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Credit market development and firm innovation: Evidence from the People's Republic of China

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ADB Working Paper Series

**CREDIT MARKET DEVELOPMENT
AND FIRM INNOVATION: EVIDENCE
FROM THE PEOPLE'S REPUBLIC
OF CHINA**

Hua Shang,
Quanyun Song,
and Yu Wu

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Abstract

From the perspective of credit allocation, this paper analyzes the effects of credit market development on the innovative capacities of industrial firms in the People's Republic of China. Using a large dataset of industrial firms in 31 provinces in the People's Republic of China, we find that credit market development enhances firms' product innovation incentives and outcomes. We further show that firms' credit constraints and firms' performances are two channels through which credit market development affects innovative capacities of firms. Our results are neither driven by the increase in the quantity of credit, nor by the increase in the number of firms in a province. The results are robust to different samples, different estimation methods, and alternative measures of credit market development.

JEL Classification:G15; O31; R11

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1. INTRODUCTION

Innovation, as the engine of a firm's development, has been considered a major driving force of economic growth (Solow 1957). However, what drives innovation is still worth investigating. There is a growing literature exploring the factors affecting innovation from various perspectives. In this paper, we contribute to this literature by analyzing how the development of the credit market affects firms' product innovation through improved credit resource allocation.

As Levine (2005: 6) argues, "if finance is to explain economic growth, we need theories that describe how financial development influences resource allocation decisions in ways that foster productivity growth." If the financial intermediaries are active in researching firms, monitoring firms, and pooling risks, they are likely to allocate more credit to firms and projects that increase productivity growth. Knowing that financial intermediaries are allocating credit more effectively and efficiently, firms might be more willing to engage in projects that are risky but foster productivity growth. Therefore, credit market development, through improved credit allocation, is expected to enhance firms' product innovation incentives and outcomes.

Compared with financial depth, credit allocation might play a more important role in fostering firms' product innovation in the People's Republic of China (PRC). Financial depth can only represent the increase of the total credit to gross domestic product (GDP). However, it cannot reveal how the credit is allocated in a financial system. As argued by King and Levine (1993), a well-developed financial system should be able to allocate more credits to firms or projects that promote economic growth. A financial system that passively allocates credits only to non-state-owned enterprises (non-SOEs) is quite different from that allocating to private firms. The PRC financial system used to be inefficient and ineffective. The financial intermediaries lent most of their credit to state-owned enterprises (SOEs), which are known to be less efficient and less profitable (Guariglia and Poncet 2008). On the other hand, the non-SOEs, especially privately owned firms,¹ were discriminated by financial intermediaries due to their short credit history and low status in the socialist economy (Guariglia and Poncet 2008, Brandt and Li 2003). Even though the non-SOEs, on average, are much more efficient and profitable than SOEs, most of them are in shortage of credit for further development. If the credit allocation of the PRC financial intermediaries become more efficient and effective, it can reduce non-SOEs' cost of external fund on average and enable savers to invest in more risky but productive firms and projects (Rajan and Zingales 1998). Therefore, non-SOEs with better performances and/or more promising are expected to obtain more credit. It is likely to induce these firms, especially those with large credit constraints, to be concerned about their long-term growth and engage in innovative projects. On the other hand, the SOEs could also be forced to care about their performances in case they are not able to get enough credit.

We examine how credit market development, through improvement of credit allocation, affects firms' product innovation incentives and outcomes. Our data are obtained from the National Bureau of Statistics of China (NBS of China) from 2000 to 2007, based on annual surveys of industrial firms, including SOEs and non-SOEs, with sales of more than CNY5 million in each province. One advantage of the dataset is that it allows us to analyze the product innovation behavior of the non-listed firms, which make up more than 99% of the firms in this dataset. Since the non-listed firms account for a much larger part of the PRC economy, it is important to explore the factors affecting

¹ Privately owned firms are part of non-SOEs.

non-listed firms' product innovation incentives and outcomes. Further, unlike the listed firms, non-listed firms do not have access to capital market. Therefore, we do not need to include the local capital market development, which is difficult to measure correctly (Rajan and Zingales 1998). Another advantage of this dataset is that banks make commercial lending judgments, to a larger degree, for the manufacturing industry, as argued by Firth et al. (2009) using 2002 data.

One of the important problems in the financial market development-innovation literature is the endogeneity problem caused by omitted variables and the reverse causality of finance and innovation. The traditional way to investigate how financial market development affects innovation is to rely on cross-country-level or state-level (province) financial market development and innovation data. Therefore, the control variables can only include cross-country-level or state-level (province) variables. Following the most recent researches (i.e., Ayyagari, Demircuc-Kunt, and Maksimovic 2011; Amore, Schneider, and Zaldokas 2013; etc.), we minimize the omitted variable problem by using firm-level innovation data. Firm-level analysis allows us to control for many unobserved variables such as firm-, industry-, and province-level variables that might affect both credit market development and firm innovation. We then lag the credit market development for one period to minimize the reverse causality problem. In addition, we apply the instrumental variable method to solve the endogeneity problem.

Our results indicate that credit market development enhances firms' product innovation incentives and outcomes through improved credit allocation, which is consistent with the theories established by King and Levine (1993) and Morales (2003). We further demonstrate that there are two possible channels for this: first, relaxing firms' credit constraints is marginally more beneficial for credit-restrained firms than for other firms. Credit market development has more of an effect on the product innovation incentives and outcomes of credit-restrained firms, such as privately owned firms and small and medium-sized enterprises (SMEs), as opposed to other types of firms. Second, financial institutions are more willing to lend to firms with better performances in better developed credit markets. Therefore, credit market development affects the product innovation incentives and outcomes of firms with better performances more than those of firms with worse performances. In addition, we demonstrate that our results are driven by improvement of credit allocation rather than by an increase in the quantity of total credit or an increase in the number of non-SOEs in a province. Our results are also robust for different estimation methods, different samples, and alternative measures for credit market development.

Our paper is closely related to the literature on whether and how credit market development affects innovation. One part of the literature argues that credit market development mobilizes and provides appropriate financing to firms and projects, which promotes economic growth; and in a well-developed credit market, research, evaluation, and monitoring services are more effective and less expensive. Financial intermediaries may promote innovation by identifying those entrepreneurs with the best chances of successfully initiating new goods and production processes, and monitoring them to generate more innovation outputs (King and Levine 1993, Morales 2003, Levine 2005). The other part of the literature argues that credit market development discourages innovation. First, banks are conservative and dislike risky innovative projects (Weinstein and Yafeh 1998, Morck and Nakamura 1999). Second, banks prefer to use physical assets to secure loans, favoring firms that have large investments in plants and equipment, rather than those that have substantial research and development investments to generate intangible assets.

The most recent cross-country and within-country empirical analyses² also reach contradictory conclusions. For example, Ayyagari, Demirguc-Kunt, and Maksimovic (2011) find that bank financing enhances the innovation of SMEs in developing countries. Xiao and Zhao (2012) argue that credit market development enhances innovation in countries with lower government ownership of banks. Hsu, Tian, and Xu (2014) find that credit market development discourages innovation for more high-tech-intensive industries and industries that are more dependent on external finance. Benfratello, Schiantarelli, and Sembenelli (2008) argue that for firms in Italy, banking development accelerates the probability of process innovation, but this is less true for product innovation. Amore, Schneider, and Zaldokas (2013) find that for United States-listed firms from 1976 to 1995, credit market development enhanced the quantity and quality of innovation activities.

The contributions of this paper are the following: first, we provide within-country analysis to investigate how credit market development affects firms' product innovation incentives and outcomes. Compared with cross-country analysis, within-country analysis can avoid the problems caused by the incomparability of variables between countries. Second, our analysis can be distinguished from many within-country studies because we focus on the perspective of credit allocation. We show that firms' product innovation incentives and outcomes are promoted by credit allocation rather than the quantity of credit (financial depth) in the PRC. Third, compared with country-level and industry-level analyses, we provide a firm-level analysis, which allows us to control for many unobserved firm-, industry-, and province-level variables that might affect both firms' product innovation and credit market development. Firm-level analysis also helps us to minimize the endogeneity problem caused by omitted variables and make the results more trustworthy. Fourth, the non-listed firms make up more than 99% of our sample, which means that our research is much less affected by the development of the capital market. Our further analysis shows that even after we exclude all the listed firms, our results still hold. Fifth, as far as we know, this is the first paper investigating whether credit market development, through improvement of credit allocation, enhances PRC firms' product innovation incentives and outcomes. The PRC financial system is evolving toward a more well-developed system. It is important to understand whether the development improves PRC firms' innovative capacities.

The rest of the paper is organized as follows: in section 2, we provide institutional background; section 3 describes the data and provides summary statistics; section 4 presents the results; section 5 provides a robustness check; and section 6 concludes.

2. INSTITUTIONAL BACKGROUND

After several years of development, the PRC financial system is gradually becoming a more well-developed system wherein credit allocation is also becoming more efficient and effective.

² In the financial development and firm innovation literature, it is common to analyze how macro-level financial development affects micro-level firm innovation. For example, Ayyagari, Demirguc-Kunt, and Maksimovic (2011); Xiao and Zhao (2012); and Hsu, Tian, and Xu (2014) analyze how country-level financial development affects industry-level and firm-level innovation. Benfratello, Schiantarelli, and Sembenelli (2008) and Amore, Schneider, and Zaldokas (2013) analyze how state-level financial development affects firm innovation.

The PRC financial system originates from a monobank system, with the credit allocating to SOEs only. Since 1986, with the development of various types of financial institutions, the credit has been extended to more diversified customers. A bit more credit has been allocated to non-SOEs since 1997 (Lin 2011). It was when the PRC government pointed out that non-SOEs were important components of socialist market economy. However, the four state-owned banks with the largest market shares continue to lend to SOEs only (Guariglia and Poncet 2008) because the central and local governments issued lending quotas to firms which submitted investment plans. The non-SOEs are excluded from submitting investment plans. The banks discriminate against the non-SOEs due to their short credit history and low chances of being bailed out by the government (Guariglia and Poncet 2008, Brandt and Li 2003).

In 1998, the central bank, People's Bank of China, reformed the commercial banks' lending behavior, abolishing the loan-size restrictions on the four state-owned commercial banks. The People's Bank of China's management style also changed from mandatory plans to guiding plans, and all commercial banks were required to rank their loans into five categories according to loan risk from 1998 to 2000. After the PRC's entry to the World Trade Organization in 2001, the PRC banks further went through several reforms, including attracting foreign strategic investors, going public, and reconstructing themselves. The financial institutions thus became more efficient and the credit allocation started to become more commercialized (Lin 2011). Using World Bank survey data from 2002, Firth et al. (2009) also argue that the state-owned banks allocating credits to non-state-owned sectors tend to use commercial judgments. Even though the proportion of lending to non-SOEs has been increased gradually, the non-SOEs are still financially constrained as argued by Poncet, Steingress, and Vandebussche (2010) using data from 1998 to 2005.

3. DATA AND SUMMARY STATISTICS

3.1 Sample

The sample is taken from annual surveys on industrial firms, including SOEs and non-SOEs with sales above CNY5 million, conducted by NBS of China from 2000 to 2007. The industrial firms include manufacturing firms, mining firms, and public utilities. The database includes firm characteristics, financial information, and production information. We employ the method in Brandt, Biesebroeck, and Zhang (2012) to construct the panel. The firms in the sample are those adopting the enterprise accounting standard. Firms whose fixed assets are higher than total assets and whose new product production is higher than total production have been excluded from the analysis. To further remove the outliers, firms in the 1st and 99th percentiles of each variable have been excluded. Firms changing industries have also been excluded because the characteristics of the firms may differ if they switch from one industry to another (Ouyang, Zhang, and Dong 2015).

3.2 Innovation Measure

Following Zhang (2015), we measure the product innovation incentive and outcomes by using two measures constructed from the value of new products.³ According to NBS of China, new products “refer to brand new products produced with new technology and new design, or products that represent noticeable improvement in terms of structure, material, or production process for improving significantly the character or function of the older versions. They include new products certified by relevant government agencies within the period of certification, as well as new products designed and produced by enterprises within a year without certification by government agencies. This indicator reflects the direct contribution of science and technology output to economic growth.”⁴

One measure is firms' product innovation incentives, NP, a dummy variable.

$$NP_{i,t} = \begin{cases} 1 & \text{if firm produces new product in year } t \\ 0 & \text{if firm does not produce new product in year } t \end{cases}, \text{ for } i = 1, \dots, N; t = 2000, \dots, 2007$$

However, this can only measure whether a firm would like to engage in innovative activities and cannot distinguish firms with more innovative activities from those with less innovative activities. Therefore, the second measure we construct is called product innovation outcome, NPr, which is measured as the ratio of the new product production of a firm in 1 year to its total production in that year. The higher the NPr, the more innovative the firm is in a particular year. Panel A of Table 1 provides the summary statistics for NP and NPr in the full sample and for innovative companies only. The sample size for the full sample is 891,462 and that for the innovation companies is 127,959. For NP, the mean is 0.067 and the standard deviation is 0.250. For NPr, the mean is 0.03 and the standard deviation is 0.139. The medians for both NP and NPr are zero, indicating that there are many zeros in the data. For the sample including innovative companies only, the mean is 0.4 and the standard deviation is 0.490. For NPr, the mean is 0.19 and the standard deviation is 0.303. The median is 0.021.

Table 1: Summary Statistics

Panel A

Var	Full Sample				Innovative Companies			
	N	Mean	Std	Median	N	Mean	Std	Median
NP	891,462	0.067	0.250	0	127,959	0.400	0.490	1
NPr	891,462	0.030	0.139	0	127,959	0.190	0.303	0.021

Panel B

Year	1999	2000	2001	2002	2003	2004	2005	2006
CMD_mean	3.27	4.03	4.38	5.27	6.63	7.52	8.32	8.73
CMD_median	2.76	3.38	4.40	5.20	6.58	7.52	8.41	9.03
CMD_std	3.03	3.07	2.47	2.43	2.24	2.09	2.21	2.07

continued on next page

³ According to Griliches (1990); Ayyagari, Demircuc-Kunt, and Maksimovic (2011); and the definition of innovation by the Organisation for Economic Co-operation and Development, product innovation is far beyond research and development and patent, especially for emerging economies.

⁴ See Explanatory Notes on Main Statistical Indicators in Section 20, Education, Science, and Technology available at <http://www.stats.gov.cn/tjsj/ndsj/2008/indexeh.htm> (accessed 30 December 2016).

Table 1 *continued***Panel C**

Variable	N	Mean	p50	Min	Max
size	891,462	9.750	9.583	6.717	13.985
lnage	891,462	2.068	1.946	0.693	4.094
lnage2	891,462	4.975	3.787	0.480	16.764
Leverage	891,462	0.567	0.590	0.011	1
Investment intensity	891,462	0.370	0.347	0.007	0.909
Export	891,462	0.153	0	0	1
HHI	891,462	0.008	0.005	0.001	1
ROA	891,462	0.067	0.030	−0.200	0.787
subsidy	891,462	0.002	0	0	0.078
SOE	891,462	0.124	0	0	1
COE	891,462	0.136	0	0	1
private	891,462	0.460	0	0	1
HMT	891,462	0.106	0	0	1
foreign	891,462	0.096	0	0	1
secondary industry	891,462	0.485	0.492	0.197	0.574
third industry	891,462	0.400	0.395	0.300	0.719
lngdppc	891,462	9.630	9.640	7.842	10.913
FD	891,462	0.985	0.920	0.562	2.139
nonSOE_ratio	891,462	0.827	0.884	0.128	0.983

Note: The definitions of variables are in Table 2.

3.3 Credit Market Development Measure

Following King and Levine (1993),⁵ we measure the credit market development from the perspective of credit allocation by using an index constructed from a ratio of the amount of credit allocated to non-SOEs to the total credit amount for 31 provinces as the measure of credit market development. King and Levine (1993) argue that a financial system allocating more financial resources to private firms is more efficient and effective than that allocating financial resources to SOEs or publicly owned enterprises only. Because in such a financial system, the financial intermediaries are more active in researching, monitoring firms, and managing risks. As argued by Fan, Wang, and Zhu (2011), this index denotes the marketization of credit allocation of financial institutions in the PRC. A higher value of this index indicates that the financial institutions are more active in researching firms rather than just allocating credit to SOEs.⁶

⁵ King and Levine (1993) use the ratio of credit allocated to private firms (firms not owned by the state) to total credit, to proxy the credit allocation of the financial market development.

⁶ Some might argue that this measure might be affected by the relative number of non-SOEs and SOEs. In our robustness check, after controlling the proportion of the number of non-SOEs to total number of firms in each province, our results remain the same.

The credit market development index is a subindex of the National Economic Research Institute (NERI) index. The NERI index is constructed by Fan, Wang, and Zhu (2011) and sponsored by the NERI of the PRC and the China Reform Foundation.⁷ The original data is from China Banking Yearbooks compiled by the China Banking Association, statistical yearbooks of various provinces, related statistical data on banking and finance, and surveys on finance and banking for each province. This measure has been used in Qian and Yeung 2014.⁸ The NERI index had been used in many papers (e.g., in Firth et al. 2009 and in Qian, Strahan, and Yang 2015).⁹

The measure we used in this paper can reflect the credit allocation in the PRC well (Fan, Wang, and Zhu 2011). The PRC financial system used to be very inefficient and ineffective. The financial intermediaries used to allocate credit to SOEs only even though the performances of the SOEs were less efficient than those of non-SOEs. The system has gradually evolved to become a more well-developed system after a series of reforms since 1978 until now.¹⁰ The financial intermediaries have grown to more actively investigate and monitor firms due to improvement of the status of non-SOEs, the reform of the PRC financial system, the increasing competition among the financial institutions, etc. Since non-SOEs, in general, are having better performances and are more promising than SOEs, the proportion of credit allocated by the PRC financial institutions to non-SOEs to total credit has increased gradually.

Panel B of Table 1 presents the mean, median, and standard deviation of the credit market development index from 1999 to 2006. The mean of the credit market development index increases from 3.27 to 8.73. The median is close to the mean. These show that credit allocation of the PRC financial intermediaries has improved throughout these years. The standard deviation of the credit market development index in each year ranges from 2.07 to 3.07, indicating that credit allocation varies from one province to another.

3.4 Control Variables

Following the literature, we include firm, industry, and province control variables that might affect firms' product innovation. The firm control variables include firm size, firm age, age square, leverage, investment intensity, whether it is an export firm, return on asset (ROA), and ownership types. The industry control variable is industry concentration (measured by Herfindahl–Hirschman Index). Province control variables include the secondary-industry production ratio, third-industry production ratio, and provincial GDP per capita. In addition, we include the government subsidy variable since the PRC government subsidizes companies that engage in more innovative activities.

Table 2 provides the definitions for all of the variables, including the control variables, the credit market development variable (CMD), NP, NPr, and the variables used in the following sections. Panel C of Table 1 presents the summary statistics for the sample mean, median, minimum value, and maximum value of the control variables.

⁷ Please refer to www.cerdi.org/uploads/sfCmsContent/html/192/Fangang.pdf for a detailed description of the data.

⁸ Qian and Yeung (2014) use the same index as we used to proxy banking industry development (page 3).

⁹ Firth et al. (2009) use the NERI index as an indicator of market development conditions (page 1154). Qian, Strahan, and Yang (2014) use the NERI index as the Coastal indicator (page 20). The credit market development index used in our paper is one of the components of the NERI index.

¹⁰ Please see section 2 for a detailed overview of the PRC financial system.

Table 2: Definitions of Variables

Variable	Definition
NP	New product dummy, equals 1 if new product production is greater than zero and zero otherwise.
NPr	Ratio of new product production on total production.
CMD	Credit market development index from Fan, Wang, and Zhu (2011), constructed from the ratio of credits allocated to non-SOEs on total credits for each province.
size	Firm size, constructed as natural log of total asset of a firm at the end of a fiscal year.
Inage	Firm age, defined as natural log of current year minus firm establish year.
Inage2	Firm age square
leverage	Leverage, defined as total debt dividing total asset of a firm at the end of a year.
Investment intensity	Fixed asset, defined as fixed asset dividing total asset of a firm at the end of a year.
export	Export, defined as total export dividing total production of a firm at the end of a year.
HHI	Industry concentration, measured as the Herfindahl–Hirschman Index based on 3-digit industry code.
ROA	Firm return on asset, measured as profit dividing total asset of a firm at the end of a year.
subsidy	Government subsidy to a firm, defined as government subsidy dividing the asset of a firm at the end of a year.
SOE	State-owned enterprises, equals 1 if the firms are state-owned enterprises, and 0 otherwise. The state-owned enterprises are defined according to the ownership type provided by the National Bureau of Statistics of China (NBS of China). We also include firms whose share of the state capital exceeds 50%.
COE	Collectively owned enterprises, equals 1 if the firms are collectively owned, and 0 otherwise. It is defined by the NBS of China as assets owned collectively, including township–village enterprises (TVEs).
private	Privately owned enterprises, equals 1 if the firms are privately owned, and 0 otherwise. It is defined by the NBS of China as assets owned by natural persons.
HMT	Companies owned by investors from Hong Kong, China; Macau, China; and Taipei, China, equals 1 if the firms are HMT, and 0 otherwise.
foreign	Companies owned by foreign investors
secondary industry	Ratio of gross domestic product (GDP) from industries including mining, manufacturing, electricity, gas and water producing and supplying, and construction, defined as GDP of secondary industry dividing total GDP of a province at the end of a year
third industry	Ratio of GDP from industries excluding agriculture and those in secondary industry, defined as GDP of third industry dividing total GDP of a province at the end of a year
Ingdppc	Ln GDP per capita defined as logarithm of provincial GDP dividing provincial population at the end of a fiscal year
small	Small-sized firms, equals 1 if the size of the companies are small as defined by NBS of China, and 0 otherwise
mid	Middle-sized firms, equals 1 if the size of the firms are middle as defined by NBS of China, and 0 otherwise
fp50	Firm performance dummy, equals 1 if the return on asset of the firm is above the 50% of all firms in the same province, industry, and year. It equals zero otherwise.
nonSOE_ratio	The ratio of the number of non-SOEs on total number of firms in one province at the end of a year
FD	Financial depth, defined as the total credits of a province dividing the GDP of that province at the end of a year

4. RESULTS

4.1 Empirical Models

In this subsection, we describe the models used in our analysis. To test whether credit market development affects firms' product innovation incentives, we estimate two models. The first model is

$$\ln\left(\frac{p_{i,t}}{1-p_{i,t}}\right) = \beta_1 + \beta_2 \times CMD_{k,t-1} + \lambda' \times X_{i,j,k,t-1} + v_k + w_j + \alpha_t + \varepsilon_{i,j,k,t}$$

where $p_{i,t} = Prob(NP_{i,t} = 1)$, the possibility that firm i produces new products at time t ; $CMD_{k,t-1}$ represents the credit market development for province k in year $t-1$; $X_{i,j,k,t-1}$ denotes the control variables for firm i , in industry j , province k , at time $t-1$; v_k , w_j and α_t represent province-level, industry-level, and year fixed effects, respectively; $\varepsilon_{i,j,k,t}$ is the error term; β_1 is the constant term; β_2 represents the effect of credit market development through improving credit allocation on firms' product innovation incentives; λ' are vectors of coefficients of the control variables.

In the second model, we use the conditional logit method. The second model is

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_2 \times CMD_{k,t-1} + \lambda' \times X_{i,j,k,t-1} + u_i + v_k + w_j + \alpha_t + \varepsilon_{i,j,k,t}$$

where u_i represents firm-level fixed effect.

To test whether credit market development affects firms' product innovation outcomes, we estimate the third model using the fixed effect regression method and the fourth model using the tobit method. The third model is

$$NPr_{i,t} = \beta_1 + \beta_2 \times CMD_{k,t-1} + \lambda' \times X_{i,j,k,t-1} + u_i + v_k + w_j + \alpha_t + \varepsilon_{i,j,k,t}$$

where $NPr_{i,t}$ is the ratio of the new product production to total production for firm i at time t .

The fourth model is

$$NPr_{i,t}^* = \beta_1 + \beta_2 \times CMD_{k,t-1} + \lambda' \times X_{i,j,k,t-1} + v_k + w_j + \alpha_t + \varepsilon_{i,j,k,t}$$

where $NPr_{i,t} = \begin{cases} NPr_{i,t}^*, & \text{if } NPr_{i,t}^* > 0 \\ 0, & \text{if } NPr_{i,t}^* \leq 0 \end{cases}$.

4.2 Baseline Results

From two perspectives, we analyze how credit market development affects product innovation by improving credit allocation. First, we explore whether the improvement in allocation affects firms' incentives to produce new products in general. Second, we investigate whether improved credit allocation encourages firms to produce more products.

Table 3 provides the results for firms' product innovation incentives and outcomes. For the product innovation incentives, we apply both pooled logit and conditional logit estimation methods. The advantage of the pooled logit is that it can utilize the information in all observations and provide the average partial effect of a variable. In comparison with the pooled logit method, the advantage of the conditional logit is that it allows us to control for the unobserved firm fixed effect. In other words, the method allows us to include many time-invariant firm characteristics that affect both credit market development and firms' product innovation incentives. This reduces the endogeneity problems caused by omitted variables. Nevertheless, the conditional logit method only considers the within variation of the variables. The firms which always or never produce new products are dropped during the estimation, and this therefore results in a big loss of observations. The standard errors are clustered by industry and province.

Table 3: Credit Market Development and Firm Innovation: Full Sample

	(1) NP_logit	(2) NP_xtlogit	(3) NPr_xtreg	(4) NPr_tobit
CMD	0.0593*** [0.0037] (0.0087)	0.0654*** (0.0053)	0.0005** (0.0002)	0.0216*** (0.0011)
size	0.5573*** (0.0144)	0.5728*** (0.0204)	0.0073*** (0.0009)	0.1888*** (0.0014)
Inage	-0.6672*** (0.0533)	-0.0904 (0.0730)	-0.0054** (0.0018)	-0.2210*** (0.0089)
Inage2	0.1853*** (0.0129)	0.0499** (0.0166)	0.0014*** (0.0004)	0.0587*** (0.0020)
leverage	-0.2213*** (0.0612)	-0.1082* (0.0585)	-0.0011 (0.0009)	-0.0968*** (0.0072)
Investment intensity	-0.5097*** (0.0986)	0.2107** (0.0719)	0.0025* (0.0013)	-0.1989*** (0.0085)
export	0.3468*** (0.0854)	0.1904*** (0.0518)	0.0027* (0.0015)	0.1290*** (0.0056)
HHI	2.8389*** (0.7528)	-2.3018** (1.0191)	-0.0473** (0.0225)	1.3456*** (0.1240)
ROA	0.7062*** (0.1454)	0.4606*** (0.1119)	0.0024 (0.0022)	0.2574*** (0.0155)
subsidy	-0.1908 (1.1373)	1.8736 (1.2853)	0.0471* (0.0263)	0.0785 (0.1940)
SOE	-0.0582 (0.0381)	0.2985*** (0.0549)	0.0027* (0.0014)	-0.0343*** (0.0072)
COE	-0.5163*** (0.0454)	0.0442 (0.0490)	0.0018 (0.0011)	-0.1861*** (0.0072)
private	-0.2226*** (0.0305)	0.0005 (0.0375)	0.0010 (0.0009)	-0.0838*** (0.0056)
HMT	-0.6137*** (0.0584)	0.1308 (0.0806)	0.0015 (0.0022)	-0.2160*** (0.0072)
foreign	-0.5674*** (0.0488)	0.1943** (0.0815)	0.0031 (0.0021)	-0.1900*** (0.0070)
secondary industry	-3.9274** (1.4428)	-5.1391*** (1.1289)	-0.1345** (0.0430)	-1.9515*** (0.2062)

continued on next page

Table 3*continued*

	(1) NP_logit	(2) NP_xtlogit	(3) NPr_xtreg	(4) NPr_tobit
third industry	8.4675*** (1.7083)	15.5376*** (1.3172)	0.2124*** (0.0528)	2.6136*** (0.2450)
lngdppc	0.7966* (0.4348)	1.1845*** (0.2496)	0.0220** (0.0111)	0.3290*** (0.0464)
constant	-18.5556*** (3.9894)		-0.2642** (0.1096)	-6.5475*** (0.3781)
Prov FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Firm FE		Y	Y	
N	891,384	96,497	891,462	891,462

The first two columns provide results for firms' innovation incentives. Coefficients are estimated by logit and conditional logit methods. The third and fourth columns provide results for firms' innovation outcomes. Coefficients are estimated by fixed effect regression and tobit methods. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. The definitions of all other control variables can be found in Table 2. Standard errors are in parentheses. Marginal effect for CMD is in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

The results from the pooled logit method, which are shown in column (1) of Table 3, demonstrate that credit market development, through improvement of credit allocation, enhances the probability of firms producing new products. This finding is statistically significant at the 1% level, holding other factors constant. When credit market development increases by 1 point, around 471 ($891,384/7 \times 0.0037$) firms will be induced to engage in producing new products in 1 year, on average. The magnitude is similar to that of Benfratello, Schiantarelli, and Sembenelli (2008) who have shown that credit market development induces 133 ($6,025/9 \times 0.2$) firms in Italy to engage in product innovation. Column (2) provides the results of the conditional logit method: credit market development is also significantly positive at the 1% level. All of the results confirm the idea that credit market development, by improving credit allocation, does increase firms' product innovation incentives.

The results also indicate that firm size, the ratio of firms' exports to production, firms' performances, GDP per capita in a province, and the proportion of third-industry production in GDP have statistically positive effects on firms' incentives in engaging in innovative activities. In contrast, firms' leverage and the proportion of secondary-industry production in GDP in a province have statistically negative effects on firms' product innovation incentives. In addition, as firms' age increases, their product innovation incentives first decrease and then increase.

For firms' product innovation outcomes, the estimation methods we use include the fixed effect regression method and the tobit method. The fixed effect regression method is commonly used, is very easy to apply, and can help reduce the endogeneity problem caused by omitted variables. However, this method cannot account for the fact that the data are censored. Since not all firms produce a new product each year, there are many zeros in the data, which might make the fixed effect regression less trustworthy. In comparison with the fixed effect regression method, the tobit method is more suitable for censored data. In addition, the standard errors are also clustered at the province and industry levels.

The results for firms' product innovation outcomes are presented in columns (3) and (4) in Table 3. In column (3), we provide the results estimated by the fixed effect regression method, which show that the coefficient of credit market development is positive and significant at the 5% level. When credit market development increases by 1 point, a firm will produce CNY33(66,739.79 \times 0.05%)¹¹ more in new products in 1 year on average. The magnitude of the coefficients is close to that of Ayyagari, Demirguc-Kunt, and Maksimovic (2011) who have shown that when bank financing increases by 1 point, the core innovation of firms increases by 0.2%. The results estimated by the tobit method are presented in column (4). The coefficient of credit market development is positive and significant at the 1% level. After accounting for the fact that the data are censored, the coefficient of credit market development on firms' product innovation outcomes increases substantially. This illustrates that, when credit market development increases by 1 point, a firm is predicted to produce CNY1,441(66,739.79 \times 2.16%) more in new products in 1 year on average. All of the results in Table 3 reinforce the idea that credit market development, by improving credit allocation in the PRC, does promote industrial firms' product innovation incentives and outcomes.

4.3 Mechanisms

In this subsection, we investigate the mechanism through which credit market development affects firms' product innovation incentives and outcomes by improving credit allocation. Specifically, we examine the credit constraint channel. We hypothesize that, if financial intermediaries can effectively alleviate firms' credit constraints over time, more credit-constrained firms should be more affected by credit market development. This is because the marginal utility provided by credit market development is higher for more credit-constrained firms than for less constrained firms.

To examine whether the more credit-constrained firms are more affected by credit market development, we first test whether privately owned firms are more affected by credit market development than other types of firms. We then test whether SMEs are more affected by credit market development than large firms.

Firm size has been widely used as a measure of credit constraint (Guariglia 2008). In the PRC, firm ownership has also been used as a proxy for firm credit constraint (Poncet, Steingress, and Vandebussche 2010). SMEs and privately owned firms have been found to be more credit constrained than other firms. First, the PRC financial system originated from a state-owned monobank system. The financial institutions tend to allocate credit following the central government's or local governments' directives (Cull and Xu 2003). Second, due to non-listed privately owned firms' and SMEs' short credit history and non-standardized financial reports, the financial institutions tend to discriminate against them (Brandt and Li 2003; Guariglia and Poncet 2008; Chong, Lu, and Ongena 2013). We construct a dummy variable, *private*, where *private* is equal to one if the firm is privately owned and zero otherwise. We then add the interaction of *private* and credit market development to the models in section 4.1. The coefficient of the interaction term captures the effect of credit market development on privately owned firms' innovative capacities compared with those of SOEs. In Table 4, we provide the results for product innovation incentives and outcomes for both types of firms. Columns (1) and (2) show the results for firms' product innovation incentives using the logit and conditional logit methods. The coefficients of the interaction of the variables *private* and credit market development are positive and significant at the 5%

¹¹ The average production in our sample is 66,739.79.

level in both regressions. This means that credit market development has a greater effect on the product innovation incentives of privately owned firms compared with other types of firms. The effect of credit market development on privately owned firms' product innovation incentives is 0.12% higher than it is for other types of firms. Columns (3) and (4) present the results for firms' product innovation outcomes. The coefficients of the interaction of the variables private and credit market development are also positive and significant at the 5% level. Compared with other types of firms, the effect of credit market development on privately owned firms' product innovation outcomes is 0.09% higher using the fixed effect regression method and 0.59% higher for the tobit method.

Table 4: Credit Market Development and Firm Innovation: Private vsOthers

	(1) NP_logit	(2) NP_xtlogit	(3) NPr_xtreg	(4) NPr_tobit
CMD	0.0552*** [0.0034] (0.0093)	0.0559*** (0.0055)	0.0003 (0.0002)	0.0204*** (0.0033)
CMD*private	0.0198** [0.0012] (0.0078)	0.0427*** (0.0072)	0.0009*** (0.0002)	0.0059** (0.0028)
private	-0.3984*** [-0.0246] (0.0712)	-0.3678*** (0.0724)	-0.0066** (0.0022)	-0.1352*** (0.0262)
Constant	-17.6119*** (3.8884)		-0.2329** (0.1050)	-6.2811*** (1.3520)
Controls	Y	Y	Y	Y
Prov FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Firm FE		Y	Y	
N	891,384	96,497	891,462	891,462

The first two columns provide results for firms' innovation incentives. Coefficients are estimated by logit and conditional logit methods. The third and fourth columns provide results for firms innovation outcomes. Coefficients are estimated by fixed effect regression and tobit methods. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. Private is a dummy of private firms. CMD*private denotes the interaction of private and CMD. The other control variables are the same as those in Table 3. For simplicity, we do not report the estimation results for other control variables. Standard errors are in parentheses. Marginal effects are in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

We then test whether the SMEs are more affected than large firms by improved credit allocation as a result of credit market development. We construct two dummy variables: middle and small. Middle is equal to one if the size of the firm is middle and zero otherwise. Small is equal to one if the size of the firm is small and zero otherwise. The variables small dummy, middle dummy, interaction of small dummy and credit market development, and interaction of middle dummy and credit market development are added to the models in section 4.1. The results are presented in Table 5. All coefficients of the interaction terms in columns (1) and (2) are positive and significant at the 1% level. The results indicate that, compared with large firms, credit market development affects SMEs' product innovation incentives by 0.63% (0.4% + 0.23%) more. Both coefficients of the interaction terms are also positive and significant at the 5% level using the tobit method. This finding shows that compared with large firms, the effect of credit market development on SMEs is 3.14% higher.

**Table 5: Credit Market Development and Firm Innovation:
Small and Medium-sized Enterprises vsOthers**

	(1) NP_logit	(2) NP_xtlogit	(3) NPr_xtreg	(4) NPr_tobit
CMD	0.0159 [0.0010] (0.0106)	0.0087 (0.0070)	0.0001 (0.0003)	0.0073* (0.0038)
CMD*small	0.0644*** [0.0040] (0.0090)	0.0727*** (0.0062)	0.0003 (0.0002)	0.0200*** (0.0032)
CMD*mid	0.0370*** [0.0023] (0.0081)	0.0783*** (0.0084)	0.0018*** (0.0005)	0.0114*** (0.0030)
small	-1.2171*** [-0.0748] (0.0764)	-0.6196*** (0.0681)	-0.0017 (0.0029)	-0.3874*** (0.0289)
mid	-0.5665*** [-0.0348] (0.0687)	-0.3498*** (0.0830)	-0.0070 (0.0045)	-0.1786*** (0.0243)
constant	-16.2577*** (4.1117)		-0.2646** (0.1110)	-5.9158*** (1.4206)
Controls	Y	Y	Y	Y
Prov FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Firm FE		Y	Y	
N	891,384	96,497	891,462	891,462

The first two columns provide results for firms' innovation incentives. Coefficients are estimated by logit and conditional logit methods. The third and fourth columns provide results for firms innovation outcomes. Coefficients are estimated by fixed effect regression and tobit methods. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. Small is a dummy of small-sized firms. Middle is a dummy of middle-sized firms. CMD*small denotes the interaction of small and CMD. CMD*mid denotes the interaction of mid and CMD. The other control variables are the same as those in Table 3. For simplicity, we do not report the estimation results for other control variables. Standard errors are in parentheses. Marginal effects are in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

All of the results in Tables 4 and 5 show the heterogeneous effects of how credit market development promotes firms' product innovation incentives and outcomes. Credit market development, through improved credit allocation, encourages credit-constrained firms to innovate more than firms that are less constrained.

4.3.2 Financial Performance of Firms

We then examine whether credit market development, by improving credit allocation, has a different effect on product innovation incentives and outcomes based on the firm's financial performance. We hypothesize that, as the financial institutions become more active in investigating firms and projects instead of just allocating credit to SOEs following government directives, they will be more likely to lend to firms with better performances. First, firms with better performances have the ability to repay loans on time. Second, firms with better performances might also have superior operations, management, and strategy than other firms, and they might care more about their long-term growth. Third, firms with better performance might be better able and more willing to engage in risky innovative projects. Therefore, banks might be more willing

to lend to the innovative projects of firms with better performances than those which have underperformed.

We use ROA as a proxy for firm performance: the higher the ROA, the better the firm performance. Table 3 shows that firms' ROA has a positive and significant effect on firms' product innovation incentives and outcomes. We generate a dummy variable, *fp50*, by first sorting the firms within the same industry, province, and year based on their ROAs. The dummy variable *fp50* is equal to one if the firms' performances are above the 50th percentile, and zero otherwise. The variable *fp50* and the interaction term of *fp50* and credit market development are added to all of the models in section 4.1. A positive and significant interaction term indicates that the firm performance is indeed a factor.

In Table 6, we present our results. Column (1) shows the results for firms' product innovation incentives estimated by the logit method, and column (2) shows those estimated by the conditional logit method. Column (3) shows the results for firms' product innovation outcomes estimated by the fixed effect regression model, and column (4) shows those estimated by the tobit method. The coefficients associated with the interaction terms of credit market development and *fp50* are all positive and significant at the 5% level, which indicates that, compared with low-performance firms, the effect of credit market development on high-performance firms' product innovation incentives and outcomes is 0.09% higher—0.04% higher using the fixed effect regression method, and 0.48% higher with the tobit model.

**Table 6: Credit Market Development and Firm Innovation:
Better Performance vsOthers**

	(1) NP_logit	(2) NP_xtlogit	(3) NPr_xtreg	(4) NPr_tobit
CMD	0.0540*** [0.0033] (0.0097)	0.0539*** (0.0060)	0.0003 (0.0002)	0.0197*** (0.0033)
CMD* <i>fp50</i>	0.0138** [0.0009] (0.0070)	0.0241*** (0.0055)	0.0004** (0.0001)	0.0048** (0.0024)
<i>fp50</i>	0.1026** [0.0063] (0.0523)	-0.0862* (0.0508)	-0.0012 (0.0009)	0.0388** (0.0185)
constant	-18.9447*** (3.9437)		-0.2664** (0.1092)	-6.6912*** (1.3675)
controls	Y	Y	Y	Y
Prov FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Firm FE		Y	Y	
N	891,384	96,497	891,462	891,462

The first two columns provide results for firms' innovation incentives. Coefficients are estimated by logit and conditional logit methods. The third and fourth columns provide results for firms innovation outcomes. Coefficients are estimated by fixed effect regression and tobit methods. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. The variable *fp50* is a dummy of profitable firms in the first 50% percentile of all firms in the same province and industry. CMD**fp50* denotes the interaction of *fp50* and CMD. The other control variables are the same as those in Table 3. For simplicity, we do not report the estimation results for other control variables. Standard errors are in parentheses. Marginal effects are in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

5. ROBUSTNESS CHECK

In this section, we check the robustness of our results. We first check the validity of our results using the instrumental variable method. We then examine whether our results are driven by an increase in the number of non-SOE firms or an increase in total credit rather than improvement of credit allocation. Afterwards, we evaluate our results using firms that produce new products only. Furthermore, we investigate our results by employing an alternative credit market development measure. In the end, we check our results by excluding listed firms in the sample.

5.1 Instrumental Variable Regression

In this subsection, we solve the endogeneity problem using the instrumental variable (IV) method. Similar to Chong, Lu, and Ongena (2013), we construct an IV as follows: we use the average of the credit market development in neighboring provinces as the IV. First, the innovative capacities of firms in one province might not affect credit market development in other provinces. Second, the credit market development of other provinces is not likely to affect the local firms' innovative capacities because the PRC credit market is region specific (Qian and Yeung 2014). Bank branches are discouraged from lending to firms in other regions to minimize the overlapping competition. Third, the first-stage F-test shows that our instrument is valid. Since the logit methods cannot accommodate the IV method, we use a linear probability model to estimate how credit market development affects firms' product innovation incentives.

Table 7 presents the results. Column (1) presents the results for firms' product innovation incentives using a linear probability model, and column (2) presents those using the fixed effect linear probability model. Column (3) provides the results using the fixed effect regression method, and column (4) provides those using the tobit model. The first-stage F-statistics shows that the IV variable is statistically significant at the 1% level. The coefficients obtained by these four methods are all statistically significant at the 1% level, further reinforcing the idea that credit market development, by improving credit allocation, promotes firms' product innovation.

**Table 7: Credit Market Development and Firm Innovation:
Instrumental Variable Method**

	(1) NP	(2) NP	(3) NPr_reg	(4) NPr_tobit
CMD	0.0027*** (0.0007)	0.0064*** (0.0012)	0.0024*** (0.0004)	0.0338*** (0.0050)
size	0.0407*** (0.0019)	0.0407*** (0.0019)	0.0074*** (0.0009)	0.1889*** (0.0044)
Ln(age)	-0.0531*** (0.0048)	-0.0527*** (0.0048)	-0.0056** (0.0018)	-0.2194*** (0.0189)
Ln(age)^2	0.0150*** (0.0013)	0.0149*** (0.0013)	0.0014*** (0.0004)	0.0584*** (0.0046)
leverage	-0.0217*** (0.0034)	-0.0217*** (0.0034)	-0.0010 (0.0009)	-0.0967*** (0.0227)
Investment intensity	-0.0340*** (0.0053)	-0.0341*** (0.0053)	0.0025* (0.0013)	-0.1992*** (0.0359)

continued on next page

Table 7 *continued*

	(1) NP	(2) NP	(3) NPr_reg	(4) NPr_tobit
export	0.0249*** (0.0061)	0.0247*** (0.0061)	0.0026* (0.0015)	0.1282*** (0.0343)
HHI	0.2618*** (0.0757)	0.2609*** (0.0756)	−0.0468** (0.0230)	1.3411*** (0.3037)
ROA	0.0607*** (0.0085)	0.0599*** (0.0085)	0.0017 (0.0022)	0.2553*** (0.0480)
Subsidy_ratio	−0.0662 (0.0809)	−0.0691 (0.0808)	0.0458* (0.0264)	0.0638 (0.4103)
SOE	−0.0043 (0.0037)	−0.0039 (0.0038)	0.0027* (0.0014)	−0.0325** (0.0136)
Collectively-owned	−0.0395*** (0.0036)	−0.0394*** (0.0036)	0.0017 (0.0011)	−0.1853*** (0.0173)
private	−0.0246*** (0.0027)	−0.0244*** (0.0027)	0.0012 (0.0009)	−0.0830*** (0.0118)
HMT	−0.0566*** (0.0046)	−0.0563*** (0.0047)	0.0016 (0.0022)	−0.2149*** (0.0216)
foreign	−0.0502*** (0.0046)	−0.0498*** (0.0046)	0.0035* (0.0021)	−0.1889*** (0.0183)
secondary industry	−0.4119*** (0.1100)	−0.3670*** (0.1078)	−0.1126** (0.0411)	−1.7973*** (0.5238)
third industry	0.4956*** (0.1102)	0.5146*** (0.1150)	0.2020*** (0.0532)	2.6534*** (0.6277)
Ln(gdppc)	0.0643** (0.0264)	0.0699** (0.0262)	0.0225** (0.0107)	0.3419** (0.1498)
constant	−0.8719*** (0.2325)	−0.9589*** (0.2396)	−6.4420*** (1.3562)	−6.7775*** (1.4023)
Prov FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Firm FE		Y	Y	
N	891,462	891,462	798,324	891,462
F-statistics first stage		733.92		

The first column presents estimated results under fixed effect regression method. The second column presents results for under tobit method. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. Standard errors are in parentheses.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

5.2 Improvement of Credit Allocation or Not?

Since the credit market development variable is constructed as an index of credit extended to non-SOEs relative to total credit, a larger number of non-SOEs might lead to a higher value. This would indicate that the increase in credit market development might not be due to improved credit allocation, instead resulting from the increase in the number of non-SOEs. To check whether our results are due to improved credit allocation or a higher number of non-SOEs, we construct a variable nonSOE_ratio, as the ratio of the number of non-SOEs to the total number of firms. We then add the nonSOE_ratio into the equations in section 4.1.

Our results show that the credit market development variable is still significant for all cases after controlling for the nonSOE_ratio (Table 8).

**Table 8: Credit Market Development and Firm Innovation:
Control Number of Non-state-owned Enterprises**

	(1) NP_logit	(2) NP_xtlogit	(3) NPr_xtreg	(4) NPr_tobit
CMD	0.0640*** [0.0040] (0.0090)	0.0822*** (0.0054)	0.0007*** (0.0002)	0.0231*** (0.0011)
nonSOE	-0.9595** (0.3497)	-3.5345*** (0.2020)	-0.0492*** (0.0129)	-0.3094*** (0.0373)
constant	-14.1391*** (3.8220)		-0.1124 (0.0913)	-5.2146*** (0.4109)
controls	Y	Y	Y	Y
Prov FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Firm FE		Y	Y	
N	891,384	96,497	891,462	891,462

The first two columns provide results for firm innovation incentive. Coefficients are estimated by logit and conditional logit. The third and fourth columns provide results for firm innovation ability. Coefficients are estimated by fixed effect regression and tobit method. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. nonSOE denotes the ratio of the number of non-SOEs on total number of firms in a province. The definitions of all other control variables can be found in Table 2. Standard errors are in parentheses. Marginal effect for CMD is in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

**Table 9: Credit Market Development and Firm Innovation:
Control Financial Depth**

	(1) NP_logit	(2) NP_xtlogit	(3) NPr_xtreg	(4) NPr_tobit
CMD	0.0606*** [0.0037] (0.0086)	0.0742*** (0.0053)	0.0006** (0.0002)	0.0218*** (0.0011)
FD	0.2114 (0.2147)	1.6633*** (0.0987)	0.0283*** (0.0074)	0.0184 (0.0191)
constant	-17.5551*** (3.7531)		-0.2490** (0.1064)	-6.4741*** (0.3857)
controls	Y	Y	Y	Y
Prov FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Firm FE		Y	Y	
N	891,384	96,497	891,462	891,462

The first two columns provide results for firm innovation incentive. Coefficients are estimated by logit and conditional logit. The third and fourth columns provide results for firm innovation ability. Coefficients are estimated by fixed effect regression and tobit method. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. FD denotes the financial depth. The definitions of all other control variables can be found in Table 2. Standard errors are in parentheses. Marginal effect for CMD is in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

Credit market development consists of various dimensions, including improvement of credit resource allocation and an increase in total credit (financial depth). To further investigate whether our results are driven by an increase in the quantity of credit or improvement in credit allocation, we add the financial depth variable to the equations in section 4.1. Following the literature, financial depth is defined as total credit/GDP for each province in each year.

The results indicate that the increase in the industrial firms' product innovation incentives and outcomes are more likely to be driven by improved credit allocation rather than financial depth (Table 9). After controlling for financial depth, the credit market development variable is significant in all cases. However, the financial depth variable is only statistically significant using the conditional logit method and fixed effect regression method.

5.3 Firms with New Products Only

Our primary results apply to all firms regardless of whether they have new products or not. In this part, we restrict our sample to firms producing new products to further check our results. We select firms producing new products in at least 1 year of our sample period. The sample size is then reduced to 129,131.

We report all results using the fixed effect regression and tobit methods in Table 10. These results are consistent with our primary results. The credit market development term for the full sample is positive and statistically significant at the 1% level for both methods. The interactions of the private variable and the credit market development term, the small variable and the credit market development term, and the middle variable and the credit market development term are also positive and significant for both methods.

**Table 10: Credit Market Development and Firm Innovation:
Firms with New Products Only**

	Full Sample		Private		Scale		Profit	
	(1) xtreg	(2) Tobit	(3) xtreg	(4) Tobit	(5) xtreg	(6) Tobit	(7) xtreg	(8) Tobit
CMD	0.0036*** (0.0009)	0.0141*** (0.0018)	0.0029** (0.0009)	0.0123*** (0.0019)	0.0012 (0.0010)	0.0064** (0.0022)	0.0029*** (0.0009)	0.0122*** (0.0018)
CMD*private			0.0032** (0.0010)	0.0082*** (0.0019)				
private			-0.0223** (0.0092)	-0.0873*** (0.0183)				
CMD*small					0.0031** (0.0011)	0.0122*** (0.0023)		
CMD*mid					0.0033** (0.0011)	0.0054** (0.0022)		
small					-0.0142 (0.0094)	-0.1528*** (0.0178)		
mid					-0.0085 (0.0102)	-0.0861*** (0.0166)		
CMD*fp50							0.0015** (0.0007)	0.0043*** (0.0014)
fp50							-0.0026 (0.0053)	0.0020 (0.0119)
constant	-1.1011** (0.4637)	-3.2691*** (0.9755)	-0.9443** (0.4583)	-2.8567** (0.9419)	-1.2094** (0.4852)	-3.1127** (1.0141)	-1.1249** (0.4606)	-3.3290*** (0.9646)

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Table 10 *continued*

	Full Sample		Private		Scale		Profit	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	xtreg	Tobit	xtreg	Tobit	xtreg	Tobit	xtreg	Tobit
controls	Y	Y	Y	Y	Y	Y	Y	Y
Prov FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y		Y		Y		Y	
N	127,959	127,959	127,959	127,959	127,959	127,959	127,959	127,959

The first two columns provide full sample results for firms' innovation outcomes. Columns (3) and (4) are comparisons of private and other types of firms. Columns (5) and (6) are comparisons of small and medium-sized enterprises, and large firms. Columns (7) and (8) are comparisons of profitable and other firms. Coefficients are estimated by fixed effect regression and tobit methods. All independent variables are lagged by one period. The standard errors are clustered by province and industry. CMD is credit market development index. The variable fp50 is a dummy of profitable firms in the first 50% percentile of all firms in the same province and industry. CMD*fp50 denotes the interaction of fp50 and CMD. Small is a dummy of small-sized firms. Middle is a dummy of middle-sized firms. CMD*small denotes the interaction of small and CMD. CMD*mid denotes the interaction of mid and CMD. Private is a dummy of private firms. CMD*private denotes the interaction of private and CMD. The other control variables are the same as those in Table 3. For simplicity, we do not report the estimation results for other control variables. Standard errors are in parentheses. Marginal effects are in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

5.4 An Alternative Credit Market Development Measure

In this part, we employ an alternative measure to proxy the credit market development. The variable CMD only represents the credit side of the credit market development. Nevertheless, the deposit side also affects the availability of the credits to firms. Therefore, we use a composite index by combining both the credit side and the deposit side of the credit market development as a proxy for credit market development. The index is constructed as a combination of deposits to non-state-owned financial institutions on total deposits and credit allocated to non-SOEs on total credit. The higher this index, the more marketization the financial market is (Fan, Wang, and Zhu 2011). The results shown in Table 11 are consistent with our primary results.

Table 11: Credit Market Development and Firm Innovation: Alternative Measure of CMD

	Full Sample		Private		Scale		Profit	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	xtreg	Tobit	xtreg	Tobit	xtreg	Tobit	xtreg	Tobit
Fmkt	0.0015*** (0.0004)	0.0366*** (0.0024)	0.0010** (0.0004)	0.0345*** (0.0068)	0.0011*** (0.0003)	0.0245*** (0.0065)	0.0012*** (0.0004)	0.0352*** (0.0069)
Fmkt*private			0.0016*** (0.0003)	0.0060* (0.0033)				
Private			−0.0111*** (0.0027)	−0.1328*** (0.0271)				
Fmkt*small					0.0004 (0.0003)	0.0233*** (0.0040)		
Fmkt*mid					0.0033*** (0.0007)	0.0127** (0.0044)		
Small					−0.0022 (0.0032)	−0.3981*** (0.0325)		
Mid					−0.0167** (0.0059)	−0.1816*** (0.0289)		

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Table 11 *continued*

	Full Sample		Private		Scale		Profit	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	xtreg	Tobit	xtreg	Tobit	xtreg	Tobit	xtreg	Tobit
Fmkt*fp50							0.0006** (0.0002)	0.0032 (0.0033)
Fp50							-0.0025** (0.0013)	0.0541** (0.0228)
controls	Y	Y	Y	Y	Y	Y	Y	Y
Prov FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y		Y		Y		Y	
N	891,462	891,462	891,462	891,462	891,462	891,462	891,462	891,462

The first two columns provide results for firms' innovation incentives. Coefficients are estimated by logit and conditional logit methods. The third and fourth columns provide results for firms' innovation outcomes. Coefficients are estimated by fixed effect regression and tobit methods. All independent variables are lagged by one period. The standard errors are clustered by province and industry. Fmkt is an alternative credit market development index constructed as a composite index of deposit for non-state-owned financial institutions divided by total deposits and CMD. The definitions of all other control variables can be found in Table 2. Standard errors are in parentheses. Marginal effect for Fmkt is in square brackets.

* significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

5.5 Excluding Listed Firms

We check our results by excluding listed firms in the sample, matching the firms by name, and removing listed firms. Listed firms comprised only 0.5% of the sample. The results are also consistent with our primary results and are available upon request.

6. CONCLUSIONS

In this paper, we examine the effects of credit market development, and the resulting improvement in credit allocation, on firms' product innovation incentives and outcomes in the PRC. Using a large dataset of industrial firms in 31 provinces in the PRC from 2000 to 2007, we find that provincial-level credit market development enhances firms' product innovation incentives and outcomes. We show that firms' credit constraints and performances are two channels through which credit market development affects firms' product innovation abilities. The product innovation incentives and outcomes of more credit-constrained firms and firms with better performances are more affected by credit market development than other types of firms. We also show that our results are not due to a higher number of non-SOEs, nor are the results driven by the increase in the quantity of total credit (financial depth) in each year.

Our results are also robust for different estimation methods, different samples, and alternative measures for credit market development. To solve the endogeneity problem caused by omitted variables, we control for many unobserved variables, including firm fixed effect, industry fixed effect, and province fixed effect. We also used the IV method to solve the reverse causality problem.

To our knowledge, this is the first paper to investigate whether provincial credit market development enhances PRC firms' innovation abilities through improved credit allocation. Distinct from research that provides country-level and industry-level data, we provide firm-level evidence for the ongoing debate on whether and how credit market development affects innovation.

REFERENCES

- Amore, M.D., C. Schneider, and A. Žaldokas. 2013. Credit Supply and Corporate Innovation. *Journal of Financial Economics*. 109: 835–855.
- Ayyagari, M., A. Demirguc-Kunt, and V. Maksimovic. 2011. Firm Innovation in Emerging Markets: The Role of Finance, Governance, and Competition. *Journal of Financial and Quantitative Analysis*. 46: 1545–1580.
- Benfratello, L., F. Schiantarelli, and A. Sembenelli. 2008. Banks and Innovation: Microeconomic Evidence on Italian Firms. *Journal of Financial Economics*. 90: 197–217.
- Brandt, L., J. V. Biesebroeck, and Y. Zhang. 2012. Creative Accounting or Creative Destruction? Firm-level Productivity Growth in Chinese Manufacturing. *Journal of Development Economics*. 97: 339–351.
- Brandt, L., and H. B. Li. 2003. Bank Discrimination in Transition Economies: Ideology, Information, or Incentives? *Journal of Comparative Economics*. 31: 387–413.
- Chong, T. L., L. Lu, and S. Ongena. 2013. Does Banking Competition Alleviate or Worsen Credit Constraints Faced by Small- and Medium-sized Enterprises? Evidence from China. *Journal of Banking & Finance*. 37: 3412–3424.
- Cull, R., and L. C. Xu. 2003. Who Gets Credit? The Behavior of Bureaucrats and State Banks in Allocating Credit to Chinese State-owned Enterprises. *Journal of Development Economics*. 71: 533–559.
- Fan, G., X. Wang, and H. P. Zhu. 2011. NERI Index of Marketization of China's Provinces. Economics Science Press, Beijing. (in Chinese).
- Firth, M., C. Lin, P. Liu, and M. L. Wong. 2009. Inside the Black Box: Bank Credit Allocation in China's Private Sector. *Journal of Banking & Finance*. 33: 1144–1155.
- Griliches, Z. 1990. Patent Statistics as Economic Indicator: A Survey. *Journal of Economic Literature*. 28: 1661–1707.
- Guariglia, A. 2008. Internal Financial Constraints, External Financial Constraints, and Investment Choice: Evidence from a Panel of UK Firms. *Journal of Banking & Finance*. 32: 1795–1809.
- Guariglia, A., and S. Poncet. 2008. Could Financial Distortions Be No Impediment to Economic Growth after All? Evidence from China. *Journal of Comparative Economics*. 36: 633–657.
- Hsu, P. H., X. Tian, and Y. Xu. 2014. Financial Development and Innovation: Cross-country Evidences. *Journal of Financial Economics*. 112: 116–135.
- King, R. G., and R. Levine. 1993. Finance, Entrepreneurship and Growth: Theory and Evidence. *Journal of Monetary Economics*. 32: 513–542.
- Levine, R. 2005. Finance and Growth: Theory and Evidence. In *Handbook of Economic Growth*, edited by P. Aghion and S. Durlauf. The Netherlands: Elsevier Science.
- Lin, H. D. 2011. Foreign Bank Entry and Firms' Access to Bank Credit: Evidence from China. *Journal of Banking & Finance*. 35: 1000–010.
- Morales, M. F. 2003. Financial Intermediation in a Model of Growth through Creative Destruction. *Macroeconomic Dynamics*. 7: 363–393.

- Morck, R., and M. Nakamura. 1999. Banks and Corporate Control in Japan. *The Journal of Finance*. 54: 319–340.
- Ouyang, P., T. Zhang, and Y. Dong. 2015. Market Potential, Firm Exports and Profit: Which Market Do the Chinese Firms Profit From? *China Economic Review*. 34: 94–108.
- Poncet, S., W. Steingress, and H. Vandenbussche. 2010. Financial Constraints in China: Firm-level Evidence. *China Economic Review*. 21: 411–422.
- Qian, J., P. E. Strahan, and Z. Yang. 2015. The Impact of Incentives and Communication Costs on Information Production and Use: Evidence from Bank Lending. *Journal of Finance*. 70: 1457–1493.
- Qian, M., and B. Y. Yeung. 2014. Bank Financing and Corporate Governance. *Journal of Corporate Finance*. 32: 258–270.
- Rajan, R. G., and L. Zingales. 1998. Financial Dependence and Growth. *The American Economic Review*. 88 (1998): 559–586.
- Solow, R. M. 1957. Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*. 39: 312–320.
- Weinstein, D. E., and Y. Yafeh. 1998. On the Costs of a Bank-centered Financial System: Evidence from the Changing Main Bank Relations in Japan. *The Journal of Finance*. 53: 635–672.
- Xiao, S., and S. Zhao. 2012. Financial Development, Government Ownership of Banks and Firm Innovation. *Journal of International Money and Finance*. 31: 880–906.
- Zhang, H. 2015. How Does Agglomeration Promote the Product Innovation of Chinese Firms? *China Economic Review*. 35: 105–120.