also lacks the incentive to accumulate proprietary information due to lower rent exaction in lending rates (Hauswald and Marquez, 2006). Furthermore, in concentrated market, firms are also likely to borrow more often from the same lender due to limited outside option, and these repeated transactions allow incumbent bank to accumulate more private information about the borrower and enjoy informational monopoly. Moreover, in such market, the entrant banks face larger adverse selection costs while firms face higher switching cost to outside banks, both of which that can further deter entry and consolidate the bank market. Therefore, a natural implication of this view is that concentrated market allows banks to accumulate proprietary information easier, which in turn allows banks to charge informational rent through collateral more likely.

If the private information about the borrowers are easily spilled over to competitors, charging informational rent becomes difficult or impossible (Hauswald and Marquez, 2003). We argue that concentrated market structure allows better protection of this private information. Banks that possess the major share of the market have higher incentive or capacity to protect this proprietary information from leaking to competitors, because they have more to lose if this informational advantage vanishes.

The above arguments suggest concentrated market allows both better extraction of private information, consolidation of information within a few banks, and better protection of private information from spilled over to competitors, hence through this informational advantage concentrated market structure allows rent extraction through collateral. We label this channel as *Information Channel*.

The second channel is the standard market power channel. In concentrated market, banks can explore their market power by charging higher interest rate, and asking for collateral. This channel can be effective independent of the level of information asymmetry among banks. In extreme case where no information asymmetry between borrowers and lenders is present (information asymmetry among banks is therefore also not present), collateral is still valuable for lenders because it reduces losses in time of default. Banks with market power can better exploit this benefit, while competitive banks may reduce collateral requirement under competition pressure. We refer this channel as *Market Power Channel*.

These two channels are difficult to differentiate from each other, and both channels can be at force simultaneously. However, the *Information Channel* depends on information asymmetry among banks, while the *Market power Channel* can be at force event without information asymmetry. An identification strategy can be derived from this observation. If an exogenous shock greatly reduces the information asymmetry among banks, market structure should have less impact on the incidence of collateral after the shock, because the informational advantage of market structure is eroded in transparent market. The more concentrated the market is before this

informational shock, the greater the moderation effect. But the impact of market structure on incidence of collateral will not vanish, because the *Market Power Channel* can be at force without information asymmetry.

We develop the following hypotheses:

H.1: Concentrated bank market allows for higher probability of collateral, either because of more market power or information monopoly in such market.

H.2: The positive impact of concentrated market structure is moderated in environment where information distribution among lenders is relatively symmetric, and the higher the market concentration, the stronger the moderation effect of informational equalization.

2.2. Relationship Lending and Collateral

The empirical literature on the impact of bank-firm relationships can be divided into two strands. The first strand focuses on whether a bank-firm relationship increases firm value. Most of the studies confirm bank-firm relationship increases firm value as stock prices react positively to bank loan agreement (e.g. James, 1987; Lummer and McConnell, 1989; Chemmanur and Fulghieri 1994). A recent study on China however supports the opposite (Bailey et al., 2011).

The second strand of literature tests directly if the value-added by relationship banking increase with relationship strength. Boot and Thakor (1994) show that repeated interaction between borrower and lender can accumulate proprietary information, build trust and reduce moral hazard problem. This information gathering process allows banks to better evaluate firms on ex ante screening and ex post monitoring, hence relationship lending and collateral are substitutes in dealing with information opaqueness. This information accumulation view suggests negative relationship between relationship lending and collateral. Empirical literature confirming this prediction are plenty (e.g. Petersen and Rajan 1994; Bergr and Udell, 1995; Harhoff and Korting, 1998; Jimemez et al., 2006; Chakraborty and Hu, 2006; Brick and Palia, 2007).

On the other hand, some studies find relationship lending plays positive role on the incidence of collateral (Menkhoff et al., 2006). These findings can be explained by the hold-up theory of Sharpe (1990) and Rajan (1992). The incidence of collateral is positively related to the intensity of lending relationship because banks can lock-in borrower due to their informational advantage (Machauer and Weber, 1998; Elsas and Krahnen, 2000; Lehmann and Neuberger, 2001; Degryse and Van Cayseele, 2000). Degryse and Van Cayseele (2000) find for European market, the incidence of collateral increases if the lender is the Main Bank, supporting the hold-up view. They argue hold-up is more prevalent in Europe than U.S. because the banking market in Europe is more consolidated, and fewer credit alternatives exist for borrowers.

The theoretical foundation of hold-up theory depends on information

asymmetry among banks. A natural prediction is that if information among banks is relatively symmetrically distributed, the likelihood that hold-up problem should be reduced. Furthermore, as information asymmetry between inside and outside banks are higher for relationship borrowers, the moderation effect of informational equalization shock is stronger for those borrowers.

From the above discussion, we develop the following two hypotheses:

H.3: Intensified relationship lending is positively related the incidence of collateral if hold-up effects dominant. Information accumulation view holds if relationship lending is negatively related to collateral.

H.4: If relationship lending increases incidence of collateral, its effect is moderated in environment where information is symmetrically distributed among banks; and the moderation effect is stronger for relationship borrowers.

3. Identification Strategy

The ideal way to test our hypotheses is to compare the incidence of collateral around a significant event that equalizes the information distribution among banks. Such shock is difficult to obtain, but existing literature provides several candidates. Marquez (2002) suggests that in market with high turn-over of borrowers, the information advantage of any incumbent banks is eroded, because all banks are equally uninformed. Padilla and Pagano (1999) propose the establishment of credit registry that facilitates information sharing among banks can be such an event to equalize the field of information distribution. However, both of the identification strategies are difficult to apply for Chinese market. In particular, it is not easy to find sufficient lending data of a sector where turn-over of borrowers significantly increases after certain event (for instance, deregulation of certain sector can cause significantly entry of unknown entrant). China introduced the Credit Registry system in 2005, however since our sample starts from 2007, it impossible to use the establishment of Credit Registry as information equalizer. We must rely on other identification strategy.

We propose that Initial Public Offerings (IPO) provides such an information releasing shock that can equalize information distribution among banks. Schenone (2010) is the first to apply this identification strategy to test if relationship banks can still exploit informational rent by charging higher interest rate than those that would prevail were all banks symmetrically informed. By design, using a sample of firms that went through IPO process is biased against finding evidence of informational rent extraction, because those are the firms that are already relatively large and transparent before IPO. If informational rent extraction through collateral is found in such a sample, it is even more likely to find similar evidence in a sample of smaller and obscurer firms. Another advantage of employing IPO as identification strategy in the particular case of China is that IPO is an exogenous event. Firms might expect to go public at some point, but the exact timing of IPO depends on the approval of CSRC, which is unpredictable and entirely exogenous to both banks and firms.

Before IPO, concentrated market structure consolidates private information of borrowers to a few banks, making informational rent extract through collateral possible. After IPO, previous privately hold information among small group of banks are made public to all banks through regularly published financial statements, public auditing, investigation by research analysts, or stock prices. Information asymmetry among banks is greatly reduced through these information releasing channels. Therefore after IPO the informational advantage of concentrated market structure becomes less important or irrelevant, reducing the impact of market structure on incidence of collateral. Furthermore, the higher the market concentration, the greater the information equalization effect of IPO will be, hence results larger reduction in the probability of collateral comparing to pre-IPO.

Similar arguments apply also to relationship lending. Before IPO, relationship lenders enjoy superior information obtained from relationship lending, which allows for rent extraction through collateral. After IPO, constant information releasing keeps any bank from obtaining or maintaining informational monopoly position. Furthermore, a secondary effect might at work which can reinforce the direct effect of IPO in reducing information asymmetry among banks. Because IPO reveals information to all banks, the incentive of relationship bank to acquire additional information to maintain information advantage is reduced. This may be result of decreasing return of investment in information or increasing cost of accumulating additional information in market where all banks are well informed. With less investment in information after IPO, the information asymmetry among banks is further reduced. These arguments suggest that the informational advantages of relationship lenders are greatly reduced after IPO, making rent extraction through collateral harder. Moreover, for relationship borrowers, the information asymmetry among incumbent banks and outside banks are higher, therefore the information equalization effect of IPO is stronger for those borrowers, which leads to greater reduction in the probability of collateral comparing to non-relationship borrowers.

4. Data and Variables

Unlike most of the previous studies on China that employ either firm-level data sets from China Securities Markets and Accounting Research Database (CSMAR) (e.g. Pan and Tian, 2013; Firth et al., 2012; Chen et al., 2013), or rely on loan-level datasets provided by one particular state-owned bank (Bailey et al., 2011; Chang et al., 2014; Qian et al., 2014), we hand collect our data from Wind Finance Co., Ltd. This unique loan-level database provides information on multiple borrowings of each firm (on average each firm has 20 loans in our sample) and from multiple banks (on average 4 banks per firm) including almost all types of Chinese banks.

After 2007, listed firms are required by China Securities Regulatory Commission (CSRC) to disclose their most important loans in appendices of each of annual and semi-annual reports and we manually collected those loan-level data from

those reports. Since hand-collecting data is very time-consuming and we give our priority to collect the data from companies listed on the Shenzhen Stock Exchange (SZSE), which is the dataset used in this paper, because firms listed on the SZSE are more diverse in terms of firm size compared with those listed on the Shanghai Stock Exchange. We are aware that the size of firms in the dataset is still relatively large compared to many Small-Medium Enterprises (SMEs) in China. Nevertheless, this is the only decent loan-level dataset with multiple lenders (banks), which enables us to test our research questions.

The data set we use consists of 10,654 loans made to 676 listed firms of SZSE in between 2007 and 2013. Some recording errors, incomplete loan contract information, and questionable financial data cut down our sample. In particular, loans issued at lower than lending rate floor (below 90% of baseline lending rate) are removed because these loans are likely to be issued at non-commercial basis. We further remove loans that are made to financial institutions. Table I provides definitions of variables and summary statistics for the remaining 9,288 observations made to 649 listed firms, broken down into six sets of characteristics: (1) loan contract terms, (2) borrower characteristics, (3) bank market structure, (4) relationship variables, (5) regional law and institution variables, and (6) monetary variables and regional macroeconomic variables. We explain the variables and theoretical predictions in detail as follows.

4.1. Loan Characteristics

For each loan facility, we register the following information: loan initiating date and ending date, which allows us to calculate maturity of loans and tell us whether the loan is issued before or after IPO by combining IPO information of those firms. In the dataset we also have loan size, loan rate, whether the loan is collateralized, and the names of the lenders and the borrowers.

Our main variable, *Collateral*, is a dummy variable that equals to 1 if the loan facility is collateralized and zero otherwise. Information on the amount of collateralization is not available, therefore in this article we focus on the incidence of collateral instead of the degree of collateralization. 66% of loans are collateralized, which is comparable to figures discovered in other developing countries with similar firm size, such as Mexico 53%, (La Porta et al.,2003) and Thailand 72% (Menkhoff et al., 2006).

Loan *Maturity* is defined as the logarithm of months between loan initiating and ending dates. The average loan maturity is 25.9 months. *Loansize* is the logarithm of real loan amount, in millions of RMB deflated to year 2006 value. Instead of using loan rate directly, we employ *Spread* which is defined as the difference between lending rate and benchmark deposit rate of corresponding maturity. The advantage of *Spread* is to isolate the funding cost that is common to all banks, so that *Spread* captures how bank evaluates the riskiness of the loan. The average *Spread* is 2.85%.

For each firm in our sample, we record its date of initial public offerings. This allows us to identify if a particular loan is issued before or after IPO. We introduce a dummy variable *IPO* equals to 1 if a loan is issued after IPO, and 0 otherwise. 83% of the loans are issued after IPO. Among the 649 firms in our sample, 111 firms reported at least one loan before IPO and at least one loan after IPO, in total these firms borrowed 2181 loans, representing 23% of all loans. The rest of the firms only have loans either before IPO (142 firms with 660 loans) or after IPO (396 firms with 6447 loans).

4.2. Firm Characteristics

Various firm characteristics that have been proven useful in previous literature are incorporated, including: *Age*, *Size*, *Liquidity*, *Z-score*, *ROA*, and *Tangibility*. When a loan is issued at certain date, we obtain all firm characteristics (except *Age*) from the most recent available financial report. For instance, if a loan is issued at 28th of March, 2008, then the corresponding firm characteristics are obtained from the financial report of 31th of December, 2007.

Firm *Age* is defined as the number of months between the firm established date and loan initiating date. It is incorporated in logarithm form as it is expected that the marginal impact to decrease as firm gets older. The average firm *Age* is around 153 months. *Size* of the firm is measured by the logarithm of total assets, deflated to 2006 value. The average *Size* is 2139.5 millions of RMB. These figures confirm our sample is composed of relatively large and old firms. *Z-score* is the Altman Z-score, with higher value indicating better firm performance. *Leverage*, defined as total outstanding debt to total assets ratio, measures the indebtness of the firm. Higher value indicates that the firm is more indebted, therefore likely to be more risky. Average *Leverage* ratio is 55.6%. *Return on Assets (ROA)* measures the profitability of the firm, defined as the ratio of net profits to total assets. *Liquidity* is the ratio of current assets to total assets. *Tangibility* is the ratio of Property, Plant and Equipment to Total Assets. Higher value indicates that the firm has more tangible assets in its asset composition. We also control for loan concentration (*Loanconcen*), measured as *Loansize/(Loansize+Outstanding Debt)*. Higher value of *Loanconcen* reflects that this particular loan represents a larger portion of firm's debt. The average loan concentration ratio is 4.3%.

Another firm characteristics that is particularly important for China is the *Firm Ownership (FT)*. *Firm Ownership (FT)* is a dummy variable equals to 1 if State is the majority owner, and equals to 0 if Private Sector has the majority ownership. Firms with state majority ownership represent 33% of all firms, and make 40% of the loans in our sample.

4.3. Bank Market Structure

There are 32 provinces in the mainland China, and this is the lowest level of

geographic market for which disaggregated data on banks are available. We treat each province as a separate banking market. Bank market structure is measured by concentration ratio. For each year and each province, we collect for the four largest banks their assets values and total assets values of all banks. Data is from People's Bank of China. Concentration ratio *ACR4* is then defined as the total assets share of the four largest banks out of all assets of all banks in each province-year. The average concentration ratio is 0.55, indicating that the largest four banks on average represents 55% of the total share of assets. On average, the most concentrated market is Tibet province, while the least concentrated market is Shanghai province.

4.4. Relationship Lending

The strength of bank firm relationship is traditionally measured by relationship *Duration*, defined as the time difference between the first loan and the current loan (see e.g. Petersen and Rajan, 1994; Berger and Udell, 1995). As suggested in Schenone (2010), *Duration* may not fully capture how dependent a firm is on its current lender, or how locked-in the firm is in the lending relationship. Following Schenone (2010), we measure intensity of relationship by the frequency with which the borrower turns to the same lender. This measure, named *Sizeconcen* (*Numconcen*), is defined as the amount of loans (number of loans) that a firm has borrowed from its current lender as a proportion of the total among of loans (total number of loans) the firm has drawn to date. By definition, *Sizeconcen* (*Numconcen*) is between 0 and 1.The borrower is more dependent on the lender if *Sizeconcen* (*Numconcen*) is high. The average *Sizconcen* (*Numconcen*) of our sample is 47% (48%). We rely on *Sizeconcen* in our main analysis and *Numconcen* in robustness test section.

Having the same *Sizeconcen* does not preclude the firm from borrowing from different number of banks. For instance, a loan associated with *Sizeconcen*=0.5 can be the result of borrowing from two banks while each accounts half of the total loans, or borrowing from five banks with the largest loan accounts for half of the total loans. To control this, we introduce Number of lenders (*Numlender*). This variable measures how many different lenders the firm has borrowed from up to the time the latest loan is initiated. This variable also has merit itself, as it measures how diversified the information of the firm is distributed among lenders, or if firm gains higher bargaining power with more lenders to reduce collateral. If the coefficient of *Numlender* is positive, it may be result that information of the firm is diluted with more lenders, hence raising uncertainty from the lender's perspective and leading to more incidence of collateral. On the other hand, with more lenders, firms can post a threat to switch banks, which may result lower incidence of collateral because of increasing bargaining power of the firms. An average firm borrows from 4 different lenders in our sample.

Scope measures the number of times the firm has borrowed from the lender. Bank in principle can obtain more private information about firm through more

frequent lending activities. In our sample, firm on average borrow 6 times from the same lender.

Switch is a dummy variable equals to 1 if the current loan is borrowed from the same lender as the previous loan, and 0 otherwise. *Switch* does not represent the termination of lending relationship, but merely means a borrower move to another lender for loans at some point.

In all those relationship variables, loans originated by either a parent bank or a subsidiary are treated as loans from the same lender, since it is expected that the information of the borrower is shared within the subsidiaries of the bank.

4.5. Law and Institution

Two variables are introduced to represent legal infrastructure and institutional development at province level: *Legal* and *Marketization Index*. Data comes from Fan and Wang (2011)[2]. This comprehensive index captures the following aspects of the regional institutional development: government and markets relationship, non-state sector development, product markets development, factor markets development, and development of market intermediaries and legal environment. For each aspect a yearly sub-index is composed and the *Marketization* index is the arithmetic average of sub-indices. Higher value of these indices indicates better institutional development. The indices however end in 2009. We interpolate the missing values of latter years by assuming the indices grow at the average growth rate of the 2006-2009. The *Legal* index, our main institutional variable, measures the legal development of each province by evaluating, for instance, the presence of lawyers, accountants, property rights protection, producer rights protection and consumer rights protection. Average value of Legal index is 10.68. We also incorporate the *Marketization index* to control aspects not captured by *Legal Index*, such as how independently markets can operate from government intervention. Li et al.,(2009) provides detailed description of this index.

4.6. Monetary Variables and Regional Macroeconomic Conditions

Monetary stance is measured by Reserve Requirement Ratio (*RRR*) and 7day Repo rate (*Repo*). *RRR* and *Repo* rate are monthly data. For each loan, we match the loan initiating month with the corresponding *RRR* and *Repo* rate of that month. Data is obtained from CEIC database.

Regional real GDP growth rate (*Realgdpindex*) is incorporated to control business cycle and demand side shocks at provincial level. Data comes from China National Bureau of Statistics. *NPLratio* is the regional non-performance loan ratio. Higher value indicates a higher default rate in that particular province. The incidence of collateral is likely to be higher in regions with higher default rate. Data comes from

[2] This index has been widely applied in Chinese setting. See for instance Wang et al., 2008; Firth et al., 2009; Li et al., 2009.

CEIC database. Another regional variable is the development of private sector. We obtain the *PrivateDevelopment* index from Fan and Wang, (2011), which measures the degree of presence of private sector in each province. All these data are on yearly frequency. These variables are introduced with one semi accounting year lag.

4.7. Other Variables

Time fixed effects, bank type fixed effects, province fixed effects and industry fixed effects are included. Time fixed effects capture differences in collateral requirement related to business or credit cycle. In total 7 year dummies are included, treating year 2007 as reference year. Bank type fixed effects capture systematic differences in bank propensities to require collateral. The 9 bank type dummies represents state owned banks, joint stock banks, city commercial banks, rural commercial (corporative) banks, policy banks, trust and finance companies, foreign bank, postal savings bank, and other financial institutions. Loans from postal savings bank (3 observations) are all collateralized therefore excluded from our analysis. Chart 1 summarizes percentage of collateral across bank types (left panel) and across provinces (right panel). Province fixed effects capture systematic differences in collateralization across provinces. In total 31 province dummies are included. Industry dummies controls for differences in technology, production, market conditions across industries that can account for systematic differences in borrowers' risks. We group firms into 52 different industries according to the classification of Wind Finance Ltd.

5. Empirical Analysis

5.1. Univariate Tests

Univariate tests are reported in Table II. We compare if the mean value of key variables differ significantly across IPO, market structure, relationship intensity, and firm ownership. The mean probability of collateral is significantly higher before IPO, in concentrated market (*ACR4*>=Medium), for private firms, and for relationship borrowers (Sizconcen>=Medium). In terms of firm ownership (*FT*), on average private firms register higher incidence of collateral, shorter loan maturity, higher loan spreads, and smaller loan sizes. This result gives a rough indication that private firms receive worse loan contract terms than state owned firms. IPO improves all loan contract terms except *Spread*. Relationship borrowers (*Sizconcen*>=Medium) on average enjoy longer loan *Maturity* and lower *Spread*, but have higher probability of pledging collateral.

5.2. Multivariate Tests

The univariate tests provide preliminary evidence that both market structure and relationship lending affect incidence of collateral, and *IPO* reduces the incidence of collateral. We progress to multivariate regressions as follows. In section 5.2.1, we first test the determinants of collateral such as firm characteristics, loan contract terms and other macroeconomic variables. Section 5.2.2 discusses the role of firm ownership in determining collateral, as this factor may be of particular importance in the context of Chinese market. Because the results of these determinants of collateral

change only marginally in latter model specifications, we choose to tabulate results of these variables before we focus on our main hypotheses. Next we test our main hypotheses in section 5.2.3, 5.2.4 and 5.2.5, i.e., if concentrated market and relationship intensity allows for higher incidence of collateral, and if their impact will be moderated in environment where information asymmetry among banks is not severe.

5.2.1. Firm Characteristics, Loan Contract Terms and Other Controls

In the following models of Table III we introduce independent variables progressively, starting from the basic model that only includes bank market structure and industry fixed effect, bank type fixed effect, time fixed effect and province fixed effect (Column I). Then we include firm characteristics (Column II), monetary and regional macroeconomic variables (Column III), loan characteristics (Column IV-Column VI), and legal and institutional variables (Column VII).

Signaling models consider collateral as signaling device to mitigate adverse selection problem. (e.g. Chan and Kanatas 1985; Bester 1985, 1987; Besanko and Thakor, 1987). These set of models predict that low risk borrowers are more likely to pledge collateral than high risk borrowers. The observed-risk hypothesis considers collateral as tool to solve moral hazard problem (e.g. Boot et al., 1991; Boot and Thakor, 1994), and predict high risk borrowers are more likely to pledge collateral. Our estimation shows all credit quality variables have the expected sign consistent with observed-risk hypothesis and are stable through all specifications.

The coefficients of *Age* and *Size* are negative and significant, indicating older and larger firms are less likely to pledge collateral. Larger and older firms are more likely to be well-established and less prone to moral hazard problem. This result may also reflect the fact that larger and older firms have higher bargaining power to obtain loans without collateral. Another possible explanation is that information about larger and older firms is relatively easier to obtain for both incumbent bank and outside banks, which makes interbank information asymmetry for these types of firms relatively low. This wide distribution of firm specific information reduces firms' switching cost, and at the same time, limits the ability of incumbent bank's ability to extract informational rent. Hence, competitive pressure from outside banks may force incumbent bank to reduce the incidence of collateral.

Firms with high profitability, high liquidity, and low leverage are less likely to pledge collateral. High profitability and high liquidity reduce insolvency risks facing by banks. A firm with high leverage faces a greater likelihood of future insolvency, and has a greater incentive to substitute high risk assets for low risk ones after a loan. This finding is consistent with moral hazard hypothesis of collateral which suggests riskier firms are more likely to post collateral.

The negative coefficient of *Tangibility* indicates that firms with high level of

tangibility are considered to be less risky. This result is consistent with previous findings such as Bharath et al. (2011). *Z-score* is not statistically significant for all specifications. Following Berger and Udell (1990) we introduce *Loan Concentration* from Column IV and onwards. Berger and Udell (1990) reports that the greater the current loan borrowing relative to the size of the total debt (higher *Loan Concentration*), the greater is the likelihood of a lender asking for collateral. We find similar results[3]. Coefficient of *Loan concentration* is significantly positive at 1% level across all specifications.

These results on firm characteristics confirm the conclusions reached in previous studies that observed credit risk is positively associated with the incidence of collateral (e.g. Berger and Udell 1990, 1995; Harhoff and Korting, 1998; Dennis et al, 2000; Menkhoff et al.,2006; Brick and Palia, 2007).

Monetary policy variables and regional macroeconomic variables are introduced from Column III. *Reserve requirement ratio (RRR)* is insignificant across all specifications, while *Repo* is significantly positive at 10% level. One standard deviation increase of Repo rate from sample mean increases the incidence of collateral by 1.4%. This result suggests collateral is more likely during monetary tightening, in contrast to the finding of Jimenez et al. (2006). The balance-sheet channel of Bernanke and Gertler (1995) points out rising interest rate increases firms' interest expenses, weaken borrowers' financial position, and shrink collateral value. All of these factors can increase firm's default risks, hence more likelihood of collateral during tightening. Monetary tightening may also lead to credit rationing through bank lending channel. This could also increase collateral requirement because firms that can pledge collateral are more likely to obtain loans under credit rationing. Identifying which channel causes the increasing of collateral is beyond the scope of this article. We leave it for future research.

Unlike Jimenez et al. (2006), we do not find significant impact of local real GDP growth and local CPI on the incidence of collateral. Those regional variables may play a role if the value of collateralization is available. The coefficients of Local None-Performance Loan Ratio (*NPLratio*) are not statistically significant across all specifications.

Next we introduce loan contract terms such as *Maturity*, *Spread* and *Loansize* to the regression. Banks design loan contracts to mitigate risks and solve information asymmetry problem. This complex contract includes both price and non-price terms including collateral, loan maturity and debt covenants. Therefore the risks of the borrower are reflected not only in collateral, but in all those contract terms. Results are reported in Column IV–Column VI. Adding additional loan contract terms changes other control variables only marginally. We therefore report marginally effect of those loan contact terms based on Column VI.

[3] Similar findings are reported in, for instance, Boot et al. 1991, Dennis et al.,2000, Bharath et al. 2011.

Loans with longer maturity are more likely to be collateralized. One standard deviation increase of loan maturity from sample mean increases the incidence of collateral by 3.3%. This result is in line with the theoretical prediction that banks use shorter loan maturities to solve adverse selection or moral hazard problems (e.g. Myers, 1977; Berlin and Mester, 1992; Flannery, 1986; Barclay et al.,, 1995). Short loan maturity and collateral seems to constitute a substitute mechanism to control borrower's risk. Similar results are reported in, e.g., Ortiz-Molina and Penas (2008), Leeth and Scott (1989), Degryse and Van Cayseele (2000), Dennis et al., (2000) and Voordeckers and Steijvers, (2006).

Larger loans are less likely to be collateralized. One standard deviation increase of loan size reduces the incident of collateral by 3.3%. This result is consistent with Leeth and Scott (1989), Jimenez and Saurina (2004) and Menkhoff et al., (2006). However, it contrasts to the findings of Steijvers and Voordeckers (2009) and Boot et al., (1991).

Most of previous researches, such as Dennis et al. (2000) and Bharath et al. (2011), assume a unidirectional relationship between *Spread* and collateral, namely collateral affects *Spread* but not the reverse case. The underlining assumption is that lending rate is determined after all non-price terms have been settled. Nevertheless, following Brick and Paila. (2007) and Ono and Uesugi (2009), we incorporate *Spread* here and later run robustness check by excluding it to avoid endogeneity issue. Loans with higher *Spread* are more likely to be collateralized. One standard deviation increase of loan *Spread* increases the incident of collateral by 1.3%. The positive and significant correlation between *Spread* and collateral implies that riskier projects are associated with more likelihood of collateral, although the economic significance of *Spread* on collateral is relatively small.

As these loan contract terms variables are potentially endogenous, we discuss this issue further in robustness test section.

Column VII includes legal and institutional variables. When lending to firms, banks must access not only the credit quality of borrowers but also the risks associated with weak law and institutions. Various empirical works have identified that banks respond to poor legal infrastructure or contract enforceability by shortening loan maturity, reducing loan volume and increasing loan spread. (Pinheiro and Cabral 1999; Diamond, 2004; Bae and Goyal , 2009; Lin et al., 2010). Theories of debt imply lenders can better control borrower risk if legal institutions allow lenders to seize collateralized assets in time of default (Aghion and Bolton 1992, Hart and Moore 1994, 1998). In a cross-region setting, these theories imply the incidence of collateral may be lower in regions with weak legal infrastructure, because seizing collateral is more difficult or more costly. In column VII, the positive and significant coefficient of *Legal* indicates that loans issued in provinces with better legal environment (higher

value of *Legal*) are more likely to be collateralized. This result is similar to Qian and Strahan (2007) who find better credit rights protection increases incident of collateral for firms with more tangibility assets. The coefficient of *Marketization* is negative and significant. This measure is a comprehensive measure that captures various aspects institutional development. We incorporate this variable mainly to control institutional effects that are not captured by *Legal*. Removing this variable does not affect any of the results reported in this article.

Table III: Collateral, Firm Characteristics, Regional and Institutional Variables

	I	II	III	IV	V	VI	VII
ACR4	2.095***	2.192***	2.494***	2.546***	2.538***	2.642***	2.279***
	(0.714)	(0.775)	(0.802)	(0.804)	(0.804)	(0.803)	(0.822)
IPO		-0.379***	-0.384***	-0.412***	-0.412***	-0.393***	-0.391***
		(0.072)	(0.072)	(0.073)	(0.073)	(0.073)	(0.073)
FT		-0.591***	-0.591***	-0.610***	-0.602***	-0.619***	-0.608***
		(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.047)
liquidity		-0.477***	-0.480***	-0.421***	-0.419***	-0.419***	-0.384**
		(0.153)	(0.153)	(0.155)	(0.155)	(0.155)	(0.156)
z-score		-0.003	-0.003	-0.002	-0.002	-0.008	-0.009
		(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
size		-0.264***	-0.262***	-0.278***	-0.276***	-0.209***	-0.204***
		(0.023)	(0.023)	(0.023)	(0.023)	(0.027)	(0.028)
leverage		0.953***	0.951***	0.856***	0.853***	0.905***	0.860***
		(0.137)	(0.138)	(0.139)	(0.139)	(0.140)	(0.140)
roa		-1.129***	-1.114***	-1.193***	-1.175***	-1.140***	-1.068***
		(0.277)	(0.282)	(0.278)	(0.278)	(0.281)	(0.279)
age		-0.428***	-0.430***	-0.420***	-0.421***	-0.418***	-0.416***
		(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
tangibility		-0.862***	-0.850***	-0.815***	-0.810***	-0.820***	-0.798***
		(0.176)	(0.177)	(0.178)	(0.178)	(0.178)	(0.179)
loanconcen		1.117***	1.143***	0.809**	0.804**	2.044***	2.064***
		(0.314)	(0.315)	(0.321)	(0.322)	(0.444)	(0.446)
maturity				0.126***	0.148***	0.165***	0.166***
				(0.025)	(0.027)	(0.027)	(0.027)
spread					0.037**	0.037**	0.040**
					(0.017)	(0.017)	(0.017)
loansize						-0.092***	-0.088***
						(0.021)	(0.021)
privatedevelopment							0.284***
							(0.046)
legal							0.029***
							(0.009)
marketization							-0.394***
							(0.082)

rrr			0.328	0.288	0.482	0.607	0.719
			(2.867)	(2.883)	(2.885)	(2.889)	(2.905)
repo			0.047*	0.051*	0.051*	0.050*	0.048*
			(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
cpi			1.995	1.612	1.563	1.505	1.859
			(1.499)	(1.506)	(1.506)	(1.508)	(1.519)
nplratio			-0.304	-0.097	-0.160	-0.420	0.494
			(1.126)	(1.129)	(1.129)	(1.133)	(1.177)
realgdpindex			1.425	1.011	1.016	1.204	1.283
			(1.431)	(1.436)	(1.436)	(1.438)	(1.457)
Constant	-0.836	2.201***	-0.278	-0.079	-0.220	-0.637	-0.446
	(0.590)	(0.700)	(1.862)	(1.864)	(1.866)	(1.871)	(1.968)
Observations	9,261	8,753	8,753	8,741	8,741	8,741	8,741
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.198	0.280	0.280	0.283	0.284	0.289	0.289

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5.2.2. Firm Ownership

In China, firm ownership may be considered as a particularly important risk factor by banks. Previous studies have indentified that private firms in China have been financially discriminated in a state-dominant banking system (e.g. Cull and Xu, 2003; Brandt and Li, 2003; Allen, Qian and Qian, 2005). This financial discrimination is also likely to prevalent in terms of higher likelihood of collateral for private firms. We test this idea in this section.

In Table III, firm ownership dummy *FT* is significantly negative at 1% level throughout all specifications. We calculate the marginal effect of firm ownership based on Column VII. When everything else being equal, private firms on average has a 16.7% more probability of pledging collateral than state owned firms. This is by far the largest marginal effect we find for all control variables. Note that the private firms in our sample are relatively large and reputable. If those firms still suffer from ownership discrimination, it is expected that the smaller and obscurer private firms suffer even more. This finding suggest that private firms in China not only suffer from higher borrowing cost comparing to state owned firms (e.g. Allen, Qian and Qian, 2005), but are also more likely to be required for collateral. Collateral requirement constitutes another obstacle for the access to finance for private firms in China. The significantly negative coefficient of *Privatedevelopment* further confirms this conclusion. One standard deviation increase of *Privatedevelopment* from its sample mean increases the likelihood of collateral by 15.5%. To explain these results, we argue that the implicit guarantee from the government constitutes a substitution of collateral for state owned firms, because the implicit guarantee reduces loan loss in

time of default, and moderates adverse selection and moral hazard problems. Private firms do not enjoy these privileges, therefore are more likely to be required collateral.

Next we investigate whether private firms pledge more collateral to signal their credit quality or because they are considered riskier. In the particular setting of Chinese market, private firms are traditionally considered to be more obscure than state owned firms. Therefore, if signal role of collateral is relevant, it should be more relevant for private firms. On the other hand, observed-risk hypothesis suggests that banks may consider private firms to be riskier and more prone to moral hazard problem, which could also contribute to higher likelihood of collateral. We test these competing hypotheses by introducing the interaction term of *Ownership* and various credit quality variables (*Age*, *Size*, *Liquidity*, *Z-score*, *ROA*, and *Tangibility*). If the signal hypothesis is true, private firms with good credit quality are more likely to pledge collateral, while the observed-risk hypothesis predicts otherwise.

Results are reported in Table IV, Column II. For comparison purpose, Column VII of Table III is reproduced as Column I in Table IV. For private firms, the coefficients of *Liquidity*, *Z-score*, and *Tangibility* are with signs consistent with the observed-risk hypothesis, but not statistically significant. Large, old, and less leveraged private firms are still less likely to pledge collateral, confirming the observed-risk hypothesis. The interaction terms are almost all significant and with expected signs. The interesting observation is that the interaction term of *FT*Age* is significantly positive. The magnitude of coefficients suggest being older for state owned firms also decrease incidence of collateral, but its effect is less pronounced compare to private firms. One standard deviation increase in *Age* reduces the incidence of collateral by 2.6% for state owned firms, while for private firms it reduces by 5.1%. This result suggests *Age* as a risk factor carries less clear information for state owned firms. Stated owned firms can survive for longer either because of state protection or good quality (or both), while for private firms, surviving longer sends a strong signal of good quality for banks. Larger firm *Size* reduces incidence of collateral for both type of firms, and it reduces more for state owned firms. This might be result of *"Too big to fail"* for state owned firms, while no such guarantee is provided by state for private large firms.

Table IV: Collateral and Firm Ownership

	I		II	
VARIABLES	coefficients	z-value	coefficients	z-value
ACR4	2.279***	(0.822)	2.082**	(0.831)
IPO	-0.391***	(0.073)	-0.356***	(0.076)
FT	-0.608***	(0.047)	0.393	(0.655)
liquidity	-0.384**	(0.156)	-0.020	(0.186)
z-score	-0.009	(0.006)	-0.002	(0.007)
size	-0.204***	(0.028)	-0.148***	(0.036)

leverage	0.860***	(0.140)	0.755***	(0.186)
roa	-1.068***	(0.279)	-0.152	(0.367)
age	-0.416***	(0.057)	-0.477***	(0.070)
tangibility	-0.798***	(0.179)	-0.174	(0.248)
loanconcen	2.064***	(0.446)	2.132***	(0.457)
maturity	0.166***	(0.027)	0.158***	(0.027)
spread	0.040**	(0.017)	0.040**	(0.017)
loansize	-0.088***	(0.021)	-0.091***	(0.021)
privatedevelopment	0.284***	(0.046)	0.274***	(0.047)
legal	0.029***	(0.009)	0.029***	(0.009)
marketization	-0.394***	(0.082)	-0.417***	(0.083)
rrr	0.719	(2.905)	-0.202	(2.929)
repo	0.048*	(0.027)	0.051*	(0.027)
cpi	1.859	(1.519)	1.886	(1.527)
nplratio	0.494	(1.177)	1.236	(1.195)
realgdpindex	1.283	(1.457)	1.369	(1.468)
FT*liquidity			-1.235***	(0.313)
FT*z-score			-0.038***	(0.012)
FT*size			-0.121***	(0.041)
FT*leverage			0.073	(0.266)
FT*roa			-3.037***	(0.642)
FT*age			0.250**	(0.111)
FT*tangibility			-1.449***	(0.355)
Constant	-0.446	(1.968)	-0.439	(1.994)
Observations	8,741		8,741	
Industry FE	Yes		Yes	
Province FE	Yes		Yes	
Bank Type FE	Yes		Yes	
Time FE	Yes		Yes	
Pseudo R2	0.289		0.295	

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

5.2.3. Relationship Lending

In Table V, from Column II to Column IV, we introduce relationship variables, starting with *Size Concentration* (*Sizeconcen*) and then introducing *Number of Lender* (*Numlender*), *Scope* and *Switch* progressively. Comparing to Column I, Incorporating relationship variables hardly affects the coefficients of other control variables. The marginal effects of relationship variables are calculated based on Column V. *Sizeconcen* is significantly positive across all specifications, confirming hypothesis *H.3* that a firm that relies more on its lender is more likely to pledge collateral, because relationship banks can extract informational rent. This result is in line with hold-up theory (e.g. Sharp, 1990; Rajan, 1992) and in contrast to the view that relationship lending and collateral are substitutes in mitigating borrower risks (e.g. Bergr and Udell, 1995; Jimenez et al. 2006). Similar findings to ours have been

reported in, e.g., Elsas and Krahnen, (2000); Lehmann and Neuberger (2001); Degryse and Van Cayseele, (2000). One standard deviation increase in *Sizeconcen* increases the incidence of collateral by 1.5%.

The coefficient of *Numlender* is significantly positive. One standard deviation increase of number of lenders from its mean increases the incidence of collateral by 2.2%. Firms that does not exclusively deal with one bank does not provide exclusive proprietary information, therefore information obtained from these firms are diluted. Therefore, it is expected that firms have multiple bank relationships are more likely to pledge collateral because of higher level of bank-firm information asymmetry associated with more lenders. This result is in line with Harkoff and Korting (1998), Chakraborty and Hu (2006) and Jimemez et al. (2006), but in contrast to, e.g., Menkhoff et al., (2006), Voordeckers and Steijvers (2006), Machauer and Weber, (1998). Having multiple bank relationship does not improve the bargaining power of firms, at least in terms of reducing collateral.

Scope is significantly positive. One standard deviation increase of *Scope* from it mean increases the incidence of collateral by 1.3%. This result implies repeated borrowing from the same lender increases the incidence of collateral. This finding is also in line with hold-up theory: incumbent banks accumulate informational advantage over outside banks through repeated lending, therefore can exploit their market power through collateralization. Another possibility is that collateral can *cause* hold-up (Menkhoff etal., 2006). *Switch* however is not statistically significant. We'll discuss this variable in detail later.

Table V: Collateral and Relationship Lending

	I	II	III	IV	V
ACR4	2.279***	2.283***	2.337***	2.227***	2.230***
	(0.822)	(0.823)	(0.823)	(0.825)	(0.825)
IPO	-0.391***	-0.388***	-0.379***	-0.387***	-0.387***
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)
FT	-0.608***	-0.610***	-0.598***	-0.592***	-0.592***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
liquidity	-0.384**	-0.415***	-0.429***	-0.416***	-0.415***
	(0.156)	(0.157)	(0.157)	(0.157)	(0.157)
z-score	-0.009	-0.008	-0.008	-0.008	-0.008
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
size	-0.204***	-0.201***	-0.209***	-0.219***	-0.219***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
leverage	0.860***	0.869***	0.833***	0.835***	0.833***
	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)
roa	-1.068***	-1.068***	-1.028***	-1.000***	-0.999***
	(0.279)	(0.280)	(0.279)	(0.280)	(0.280)
age	-0.416***	-0.422***	-0.413***	-0.416***	-0.416***

	(0.057)	(0.058)	(0.058)	(0.058)	(0.058)
tangibility	-0.798***	-0.802***	-0.845***	-0.845***	-0.846***
	(0.179)	(0.179)	(0.180)	(0.180)	(0.180)
loanconcen	2.064***	1.996***	1.993***	1.984***	1.984***
	(0.446)	(0.446)	(0.448)	(0.449)	(0.449)
maturity	0.166***	0.159***	0.172***	0.180***	0.179***
	(0.027)	(0.027)	(0.028)	(0.028)	(0.028)
spread	0.040**	0.042**	0.034**	0.036**	0.036**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
loansize	-0.088***	-0.090***	-0.099***	-0.092***	-0.092***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
privatedevelopment	0.284***	0.282***	0.286***	0.293***	0.293***
	(0.046)	(0.046)	(0.046)	(0.047)	(0.047)
legal	0.029***	0.029***	0.030***	0.030***	0.030***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
marketization	-0.394***	-0.392***	-0.396***	-0.397***	-0.397***
	(0.082)	(0.083)	(0.083)	(0.083)	(0.083)
sizeconcen		0.097*	0.229***	0.174**	0.170**
		(0.056)	(0.065)	(0.068)	(0.069)
numlender			0.031***	0.025***	0.025***
			(0.008)	(0.008)	(0.008)
scope				0.007***	0.007**
				(0.003)	(0.003)
switch					-0.012
					(0.036)
rrr	0.719	1.060	0.726	0.341	0.299
	(2.905)	(2.912)	(2.916)	(2.924)	(2.926)
repo	0.048*	0.048*	0.046*	0.047*	0.047*
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
cpi	1.859	1.888	1.778	1.825	1.838
	(1.519)	(1.518)	(1.520)	(1.521)	(1.522)
nplratio	0.494	0.464	0.400	0.442	0.433
	(1.177)	(1.177)	(1.178)	(1.180)	(1.180)
realgdpindex	1.283	1.354	1.373	1.362	1.365
	(1.457)	(1.457)	(1.458)	(1.460)	(1.460)
Constant	-0.446	-0.581	-0.560	-0.500	-0.499
	(1.968)	(1.969)	(1.971)	(1.972)	(1.972)
Observations	8,741	8,741	8,741	8,741	8,741
Industry FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Bank Type FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.289	0.289	0.291	0.291	0.291

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

5.2.4. Bank Market Structure

Throughout all specifications from Table III to Table V, the impact of *ACR4* on incidence of collateral is quite robust, as the coefficients of *ACR4* are all significantly positive and vary only marginally. This result confirms hypothesis *H.1* that concentrated market structure allows for more likelihood of collateralization. We calculate the marginal effect of *ACR4* based on Column V of Table V. One standard deviation increase of *ACR4* from its sample mean increases the incidence of collateral by 3.7%. This result is in line with the empirical findings of Hainz et.al., (2003), but in contrast to Jimenez et al. (2006).

5.2.5. Information, Market Structure and Relationship Lending

Our discussion in Section 2 suggests both market structure and relationship lending generate information asymmetry among banks, and through this channel, both factors can influence incidence of collateral. In this section, we further test if their impacts on collateral can be moderated in environment where information asymmetry among banks is not severe, i.e. we compare the impact of *ACR4* and *Sizeconcen* on collateral before and after IPO.

To test these hypotheses, we introduce interaction term of *IPO*ACR4* and *IPO*Sizeconcen*. If hypotheses *H.2* and *H.4* are true, the coefficients of those interaction terms should be negative. Results are reported in Table VII, and Chart 2.

Column I reports result with interaction term of *ACR4*IPO*. The interaction term is significantly negative, and the coefficient of *ACR4* is significantly positive. This result shows the impact of market concentration on collateral is still positive, but is moderated after IPO. Before IPO, one standard deviation increasing in concentration increases probability of collateral by 7.5%, while after IPO, its effect reduced to 3.1%. This is because IPO levels information distribution among banks, therefore the same amount increase in concentration generates less information asymmetry after IPO, hence lower banks' ability to charge informational rent through collateralization. This result confirms our prediction that market structure has less impact on the incidence of collateral in environment where information among banks is relatively symmetrically distributed. Market structure still has some level of impact on collateral after IPO. Two explanations are worth mentioning: firstly, IPO does not eliminate information asymmetry among banks, but merely moderate its level. Therefore the argument that market concentration increases collateral through information asymmetry among banks is still at force, but its impact is reduced after IPO. Secondly, the information asymmetry generate by market concentration is not the only channel that can increase incidence of collateral. The *Market Power Channel* dictates monopolistic or oligopolistic banks can extract rents by increasing collateral requirement even in environment without information asymmetry among banks. It's very likely that both of those two explanations are valid.

Next we investigate the impact of IPO on the incidence of collateral. The difference in probabilities of pledging collateral after and before IPO is 1.562-3.465**ACR4*. A negative value indicates the likelihood of pledging collateral decreases after IPO. Chart 2 left panel shows the difference in probability of collateral after and before IPO for concentration spectrum. The negative values (points to the left of the red line are insignificantly different from zero, corresponding to ACR4<0.50) indicate the probability of collateral is lower for post-IPO. The downward sloping means that this difference gets larger when market becomes concentrated. This is because information asymmetry among banks is more severe in concentrated market, therefore the informational equalization effect of IPO becomes more significant in such market. In relatively competitive market where information asymmetry among banks are not very severe, the information redistribution role of IPO is not significantly important, therefore the probability difference is insignificantly different from zero after and before IPO.

In Column II, we investigate if the hold-up effect of relationship lending is moderated by IPO. The interaction term of *Sizeconcen*IPO* are significantly negative, while the coefficient of *Sizeconcn* is significantly positive. The overall effect of *Sizeconcen* on collateral is positive, but the magnitude is significantly less after IPO. Before IPO, one standard deviation increase in *Sizeconcen* increases incidence of collateral by 3.3%, while its impact is moderated to 1.3% after IPO. This is because after IPO, the information asymmetry among banks is greatly reduced, making hold-up through relationship lending more difficult. In other words, it requires more increase in relationship intensity to generate the same amount of information asymmetry after IPO. This result confirms our prediction that hold-up through relationship lending is less likely if all banks are relatively symmetrically informed.

The negative impact of IPO on the incidence of collateral is increasing in relationship intensity, as the marginal impact of IPO is *-0.233-0.279*sizeconcen*. Chart 2 right panel shows the difference in probability of collateral after and before IPO for *Sizeconcen* spectrum. The negative value indicates the probability of collateral is lower for post-IPO relative to pre-IPO. This difference gets wider along with higher *Sizeconcen*, which suggests that IPO reduces incidence of collateral more for relationship borrowers. This is because information asymmetry among banks is more severe over relationship borrowers, therefore the informational equalization effect of IPO are stronger over those borrowers.

When both interaction terms are introduced in Column III, the coefficients only change marginally. To conclude, the positive impacts of both market structure and relationship lending on collateral are moderated after IPO. The higher the information asymmetry among banks before IPO (caused by either highly concentrated market structure or high relationship intensity), the more reduction in the probability of pledging collateral after IPO.

In Column IV, we add the interaction term of *ACR4*Sizeconcen*, which turns out to be significantly negative. This finding suggests market structure and relationship lending are substitutes in generating information asymmetry among banks and therefore market power of banks. The marginal impact of market structure now depends on whether the loan is issued before or after IPO, and the relationship intensity between the borrower and lender, namely, *dy/dACR4=6.952-3.979*IPO-2.267*Sizeconcen*. The negative coefficient of *ACR4*Sizeconcen* and positive coefficient of *ACR4* suggest increasing concentration increases incidence of collateral, but its effect is less significant for relationship borrower. Both *Market Power Channel* and *Information Channel* can explain this result. If increasing concentration increases market power of lenders to demand more collateral, this extra market power should be more relevant for non-relationship borrowers because relationship borrowers are already locked-in. If increasing concentration increases banks ability to obtain more informational advantage, this increasing ability should also affect more the non-relationship borrowers, because banks already enjoy information monopoly over relationship borrowers. In other words, the extra investment in information generates more benefit for banks if it is invested in relatively unknown borrowers.

The marginal impact of *Sizeconcen* depends also on market structure and IPO, namely, *dy/dSizeconcen=1.736-0.345*IPO-2.267*ACR4*. This result shows increasing reliance on relationship lender generates hold-up problem, but this hold-up effect is moderated by market concentration. In concentrated market, a marginal increase in relationship intensity generates less information asymmetry among banks, because information asymmetry among banks is already high. On the contrary, if the market is competitive, a marginal increase in relationship intensity gives incumbent lender significantly more informational advantage over competitors, therefore, the likelihood to hold-up firm through collateralization increases by more in such market.

Next we investigate the magnitude of the marginal effects of *ACR4* and *Sizeconcen*. Before IPO, the marginal impact of *ACR4* is always significantly positive regardless of relationship intensity, while after IPO, it is significantly positive if *Sizeconcen*<0.7, (70 percentile). This can be seen graphically in Chart 3 left panel, where observations below the red line are statistically indifferent from zero. This result suggests the positive impact of market concentration is bounded by high relationship intensity after IPO. Similarly the impact of relationship lending is bounded by market concentration. In Chart 2 right panel, before IPO, the marginal impact of *Sizeconcen* is significantly positive if *ACR4*<0.65 (90 percentile, points to the left of the blue line) and becomes insignificant afterwards. After IPO, the marginal impact of *Sizeconcen* is significantly positive if *ACR4*<0.57 (67 percentile, points to the left of the red line). These boundary effects reflect the substitution role of market structure and relationship lending. If market structure generates enough informational monopoly, the importance of relationship lending in generating additional informational monopoly becomes less significant, hence its impact on incidence of

collateral becomes insignificant. The reverse is also true. This boundary effect is similar to Boot and Thakor (2000) and Bharath et al., (2011) who find the benefit of relationship lending (lowering lending rates) is bounded by information opacity of firms (e.g. size).

Column V investigates if the impact of switching lender on collateral differs before and after IPO. *Switch* is significantly positive and its interaction term with *IPO* is significantly negative, suggesting switching banks increases (decreases) the incidence of collateral before IPO (after IPO). This result further supports the informational equalization role of IPO. Whether switching banks reduces incidence of collateral crucially depends on how informed the outside banks are about the borrower. Before IPO, because outside banks know little about the firm, switching to another bank may not reduce incidence of collateral. In fact it increases the incidence of collateral because switching carry a stigma since outside bank may consider switching are result of loan rejection from incumbent bank. This pattern reverses post-IPO because of the informational equalization effect of IPO.

Table VI: Collateral before and after IPO. Full Sample Results

	I	II	III	IV	V
ACR4	5.296***	2.292***	5.530***	6.952***	7.088***
	(1.202)	(0.826)	(1.214)	(1.312)	(1.318)
ACR4*IPO	-3.465***		-3.642***	-3.979***	-3.998***
	(0.985)		(0.997)	(1.003)	(1.009)
sizeconcen*IPO		-0.279*	-0.325**	-0.345**	-0.486***
		(0.160)	(0.161)	(0.161)	(0.168)
ACR4*sizeconcen				-2.267***	-2.343***
				(0.786)	(0.787)
switch*IPO					-0.360***
					(0.116)
IPO	1.562***	-0.233**	1.840***	2.043***	2.305***
	(0.557)	(0.114)	(0.578)	(0.580)	(0.590)
FT	-0.596***	-0.592***	-0.596***	-0.585***	-0.588***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
liquidity	-0.394**	-0.428***	-0.409***	-0.384**	-0.406**
	(0.157)	(0.157)	(0.157)	(0.158)	(0.158)
z-score	-0.008	-0.007	-0.007	-0.007	-0.007
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
size	-0.219***	-0.218***	-0.219***	-0.218***	-0.219***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
leverage	0.841***	0.838***	0.848***	0.843***	0.852***
	(0.141)	(0.141)	(0.141)	(0.141)	(0.141)
roa	-0.979***	-1.026***	-1.011***	-1.033***	-1.047***
	(0.283)	(0.279)	(0.282)	(0.283)	(0.283)
age	-0.419***	-0.413***	-0.417***	-0.421***	-0.423***

	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)
tangibility	-0.849***	-0.854***	-0.860***	-0.867***	-0.888***
	(0.180)	(0.180)	(0.180)	(0.180)	(0.180)
loanconcen	1.982***	1.964***	1.956***	1.951***	1.901***
	(0.449)	(0.448)	(0.448)	(0.448)	(0.448)
maturity	0.178***	0.179***	0.177***	0.179***	0.182***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
spread	0.035**	0.036**	0.036**	0.038**	0.038**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
loansize	-0.093***	-0.091***	-0.093***	-0.094***	-0.094***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
privatedevelopment	0.297***	0.291***	0.295***	0.301***	0.302***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
legal	0.031***	0.030***	0.030***	0.030***	0.030***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
marketization	-0.400***	-0.395***	-0.398***	-0.407***	-0.411***
	(0.083)	(0.083)	(0.083)	(0.083)	(0.083)
sizeconcen	0.178**	0.413***	0.463***	1.736***	1.906***
	(0.069)	(0.156)	(0.157)	(0.469)	(0.473)
numlender	0.026***	0.025***	0.026***	0.027***	0.028***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
scope	0.007**	0.007**	0.007***	0.007**	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
switch	-0.011	-0.013	-0.012	-0.012	0.313***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.111)
rrr	0.463	0.174	0.320	0.085	0.113
	(2.927)	(2.929)	(2.930)	(2.931)	(2.935)
repo	0.045*	0.047*	0.046*	0.050*	0.048*
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
cpi	1.874	1.900	1.942	1.914	1.970
	(1.523)	(1.523)	(1.524)	(1.526)	(1.527)
nplratio	0.418	0.397	0.375	0.406	0.422
	(1.179)	(1.181)	(1.180)	(1.184)	(1.185)
realgdpindex	1.340	1.435	1.419	1.251	1.279
	(1.461)	(1.461)	(1.462)	(1.465)	(1.466)
Constant	-2.315	-0.763	-2.710	-3.399	-3.744*
	(2.039)	(1.980)	(2.052)	(2.067)	(2.074)
Observations	8,741	8,741	8,741	8,741	8,741
Industry FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Bank Type FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.292	0.291	0.293	0.293	0.294

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

6. Robustness Test

In this section, we examine the robustness of our results with respect to different specifications, different sample, and alternative measures of relationship lending.

6.1. Endogeneity of Loan Contract Terms

Melnik and Plaut (1986) model bank loans as package of *N* contract terms that cannot be split and traded separately. Bank then offer an *N-dimensional* array of bundles from which to choose their contracts, and borrowers trade off contract terms in determining their optimal choice. This approach indicates that price, loan size, maturity and collateral maybe interrelated and endogenous. The endogenerity issue of loan contract terms has been discussed intensively in the context of collateral determination. (e.g. Barclay et al. 2003; Berger et al. 2005; Dennis et al. 2000; Ortiz-Molina and Penas 2008). To tackle this issue, simultaneous equation estimation is applied in previous literature[4]. We instead follow Berger and Udell (1995) re-estimate the specifications of Table VI without the potentially endogenous contract terms (*Maturity*, *Spread* and *Loan Size*) to determine whether any serious bias is present. Results are reported in Table VII. Excluding those loan contract terms hardly affect any of the previous results, except that *Repo* becomes insignificant in some specifications. This result indicates the potential endogeneity problem of loan contract terms does not affect our main conclusion. We exclude those loan contract terms variables in the following regressions.

Table VII: Regression Excluding Loan Contract Terms

	I	II	III	IV	V
ACR4	5.100***	2.120**	5.346***	6.664***	6.781***
	(1.197)	(0.824)	(1.209)	(1.305)	(1.311)
ACR4*IPO	-3.448***		-3.635***	-3.962***	-3.971***
	(0.981)		(0.992)	(0.999)	(1.005)
sizeconcen*IPO		-0.294*	-0.341**	-0.359**	-0.491***
		(0.159)	(0.160)	(0.160)	(0.167)
ACR4*sizeconcen				-2.099***	-2.169***
				(0.782)	(0.783)
switch*IPO					-0.340***
					(0.116)
IPO	1.560***	-0.217*	1.852***	2.048***	2.292***
	(0.555)	(0.113)	(0.575)	(0.578)	(0.588)
FT	-0.574***	-0.570***	-0.574***	-0.565***	-0.568***
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
liquidity	-0.469***	-0.504***	-0.484***	-0.461***	-0.482***
	(0.155)	(0.155)	(0.155)	(0.155)	(0.156)

[4] See for instance Dennis et al., (2000), Dennis and Sharpe, (2005), and Brick et al., (2007).

z-score	-0.003	-0.003	-0.003	-0.003	-0.002
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
size	-0.267***	-0.264***	-0.266***	-0.267***	-0.267***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
leverage	0.895***	0.894***	0.901***	0.896***	0.907***
	(0.138)	(0.138)	(0.139)	(0.139)	(0.139)
roa	-0.965***	-1.013***	-1.000***	-1.021***	-1.032***
	(0.284)	(0.280)	(0.283)	(0.284)	(0.284)
age	-0.437***	-0.431***	-0.435***	-0.439***	-0.441***
	(0.057)	(0.058)	(0.058)	(0.058)	(0.058)
tangibility	-0.872***	-0.879***	-0.882***	-0.888***	-0.908***
	(0.178)	(0.179)	(0.178)	(0.179)	(0.179)
loanconcen	1.075***	1.087***	1.059***	1.047***	1.012***
	(0.325)	(0.325)	(0.324)	(0.324)	(0.324)
privatedevelopment	0.297***	0.292***	0.295***	0.301***	0.301***
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
legal	0.031***	0.030***	0.031***	0.030***	0.031***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
marketization	-0.406***	-0.400***	-0.403***	-0.412***	-0.415***
	(0.083)	(0.082)	(0.083)	(0.083)	(0.083)
sizeconcen	0.166**	0.415***	0.464***	1.642***	1.801***
	(0.068)	(0.154)	(0.156)	(0.466)	(0.470)
numlender	0.017**	0.016**	0.016**	0.018**	0.019**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
scope	0.006**	0.006**	0.007**	0.006**	0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
switch	-0.049	-0.051	-0.050	-0.050	0.257**
	(0.036)	(0.036)	(0.036)	(0.036)	(0.111)
rrr	0.327	0.034	0.181	-0.047	-0.036
	(2.905)	(2.907)	(2.907)	(2.909)	(2.912)
repo	0.043	0.046*	0.044	0.047*	0.046*
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
cpi	2.410	2.444	2.481	2.452	2.514*
	(1.513)	(1.512)	(1.514)	(1.515)	(1.516)
nplratio	0.473	0.452	0.428	0.447	0.454
	(1.171)	(1.173)	(1.172)	(1.176)	(1.177)
realgdpindex	1.579	1.686	1.663	1.504	1.537
	(1.452)	(1.452)	(1.453)	(1.456)	(1.457)
Constant	-1.873	-0.368	-2.289	-2.904	-3.228
	(2.028)	(1.971)	(2.041)	(2.055)	(2.061)
Observations	8,753	8,753	8,753	8,753	8,753
Industry FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Bank Type FE	Yes	Yes	Yes	Yes	Yes

Time FE	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.287	0.286	0.287	0.288	0.288

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

6.2. Sample Selection

Next we estimate on a sample that includes firms that borrowed at least one loan before IPO and at least one loan after IPO. This selection procedure reduces the whole sample sharply, leaving 111 firms and 2181 loans remain. The analysis of Table VI is re-estimated and results are reported in Table VIII. Across all specifications, the coefficients of key variables, i.e. *ACR4*, *ACR4*IPO*, *Sizeconcen*, and *Sizeconcen*IPO*, have the same signs and similar magnitudes as in Table VI, except *Sizeconcen* appears insignificant in Column IV. The impact of market structure on collateral is significantly positive and the magnitude of impact declines after IPO, confirming previous results. The main difference with previously reported results is that when the interaction term of *ACR4*Sizeconcen* is introduced in Column IV and Column V, it does not appear statistically significant. The insignificant coefficient of *ACR4*Sizeconcen* may cast doubt on the substitution role of market structure and relationship lending. Unlike the full sample results in Table VI, *Switch* is significantly positive across all specifications. In particular, in Column V, switching lender increases the incidence of collateral before IPO while decreases it after IPO, in line with previous results.

Table VIII: Collateral before and after IPO, Subsample Regression

	I	II	III	IV	V
ACR4	10.480***	8.073***	10.657***	11.703***	12.750***
	(2.739)	(2.387)	(2.763)	(3.090)	(3.149)
ACR4*IPO	-5.046**		-4.891*	-5.189**	-5.353**
	(2.567)		(2.591)	(2.620)	(2.661)
sizeconcen*IPO		-0.651*	-0.622*	-0.672*	-1.194***
		(0.365)	(0.367)	(0.373)	(0.393)
ACR4*sizeconcen				-2.279	-2.301
				(3.003)	(3.030)
switch*IPO					-1.017***
					(0.216)
IPO	3.154**	0.510**	3.297**	3.490**	4.235***
	(1.481)	(0.236)	(1.496)	(1.516)	(1.549)
FT	-0.596**	-0.520**	-0.559**	-0.541**	-0.611**
	(0.252)	(0.254)	(0.255)	(0.256)	(0.257)
liquidity	-0.204	-0.509	-0.305	-0.283	-0.199
	(0.544)	(0.535)	(0.548)	(0.549)	(0.554)
z-score	-0.026	-0.022	-0.025	-0.026	-0.021
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
size	-0.294***	-0.298***	-0.298***	-0.297***	-0.297***
	(0.109)	(0.110)	(0.110)	(0.110)	(0.111)

leverage	-0.224	-0.265	-0.271	-0.270	-0.200
	(0.505)	(0.503)	(0.506)	(0.506)	(0.510)
roa	-1.363	-1.440	-1.348	-1.316	-1.727
	(1.027)	(1.026)	(1.032)	(1.034)	(1.058)
age	-1.000***	-1.018***	-1.019***	-1.041***	-1.058***
	(0.212)	(0.214)	(0.214)	(0.216)	(0.217)
tangibility	-0.499	-0.613	-0.569	-0.572	-0.650
	(0.712)	(0.711)	(0.716)	(0.716)	(0.725)
loanconcen	-0.845	-0.740	-0.710	-0.754	-0.824
	(0.922)	(0.926)	(0.929)	(0.936)	(0.948)
privatedevelopment	0.219	0.298	0.213	0.209	0.218
	(0.223)	(0.217)	(0.225)	(0.225)	(0.228)
legal	0.016	0.031	0.020	0.020	0.023
	(0.051)	(0.051)	(0.051)	(0.051)	(0.052)
marketization	-0.247	-0.336	-0.232	-0.230	-0.248
	(0.399)	(0.396)	(0.402)	(0.402)	(0.404)
sizeconcen	1.072***	1.410***	1.357***	2.649	2.942*
	(0.252)	(0.305)	(0.307)	(1.732)	(1.749)
numlender	0.098***	0.088***	0.089***	0.089***	0.102***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.031)
switch	0.209**	0.194**	0.189**	0.192**	0.927***
	(0.096)	(0.096)	(0.096)	(0.097)	(0.186)
scope	0.024***	0.028***	0.029***	0.030***	0.029***
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
rrr	10.247	12.041	10.497	10.526	10.881
	(8.944)	(8.942)	(8.972)	(8.958)	(9.017)
repo	-0.085	-0.080	-0.084	-0.084	-0.094
	(0.067)	(0.067)	(0.067)	(0.067)	(0.068)
cpi	-0.447	-1.769	-0.742	-0.840	1.234
	(4.867)	(4.837)	(4.892)	(4.892)	(4.951)
nplratio	12.319	13.222*	11.952	11.744	8.659
	(8.043)	(8.028)	(8.167)	(8.156)	(7.988)
realgdpindex	7.745	6.577	7.915	7.916	9.185*
	(4.872)	(4.831)	(4.883)	(4.884)	(4.923)
Constant	-8.399	-5.862	-9.112	-8.850	-12.565
	(175.424)	(173.966)	(832.606)	(173.998)	(163.659)
Observations	1,663	1,663	1,663	1,663	1,663
Industry FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Bank Type FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Pseudo R2	0.412	0.412	0.414	0.414	0.425

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

6.3. Alternative Relationship Measure

We further test if our results hold when alternative relationship measure is applied. This alternative relationship intensity measure is *Numconcen*, defined as the number of loans that a firm has borrowed from its current lender as a proportion of the total number of loans the firm has drawn to date. The implicit assumption of this indicator is that lender gathers more information about the borrower with each loan, while the amount of loan is irrelevant for information accumulation. From this perspective, *Sizeconcen* may be a better measure of relationship intensity because it is expected that lender devote more resources to gather information for larger loans. Column I and II of Table IX report results for whole sample and subsample, respectively. The general conclusion of previous section does not change with this alternative relationship measure. *Numconcen* is positively significant in both whole sample and subsample. The interaction term of *Numconcen*IPO* is negative, but only statistically significant in the subsample regression. *ACR4* is positively significant and the interaction term with *IPO* is negatively significant, in line with previous results.

6.4. Firm Fixed Effect

In spite that we have controlled various firms' characteristics and introduced fixed effects from industry, province, bank type and time, we still could miss some variables in our regressions, which are not easy to be observed but could matter for collateral pledging such as firm's corporate governance structure or ability to negotiate with lenders. The correlation of unobserved firm characteristics with lender's ability to extract informational rent can cause inconsistent estimation. This potential endogeneity problem can be controlled by fixed effect regression. Therefore, in this section we introduce the firm dummies to test whether our findings can survive after controlling firm fixed effect.

By using the fixed effects specification, the identification comes from within firm variation, therefore the coefficients of ACR4 and Sizeconcen measures how a firm's probability of pledging collateral changes when the banking market structure that firm is facing changes, and when that firm's relationship intensity changes.[5] As Probit model is not equipped for fixed effect regression, we resort to Logit model. Column III of Table IX reports the result of whole sample, while Column IV reports the subsample results. Our key variables, namely ACR4, Sizeconcen and their interaction terms with IPO are consistent with pooled estimation results in Table VI, and it is robust to alternative samples.

Table IX: Alternative Measure and Fixed Effect Model

	I	II	III	IV
ACR4	5.339***	10.449***	25.454***	41.272***

[5] By introducing firm fixed effect, the measurement of relationship lending comes from with-in variations inside the same firm, which helps us to mitigate measurement errors across firms because what really matters now in the regressions is variations across loans within a firm, instead of the variations across firms.

	(1.211)	(2.770)	(5.566)	(9.564)
ACR4*IPO	-3.454***	-5.445**	-18.555***	-24.127***
	(0.993)	(2.556)	(5.400)	(7.784)
numconcen	0.324*	0.820**		
	(0.180)	(0.356)		
numconcen*IPO	-0.185	-0.697*		
	(0.184)	(0.418)		
sizeconcen			1.741***	3.775***
			(0.501)	(0.852)
sizeconcen*IPO			-1.480***	-1.656*
			(0.517)	(0.996)
switch	0.268**	0.887***	0.694**	1.487***
	(0.114)	(0.189)	(0.280)	(0.427)
switch*IPO	-0.309***	-0.950***	-0.801***	-1.189**
	(0.119)	(0.220)	(0.291)	(0.479)
IPO	1.810***	4.044***	10.837***	13.748***
	(0.587)	(1.491)	(3.096)	(4.424)
numlender	0.026***	0.092***	0.025	0.152
	(0.008)	(0.031)	(0.030)	(0.113)
scope	0.007**	0.037***	0.005	0.072**
	(0.003)	(0.011)	(0.007)	(0.029)
Constant	-2.563	-9.046		
	(2.055)	(189.073)		
Observations	8,741	1,661	5,856	1,281
Industry FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Bank Type FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Firm Characteristics	Yes	Yes	Yes	Yes
Regional and Macroeconomic Variables	Yes	Yes	Yes	Yes
Legal and Institutional Variables	Yes	Yes	Yes	Yes
Pseudo R2	0.293	0.421	0.377	0.377
Number of Firms			291	67

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

7. Conclusion

Unlike previous literature that investigates if informational monopoly created by relationship lending allows banks to charge informational rent by demanding higher lending rates, we focus on the informational rent in terms of collateral. Moreover, we investigate if concentrated market structure allows banks to consolidate information of borrowers and explore this informational advantage to charge collateral. We test this hypothesis using IPO as identification strategy, an exogenous event that redistributes information of borrowers among lenders.

Using a unique hand-collected loan data of listed firms, our results confirm that higher incidence of collateral occurs in concentrated market and for relationship borrowers due to informational advantage created by those factors. Once IPO erodes this informational monopoly position, the impact of market structure and relationship lending on collateral are moderated. This result is robust to alternative model specification, sample selection and fixed effect estimation.

The role of collateral in emerging market has not been studies expensively. Our paper contributes to the existing literature on the determinants of collateral in the context of Chinese banking market, one of the largest banking markets of developing countries. Our findings confirm that riskier firms are associated with more likelihood of collateral, in line with observed-risks hypothesis of e.g. Boot and Thakor, (1994). We also provide strong evidence that private firms in China face financial obstacle in terms of collateral requirement, supporting other empirical literature that finds financial discrimination against private firms in terms of higher borrowing costs.

Table I: Summary Statistics and Variable Definition

Variable	Definition	N	Mean	Std. Dev.	Min	Max
Panel A: Market Structure						
ACR4	The market share of the top 4 banks in the region, in terms of assets.	9288	0.55	0.06	0.35	0.97
Panel B: Firm Characteristics						
Size	Natural log of Total Assets measured in millions of RMB deflated to year 2006 value	8779	7.67	1.16	4.01	12.72
Leverage	Outstanding Debt/Total Assets	8779	0.56	0.19	0.02	2.37
ROA	Return on Assets	8779	0.06	0.07	-0.44	1.71
Age	Natural log of firm age. Age is the difference in month between firm establishment date and loan initiating date.	9288	5.03	0.40	2.77	6.62
Tangibility	(Net property, plant and equipment)/Total Assets	8779	0.27	0.19	0.00	0.92
FT	=1 if majority stake is owned by State	9288	0.40	0.49	0	1
Liquidity	Current asset/Total Asset	8779	0.55	0.23	0.01	1
Z-score	Altman Z-score	8779	3.33	4.29	-4.16	79.62
Loanconcen	Loan concentration ratio. Defined as Loansize/(Loansize+Outstanding Debt)	8779	0.04	0.07	0.00	0.93
IPO	=1 if loan is issued after IPO	9288	0.83	0.37	0	1
Panel C: Loan Contract Terms						
Collateral	=1 if loan is secured by collateral	9288	0.66	0.47	0	1
Maturity	Natural log of loan maturity. Measured in month	9288	3.25	0.79	0.00	5.70
Spread	Difference between lending rate and benchmark deposit rate of corresponding maturity. Measured in percentage.	9288	2.85	1.21	0.71	13.60
Loansize	Natural log of loan size. Measured in millions of RMB deflated to year 2006 value	9288	3.13	1.41	-3.70	8.97
Panel D: Relationship Variables						
Numlender	Number of different lenders firm has borrowed from	9288	4.17	3.38	1	28
Sizeconcen	The amount of loans that a firm has borrowed from its current lender as a proportion of the total among of loans	9288	0.47	0.35	0	1
Numconcen	Number of loans that a firm has borrowed from its current lender as a proportion of the total number of loans	9288	0.48	0.33	0	1
Scope	Number of times firm has borrowed from lender	9288	5.85	7.05	1	60
Switch	=1 if the current loan is borrowed from the same lender as the previous loan, and 0 otherwise	9288	0.46	0.49	0	1

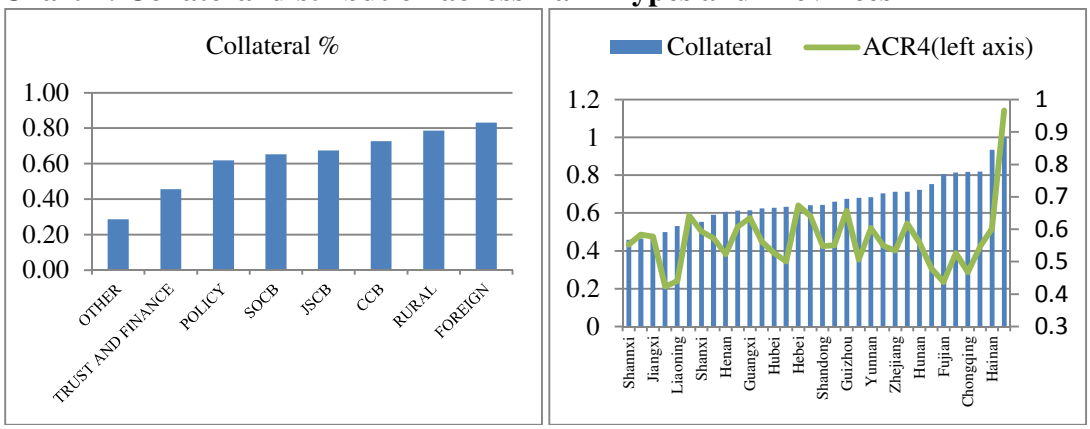
Panel E: Legal and Institutional Development Variables						
Legal	Legal environment index of Fan and Wang (2011)	9288	10.68	6.64	0.18	55.33
Marketization	Marketization Index of Fan and Wang (2011)	9288	8.71	2.01	0.38	13.24
Panel F: Monetary Policy and Regional Macroeconomic Variables						
Privatedevelopment	Private development index of Fan and Wang (2011)	9288	10.39	2.47	2.80	13.92
RRR	Reserve Requirement Ratio at the time the loan is issued.	9288	0.17	0.03	0.10	0.21
Repo	7 day repo rate at the time the loan is issued, in percentage.	9288	2.55	1.21	0.94	6.92
CPI	Provincial Consumer Price Index	9288	1.03	0.03	0.98	1.10
NPLratio	Provincial Non-Performance Loan Ratio	9288	0.03	0.03	0.00	0.21
Realgdpindex	Provincial real GDP growth rate	9288	0.09	0.03	0.01	0.18

Table II: Univariate Tests

	Panel A: IPO			Panel B: ACR4			Panel C: FT			Panel D: Sizeconcen		
	Pre-IPO	Post-IPO	Mean Diff	<Medium	>=Medium	Mean Diff	Private	State	Mean Diff	<Medium	>=Medium	Mean Diff
Collateral	0.86	0.62	0.24***	0.62	0.70	-0.08***	0.76	0.52	0.24***	0.64	0.68	-0.04***
Maturity	3.12	3.28	-0.16***	3.26	3.25	0.00	3.14	3.42	-0.28***	3.12	3.38	-0.26***
Spread	2.85	2.85	0.01	2.87	2.82	0.04*	2.98	2.65	0.33***	3.01	2.68	0.34***
ln(loansize)	2.32	3.30	-0.97***	3.17	3.10	0.08**	2.95	3.40	-0.45***	3.15	3.11	0.04
Sizeconcen	0.64	0.43	0.21***	0.43	0.50	-0.07***	0.49	0.44	0.05***	--	--	--
Numconcen	0.65	0.44	0.21***	0.44	0.51	-0.07***	0.49	0.45	0.05***	0.22	0.73	-0.51***
Numlender	2.52	4.51	-1.99***	4.63	3.72	0.91***	4.14	4.22	-0.07	6.03	2.32	3.70***
Scope	3.76	6.28	-2.52***	6.26	5.46	0.80***	5.81	5.91	-0.10	4.92	6.78	-1.85***
IPO	--	--	--	0.87	0.80	0.07***	0.75	0.95	-0.20***	0.90	0.77	0.13***
FT	0.11	0.46	-0.35***	0.42	0.39	0.03***	--	--	--	10.65	10.71	-0.06
ACR4	0.56	0.55	0.01***	--	--	--	0.55	0.55	0.00	0.55	0.56	-0.01***

*** p<0.01, ** p<0.05, * p<0.1

Chart 1: Collateral distribution across Bank Types and Provinces



Data Source: Wind Finance Co. Ltd., People's Bank of China, and authors own calculation. ACR4 is the concentration ratio of assets.

Chart 2: Marginal Effects of IPO

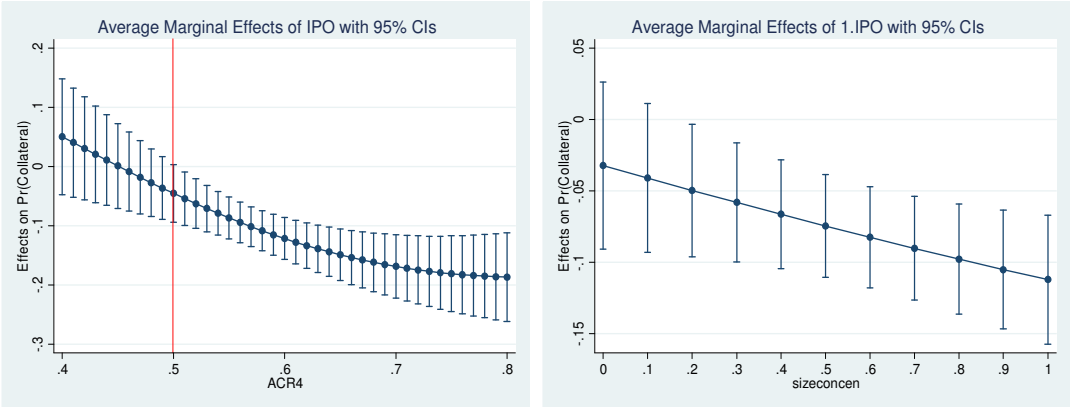
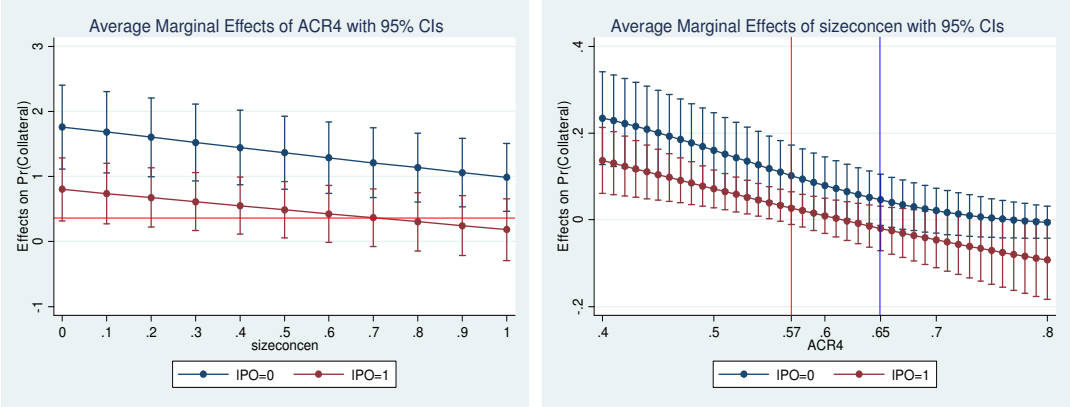


Chart 3: Marginal Effects of ACR4 and Sizeconcen



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