The Ownership and Its Impact on Research and Development of Micro and Small Enterprise: Evidence from China

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Abstract: Research and Development (R&D) has played an indispensable role in the development of micro and small enterprises. The purpose of this paper is to explore the impacts of ownership of micro and small enterprise on R&D. Utilizing the dataset of 2015 China Micro and Small Enterprise Survey, R&D of an enterprise is constructed through the variables of having R&D, having an output of R&D, and having increasing revenue of R&D. The results suggest that the ownership of public-owned enterprise, including state-owned and collective-owned enterprise, is negatively associated with R&D. The results also indicate that the ownership of foreign-owned enterprise has higher innovation efficiency, the coefficients of the variables of having R&D and having an output of R&D are significantly positive. In addition, the ownership of non-public-owned enterprise significantly and positively contributes to R&D. Moreover, this study offers implications to promote the further development of R&D for micro and small enterprise specific to various types of ownership.

Keywords: Ownership, Research and Development, Micro and Small Enterprise, Logistic Regression

1. Introduction

In recent years, China's economy has been gradually entering into a new normal era, and thereby the speed of economic growth has shifted from high to medium-high speed along with the downward pressure becoming increasingly prominent. According to the *2018 Chinese government work report*, China's economy is in the stage of storming fortifications, such as changing the development model and the growth momentum and optimizing the economic structure. Therefore, identifying the factors of growth momentum that has urged China's economic development for a long period, and to promote its high-quality growth has become more vital than ever before.

For many countries, especially for the developing countries, SMEs, or their main components, micro and small enterprises (MSEs), have played an important role in driving economic

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growth and development. Li and Rama (2015) analyzed the data of surveys and censuses from almost 20 countries, and they suggested that MSEs play a far greater role in promoting productivity growth and job creation rather than traditional mindset. Maksimov, Wang, and Luo (2017) also investigated the role of SMEs in promoting employment growth and reducing poverty using the datasets from less-developed countries, and they found approximate evidence to support the importance of small enterprises.

China is the largest developing country all over the world. Moreover, MSEs are the main source of growth momentum for China's economic further development. MSE is an important part of China's national economic and social development, which plays an irreplaceable role in promoting economic growth, increasing employment, research and development (R&D), and improving technology. In the context of the new normal era, the role of MSEs becomes increasingly important. In terms of the *"China Small and Micro Enterprises Financial Services Report"*[5] released by the People's Bank of China and the China Banking and Insurance Regulatory Commission in 2018, China's micro, small and medium enterprises have contributed more than 50% of the tax income, 60% of the GDP, and 70% of the technology innovation, over 80% of the urban labor and employment. In addition, micro, small and medium enterprises account for more than 90% of the total number of enterprises, which become the primary organization forms for mass entrepreneurship and innovation. Cunningham (2011) conducted a study of analyzing China's SMEs from the period of 1978's reform and opening up to 2008, and suggested that the importance of SMEs in China's transition to modernization and industrialization has increased, and SMEs have become the fundamental power in developing China's socialist market economy.

Prior studies have shown that R&D plays an important role for enterprises in improving market performance. Fatima, Fatima, and Fatima (2018) examined the relationships between R&D investment and performance of the Pakistani banking industry, and the results indicate that R&D initiates and promotes the improvement of new production and knowledge, and introduces new ways for technology implementation. More specifically, Booltink and Saka-Helmhout (2018) suggested that R&D is the fundamental driving power of the development of high-tech MSEs. Meanwhile, there exists an inverted U-shaped relationship between the R&D intensity and the operational performance of the non-tech enterprises, which implies that R&D positively contributes to an enterprise's operational performance before reaching the threshold value. Furthermore, Nunes, Gonçalves, and Serrasqueiro (2013) proved a quadratic relationship between the R&D intensity and the growth of SMEs by analyzing the sample from Portuguese SMEs during the period of 1999-2006, that is, the inverted "U" shape mentioned above. Therefore, R&D intensity is considered to be a key constraint that deteriorates the growth of MSEs.

5） http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/3848271/index.html

However, in recent years, china's MSEs have generally faced substantial problems such as insufficient funds, financial difficulties and lack of technologies, which will decrease their technological innovation strength, R&D intensity, and operational performance. Thus, it is difficult for MSEs to achieve high-quality and healthy development (Du and Banwo, 2015; Wang, 2016; Wonglimpiyarat, 2015). According to the data released by the National Bureau of Statistics of China, the intensity of R&D investment by Chinese enterprises in 2018 was 2.18%.[6] Moreover, the R&D intensity for MSEs is generally lower than the average level. In terms of total value, China has become the world's second-largest R&D investment country next only to the United States. However, from horizontal comparison, Hall and Oriani (2006) calculated the R&D intensity among the United States and some European countries using the data at the end of the 20th century. The results suggest that, as early as a decade ago, the R&D intensity of European and American countries has reached up to a comparatively high level. To be more specific, the proportion ratios for the United States, Germany, France, UK, and Italy account for 4.9%, 4.2%, 2.9%, and 3.3%, respectively. Therefore, the large amount of R&D investment in China is probably caused by the huge economic aggregation. From the perspective of structural proportion, the insufficient strength of R&D investment is still a serious problem for Chinese MSEs.

The purpose of this study is to examine the impacts of ownership of MSEs on R&D. The remainder of this paper is structured as follows. Section 2 reviews the literature with regard to ownership of enterprise, R&D and their relationships, then presents the hypotheses specific to the impacts of ownership of MSEs on R&D. Section 3 describes the sample data, model specification, variable measurements and statistical description of the data. The empirical results are presented and discussed in Section 4, and Section 5 offers the conclusion and implications.

2. Previous Research and Hypotheses

2.1 Previous Research on Ownership

The ownership of an enterprise is the form of occupying the means of production. There are two important stages in the transition of Chinese enterprise ownership. The first is in the early 1950s, according to the prevailing theory that the public ownership of the means of production, China's public property ownership system underwent rapid socialization. Until the economic reform in 1979, China's economic system was centrally planned, and almost all means of production were controlled by public-owned enterprises (Chao and Yang, 1987). After the economic reform, with the continuous opening up and economic development, China has gradually formed an economic system with public ownership as the main body and multiple ownership types develop together. With the formation of a variety of investment structures, the types of corporate ownership in China have also become diversified. According to the classifications of China National Bureau of Statistics, Chinese enterprises

6) http://www.stats.gov.cn/tjsj/tjgb/rdpcgb/qgkjjftrtjgb/201908/t20190830_1694754.html.

are divided into four categories: state-owned enterprises and state-holding enterprises, collective-owned enterprises, private-owned enterprises and other ownership types of enterprises. Specifically, other ownership types include joint ventures, joint-stock enterprises, foreign-owned enterprises, and enterprises involving investments from Hong Kong, Macau, and Taiwan. The ownership type of Chinese enterprises has shifted from a configuration where the state-owned enterprises are absolutely dominant to another where multiple forms of ownership coexist. This transformation is a gradual process and the result of market-oriented reforms in the Chinese economy (Jia-gui and Qun-hui, 2001). Although subdivided in the legal sense, the types of Chinese enterprises ownership have various characteristics, which are different from those in other countries. However, with the continuous improvement of the Chinese market economy system, in general, corporate ownership is classified into four categories: state-owned, collective-owned, foreign-owned, and private-owned enterprises.

From the different aspects of the connection, the existing literature on ownership mainly involves the following aspects. The first is to investigate the relationships between ownership of enterprise and market performance, which is also a more common aspect of prior studies. Ongore (2011) examined the relationships between the ownership concentration and performance indicators of 42 listed companies in Kenya and argued that there is a significantly negative association between the ownership concentration and enterprise performance. Meanwhile, previous studies also hold that foreign ownership and decentralized ownership are significantly positive to enterprise performance. Wang and Shailer (2018) analyzed datasets from 17 countries with emerging stock markets and suggested that the public ownership is negatively associated with enterprise performance, yet for private-owned enterprise, the association is positive. Moreover, institutional and foreign ownership has a stronger positive association than that of family and management ownership. Wang, Wu, Yang, Li, and Liu (2019) showed that ownership concentration has a positive impact on enterprise performance, and they also argued that compared to the enterprises with only domestic ownership, enterprises in China benefit more from foreign ownership.

The second is focused on the relationships between the ownership and its sustainable development of an enterprise, which is more specific to the impact over a longer period. Gallo and Christensen (2011) examined almost one thousand samples of accounting executives from the United States enterprises, and suggested that the ownership and size of the enterprise are positively associated with reported sustainability, and compared with private-owned enterprises, public-owned enterprises score more on sustainability measures. Memili, Fang, Koc, Yildirim-Öktem, and Sonmez (2018) indicated that family ownership may exert a negative impact on the sustainable development of the enterprises. Rustam, Wang, and Zameer (2019) also examined the role of Pakistan's foreign ownership in

stimulating the potential sustainability of leading non-financial enterprises in the context of an emerging economy. The empirical results indicate that foreign ownership has a significantly positive impact on enterprises' total sustainability disclosure.

In addition, prior studies are also focused on the relationships between the ownership and R&D, which will be reviewed in the following section in detail. Hence, in addition to the literatures that directly investigate the relationships with regard to ownership and R&D, yet there are substantial studies that have explored from other perspectives, such as the indirect relationships or synergy between ownership and R&D. Kim, Kim, and Lee (2008) conducted a sample survey to the R&D-intensive manufacturing enterprises in South Korea and used agency theory to investigate the impact of ownership structure on the relationships between financial slack and R&D investment. They indicated that financial slack has an inverted U-shaped relationship with R&D investments. Moreover, family ownership plays a positive role in alleviating this kind of relationship, while for domestic institutional investors and foreign investors, the role becomes negative. Zhang, Li, Hitt, and Cui (2007) analyzed the relationships between R&D intensity and joint enterprises performance through using a sample from China's manufacturing joint enterprises. For joint enterprises with different market goals, the link between R&D intensity and corporate performance is not identical. The intensity of R&D positively contributes to the performance of joint ventures focusing on the export market, but for joint ventures focusing on the local market, the impact becomes insignificant. In the aspect of theoretical investigation, López and Vives (2017) verified the spillover effect of enterprise ownership overlapping on R&D investment under the Cournot oligopoly model and the Bertrand oligopoly model. They argued that when the demand is not so much convex, growth in overlapping ownership will increase R&D and output, which will cause a sufficiently high overflow.

2.2 Previous Research on R&D

The *Frascati Manual 2015* published by OECD (2015) put forward the definition for R&D in a broad sense as: Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge, including knowledge of humankind, culture and society, and to devise new applications of available knowledge. Since the first publication of the *Frascati Manual* by the OECD in 1994, this definition has not changed much and has been used so far. Furthermore, the Australian Department of Industry, Science and Tourism (DIST) differentiates R&D from innovation. Overall, although the definition of R&D is unlikely to match exactly with innovation, its wide availability and the expected high association between R&D and innovation effort makes it a valuable proxy for innovation activity (Rogers and Rogers, 1998). Hence, R&D is closely related to enterprise innovation activities, and thereby becomes vital to the growth and development of an enterprise. Thus, it is

necessary to distinguish the factors affecting R&D activities in enterprises.

Specifically, the factors affecting enterprises' R&D are divided into two categories: external factors and internal factors. The external factors refer to exogenous variables that cannot be determined by the enterprise itself, such as market environment, policy systems, and the situation of the macro economy. Ito and Wakasugi (2007) used qualitative data to explore the factors affecting multinational enterprises' overseas R&D. They concluded that the protection of intellectual property plays a positive role in the expansion of knowledge sourcing R&D. In addition, Ito and Wakasugi (2007) also put forward the endogenous factors, such as export propensity of affiliate firms, the relative abundance of human resources for R&D, and accumulated technological knowledge, which will have a positive impact on R&D. As a result, the impact on R&D varies by companies and countries. Lee and Ahn (2012) investigated the impact of the institutional environment on the creative R&D performance of government research institutes in Korea. The results show that the institutional environment introduced by the government to intensify competition will not only affect related factors such as project autonomy, horizontal organization, diversity and flexibility, but also generate significant and varying influence on creative research. Zhou (2014) examined the relationships between R&D behavior and institutional quality of Chinese manufacturing enterprises, and found that institutional quality has a positive impact on companies' decision-making in R&D. Furthermore, once an enterprise begins to engage in R&D, the expansion of R&D intensity at the enterprise level depends on factors such as market structure.

The internal factors affecting enterprises' R&D refer to the endogenous factors determined by the enterprise itself. In general, those factors are the enterprise's own structural organization, scale strength, development decision, and management system. Lai, Lin, and Lin (2015) used the reports of listed companies in Taiwan, Japan, and South Korea as samples, and examined the factors affecting R&D investment of enterprise. They suggested that tangible resources such as enterprise size, and intangible resources such as goodwill and patents, have a positive impact on corporate R&D. Cho and Lee (2005) conducted a study on R&D professionals' opinion in the Korean telecommunications industry, and suggested that in the earlier period of R&D, goal achievement dimension and technology factors are more important, while the economy, market, and external assessment factors play a more important role in the later period.

Moreover, for enterprises, ownership is also an important factor in affecting R&D. Lee and O'neill (2003) analyzed the impact of R&D investment in American and Japanese companies due to different ownership structures, an increased concentration of ownership balances the power of owners relative to self-interested managers, which has led to an increase in R&D investment, but in Japan, the increase in ownership concentration does not affect the level of R&D investment. Zeng and Lin (2011) explored

samples from Chinese listed companies, and indicated that enterprises with a concentrated share ownership or inside ownership have lower R&D spending, yet enterprises with a higher level of state ownership spend more on R&D. Wu (2017) also used datasets of Chinese listed companies to examine the relationships between ownership structure and R&D subsidy. The results suggest that the subsidy from the government has a signal effect to guide private investors. State-owned enterprises can get more subsidies rather than private enterprises. However, the signal effect of R&D subsidy for private enterprises is stronger than that of state-owned enterprises.

2.3 Previous Research on Relationships between Ownership and R&D

Regarding relationships between ownership and R&D, previous studies primarily focus on two aspects. From the first perspective of the type of ownership, various types of ownership have different impacts on the R&D of enterprises. Using the data of Chinese listed companies in the two periods of 2001-2006 and 2007-2011, Boeing, Mueller, and Sandner (2016) suggested that compared with most of the state-owned enterprises, private-owned enterprises can obtain more profits from R&D, and can accordingly improve their leading position in R&D. Zhang, Zhang, and Zhao (2003) used the sample of more than 8,000 Chinese industrial enterprises to investigate the impact of ownership on the R&D efficiency and indicated that the state-owned sector's R&D and production efficiency are significantly lower than that of the non-state sector, and in the non-state sector, the efficiency of R&D and production of foreign-funded enterprises are higher than that of domestic collective-owned enterprises and joint-stock enterprises.

From the second perspective of ownership structure, most of the prior studies focus on the relationships between ownership concentration or structural changes and R&D. Sciascia, Nordqvist, Mazzola, and De Massis (2015) explored 240 small and medium-sized enterprises in Italy and showed that in family businesses when there is a high degree of overlapping between family wealth and corporate assets, there is a negative relationship between them, and when the overlapping degree becomes low, the growth in family ownership will increase the R&D intensity of the enterprise. Eng and Shackell (2001) examined the relationships between long-term performance plans and institutional ownership, respectively, and corporate R&D expenditures, and suggested that holdings by institutional investors are positively associated with corporate R&D expenditures, and among enterprises with higher R&D levels, banks and insurance companies have lower shareholdings. Di Vito, Laurin, and Bozec (2010) investigated the relationships between ownership structure and R&D activities of Canadian enterprises. The results indicate that a high concentration of ownership or the presence of controlling minority shareholders has a negative impact on enterprise R&D levels.

To summarize, although prior studies on the ownership and R&D have covered substantial issues, there are still limitations. The first is

the lack of relevant research on the MSEs. Most of the previous studies focus on large and medium-sized enterprises or listed companies. The relationships between the ownership of MSEs and R&D need to be further studied. Secondly, most of the prior studies focus on ownership structure, such as ownership concentration, but few studies on the type of ownership. Unlike prior studies, the purpose of this study is to examine the impacts of the ownership on R&D of MSEs. This study contributes to encouraging policymakers to formulate policies to strengthen the guidance and promotion of R&D of MSEs, as well as promote MSEs to transform ownership and thereby improve the efficiency of R&D.

2.4 Hypotheses

For a long period, the operating efficiency of Chinese state-owned enterprises and collective-owned enterprises has not been very high. Cheap bank loans, close ties with the government and easy access to huge financial subsidies, coupled with the possible monopoly position in the industry, policy-prone and easily accessible factors of production, make state-owned enterprises lack incentives to improve operational performance. Meanwhile, the lack of a sound system of supervision and management causes the managers of state-owned enterprises to undertake low risks for malpractice and make incorrect business decisions (Yu, 2014). Hence, comprehensive factors in various aspects lead to lower profitability and productivity of public-owned enterprises rather than other types of ownership. More specifically, Zhou, Gao, and Zhao (2017) used the relevant data of Chinese manufacturing enterprises to explore the role of state ownership in enterprises' R&D. They suggested that while state ownership in emerging economies allows companies to access key R&D resources, it reduces the efficiency with which enterprises can generate. Similarly, Yang, Lin, and Ma (2010) argued that the R&D efficiency of foreign enterprises is higher than that of the state-owned or private-owned enterprises. The results also indicate that compared with the non-state sector, the state-owned enterprises are significantly less efficient in terms of R&D. In the non-state sector, foreign-owned enterprises and enterprises with Hong Kong, Macau and Taiwan investors have higher R&D efficiency than that of domestic collective-owned enterprises and joint-stock companies. In addition, foreign-owned enterprises are considered to have the highest R&D efficiency. While the goals of state-owned enterprises' managers may be biased toward providing a wide range of social services to maintain social stability and to increase output rather than corporate performance. Thus, we propose the following two hypotheses:

H1: Given enterprises and main owners' characteristics, and other control variables, state-owned and collective-owned MSEs have lower R&D efficiency.

H2: Given enterprises and main owners' characteristics, and other control variables, private-owned and foreign-owned MSEs have higher R&D efficiency.

In addition, the state-owned and collective-owned enterprises can be defined with

public ownership. Approximately, the enterprises owned by private and foreign capital can also be considered as non-public ownership. Thus, we put forward the following two competing hypotheses:

H3: Given enterprises and main owners' characteristics, and other control variables, the impact of public-owned MSEs on the R&D is significantly negative.

H4: Given enterprises and main owners' characteristics, and other control variables, the impact of non-public-owned MSEs on the R&D is significantly positive.

3. Methodology

3.1 Data

The dataset used in this study is from the 2015 China Micro and Small Enterprise Survey (CMES) conducted by the Survey and Research Center for China Household Finance of Southwestern University of Finance and Economics. The main target of this nationwide large-scale sampling survey of MSEs is domestic small, micro-enterprises and family workshop enterprises with an independent legal personality. The sample size of the survey is more than 5,400 enterprises and covered 28 province-level administrative regions across China, which is highly representative. More specifically, to avoid possible artificial deviation, the sample size used in this paper is 5489, which is the whole available number of independent enterprise sample in the survey.

3.2 Model Specification and Variables

This study primarily investigates the relationships between the ownership and R&D of the MSEs in China using the logistic model. Based on our hypotheses, the empirical specification is given by the following equation:

$$R\&D_i = \alpha_0 + \sum_{j=1}^{M} \beta_j * ownership_{j,i} + \sum_{k=1}^{N} \varphi_k * cv_{k,i} + \varepsilon_i \quad (1)$$

In equation (1), the subscript i, j and k indicate the sampling enterprise, the subscript of the ownership related variables, and the subscript of control variables, respectively. The dependent variables of $R\&D$ incorporate having R&D, having an output of R&D and having increasing revenue of R&D. All the three dependent variables are coded as binary variables, with 1 referring to having performed the activity and 0 otherwise. For instance, having increasing revenue comes from the question worded as "Does your enterprise's R&D in technology or new production process bring an increase in revenue?" Accordingly, if the answer is "Yes", the variable is coded 1, and the variable with the answer "No" is coded 0. The independent variables with regard to ownership include the state-owned enterprise, collective-owned enterprise, private-owned enterprise and foreign-owned enterprise, and the ownership with regard to the first two types are redefined as public-owned enterprises, and those of the last two types are similarly redefined as non-public-owned enterprises.

More specifically, control variables ($cv_{k,j}$) incorporate the age and gender (two categories: female vs. male) of the enterprise's main owner, the management and related working experience of the main owner, and their educated level,

which is from high school or lower to master degree or higher. The variables to proxy the enterprise's operating time length, the population of current employees, whether the enterprise is a high-tech enterprise, and the operational revenue in 2014, as the survey was released in the year 2015, are also entered as control variables. In addition, to control for the possible deviation due to provincial effect, the variables of the GDP per capita and marketization index at the provincial level are incorporated as well. The specification of all of the variables is presented in Table 1.

3.3 Statistical Description

Table 2 presents the results of the descriptive statistics. For an individual enterprise, the

Table 1 Variable specification

Variable	Attribute
Having R&D	"Does your enterprise currently or ever have R&D activities in product or technology?" 1=yes, 0=no
Having an output of R&D	"In 2014, did your enterprise's R&D activities produce new product, new technology or other types of innovation?" 1=yes, 0=no
Having increasing revenue of R&D	"Does your enterprise's R&D in technology or new production process bring an increase in revenue?" 1=yes, 0=no
State-owned enterprise	"What are the ownership types of your enterprise?" 1=state-owned enterprise, 0=other types
Collective-owned enterprise	"What are the ownership types of your enterprise?" 1=collective-owned enterprise, 0=other types
Public-owned enterprise	1=state-owned or collective-owned enterprise, 0=other types
Private-owned enterprise	"What are the ownership types of your enterprise?" 1=private-owned enterprise (excluding foreign enterprise), 0=other types
Foreign-owned enterprise	"What are the ownership types of your enterprise?" 1=wholly foreign-owned enterprise, or Hong Kong, Macao and Taiwan wholly-owned enterprise, or Sino-foreign joint venture, 0=other types
Non-public-owned enterprise	1=private-owned or foreign-owned enterprise, 0=other types
Owner's age	The age of the main owner
Gender	1=male, 0=female
Work experience	How long has the main owner been involved in management so far?
Related work	"Before working in the enterprise, is the main owner's job the same or related to current occupation?" 1=yes, 0=no
High school or lower	1=yes, 0=no
Under graduate and some college	1=yes, 0=no
Master degree or higher	1=yes, 0=no
Operating length	The length of time that the company has actually operated, and is taken in natural logarithmic form
Total assets	The total assets of enterprise
Employee population	The population of current employees of the enterprise, and is taken in natural logarithmic form
Operational revenue	The Operational revenue of your enterprise in 2014, and is taken in natural logarithmic form
High-tech enterprise	"Is your business a high-tech enterprise?" 1=yes, 0=no
GDP per capita	GDP per capita in province level
Marketization index	The index to describe the level of marketization

Notes: All of the binary variables are appropriately recoded specific to corresponding variables from original dataset. The data of GDP per capita is from the China Statistical Yearbook in 2015. The data of marketization index is collected from Wang, Fan, and Yu (2017).

R&D related variables are coded as binary variables, with 1 referring to having performed the activity and 0 otherwise. For the dependent variables, more than one-third of the enterprises currently or ever have R&D in product or technology with a mean value of 0.325. The mean value of the variable of having an output of R&D measuring the efficiency of the R&D is 0.258, which implies that more than a quarter of the enterprises' R&D produced a new product, new technology or other types of innovation in 2014. In addition, for the third variable that indicates the profit from the R&D, and the mean value of the variable of having increasing revenue of R&D is 0.117, which indicates that one-tenth of the enterprises' R&D in technology or new production process brings an increase in revenue. Therefore, for the three dependent variables, their mean values appear a decreasing trend, which implies that less than 80% of enterprises transformed their R&D into the output of new innovation. And only 36% of the enterprises successfully turned R&D outputs into increasing revenue brought from the R&D.

As for some control variables, the mean value of the owner's age is 42.654 years old, and hence, many of the main owners are in their middle age. For the working experience, it ranges from 0 year to 65 years with a mean value of 8.852, which indicates that most of the main owners have less than ten years of management experience. To facilitate analysis of the results,

Table 2 Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Having R&D	5489	0.325	0.468	0	1
Having an output of R&D	5489	0.258	0.438	0	1
Having increasing revenue of R&D	5489	0.117	0.321	0	1
State-owned enterprise	5489	0.013	0.114	0	1
Collective-owned enterprise	5489	0.033	0.179	0	1
Public-owned enterprise	5489	0.046	0.210	0	1
Private-owned enterprise	5489	0.928	0.258	0	1
Foreign-owned enterprise	5489	0.017	0.131	0	1
Non-public-owned enterprise	5489	0.946	0.227	0	1
Owner's age	5489	42.654	8.998	15	93
Squared_ownerage/100	5489	19.003	8.064	2.250	86.490
Gender	5489	0.738	0.440	0	1
Work experience	5489	8.852	8.379	0	65
Related work	5489	0.354	0.478	0	1
High school or lower	5489	0.410	0.492	0	1
Under graduate and some college	5489	0.397	0.489	0	1
Master degree or higher	5489	0.041	0.199	0	1
Operating length	5489	1.797	0.921	0.000	4.357
Total assets	5489	11.262	6.299	0.000	25.328
Employee population	5489	9.763	7.003	0.000	22.515
Operational revenue	5489	2.582	1.423	0.000	10.597
High-tech enterprise	5489	0.066	0.249	0	1
GDP per capita	5489	10.748	1.590	0.000	11.564
Marketization index	5489	7.911	1.627	4.040	9.780

Source: The results of descriptive statistics are from the dataset of 2015 China Micro and Small Enterprise Survey.

the variables of the operating time length and employee population are taken in natural logarithmic form. Moreover, the data of GDP per capita for various provinces in 2014 is from the China Statistical Yearbook in 2015.

Table 3 presents the results of the frequency and percentage of categorical and dummy variables. 1.31% of the interviewed MSEs are state-owned enterprises, only a small part of the total number of the enterprises. Only 3.3% of the enterprises are collective-owned enterprises, which leads to 4.61% of public-owned enterprises in all. Therefore, nearly 95% of enterprises are not owned by public sectors, which make up the vast majority of enterprises number. The percentage of private-owned enterprise is 92.80% and foreign-owned enterprise accounts for 1.75%. 73.84% of the main owners are male, indicating that women are more difficult to become a high-level executive in MSEs. Only 35.4% of the main owners worked the same as or related to the current occupation before. As for the education background, 40.97% of the main owners only have high school or lower as the highest educational level, and only 4.12% of them have a master's degree or higher, which reveals that from the perspective of education level alone, there is still a large room for further improvement in the education quality of the enterprises' main owners. Besides, 6.65% are high-tech enterprises, which indicates that technology-driven enterprises still account for a small proportion.

Table 3 Frequency and percentage of categorical and dummy variables

Categorical variable	Frequency	Percentage (%)
Having R&D		
Yes	1783	32.48
No	3706	67.52
Having an output of R&D		
Yes	1418	25.83
No	4071	74.17
Having increasing revenue of R&D		
Yes	641	11.68
No	4848	88.32
State-owned enterprise		
Yes	72	1.31
No	5417	98.69
Collective-owned enterprise		
Yes	181	3.30
No	5308	96.70
Public-owned enterprise		
Yes	253	4.61
No	5236	95.39
Private-owned enterprise		
Yes	5094	92.80
No	395	7.20
Foreign-owned enterprise		
Yes	96	1.75
No	5393	98.25

Non-public-owned enterprise		
Yes	299	5.45
No	5190	94.55
Gender		
Male	4053	73.84
Female	1436	26.16
Related work		
Yes	1943	35.40
No	3546	64.60
Education		
High school or lower	2249	40.97
Under graduate and some college	2178	39.68
Master degree or higher	226	4.12
No answer	836	15.23
High-tech enterprise		
Yes	365	6.65
No	5124	93.35

Notes: Sample size=5489.

4. Empirical Results

4.1 Results of Correlation Analysis

Table 4 reports the correlations between the variables of ownership and R&D. Most of the correlations are as expected. The ownership of state-owned enterprise is negatively associated with the variable of having R&D, the correlated coefficient is -0.025 at a significance level of 10%. And it is negatively associated with the variable of having an output of R&D, with a correlated coefficient of -0.028 at a significance level of 5%. Yet not significant, the correlated coefficient between the ownership of state-owned enterprise and the variable of having increasing revenue of R&D is negative as well. The ownership of a collective-owned enterprise is also negatively correlated to R&D related variables. Because the public-owned enterprise is the general designation of the state-owned and collective-owned enterprise, the variable to proxy public-owned enterprise is negatively associated with having R&D, having an output of R&D, and having increasing revenue of R&D, and the correlated coefficients are all significant at 5% significance level. The results of the correlation analysis are identical to **H1** and **H3.**

Consistent with **H2**, foreign-owned enterprise is positively associated with R&D. And the correlated coefficients of the variables of having R&D and having an output of R&D are 0.059 and 0.064, and bothl at 1% significance level, respectively. Moreover, the ownership of foreign-owned enterprises is positively associated with the variable of having increasing revenue of R&D, yet the correlated coefficient is at 10% significance level. For the ownership of foreign-owned enterprises, the correlated coefficients with R&D related variables are all positive, but for the variables of having R&D and having an output of R&D, the correlation is not statistically significant. The ownership of private-owned enterprises is only positively associated with the

variable of having increasing revenue of R&D at 10% significance level. In addition, the ownership of non-public-owned enterprise is positively associated with the R&D related variables, which is identical to **H4**.

Table 4 Correlations between ownership and R&D

Variable	State-owned enterprise	Collective-owned enterprise	Public-owned enterprise	Private-owned enterprise	Foreign-owned enterprise	Non-public-owned enterprise	Having R&D	Having an output of R&D
Collective-owned enterprise	-0.021							
Public-owned enterprise	0.525***	0.840***						
Private-owned enterprise	-0.414***	-0.663***	-0.789***					
Foreign-owned enterprise	-0.015	-0.025*	-0.029**	-0.479***				
Non-public-owned enterprise	-0.480***	-0.769***	-0.916***	0.862***	0.032**			
Having R&D	-0.025*	-0.024*	-0.034**	0.004	0.059***	0.038***		
Having an output of R&D	-0.028**	-0.023*	-0.035**	0.005	0.064***	0.043***	0.850***	
Having increasing revenue of R&D	-0.022	-0.029**	-0.037**	0.022*	0.025*	0.040***	0.524***	0.616***

Notes: Sample size = 5489. ***, **, and * denote statistical significance at 1%, 5% and 10%, respectively.

4.2 Results of the Impacts of Ownership on R&D

4.2.1 Ownership and Having R&D

Table 5 presents the estimation results of regressions of the ownership on having R&D. In column (1), only the control variables are entered. In columns (2) to (7), the independent variables with regard to ownership (state-owned enterprise, collective-owned enterprise, public-owned enterprise, private-owned enterprise, foreign-owned enterprise and non-public-owned enterprise) are incorporated, respectively. For example, column (4) reveals the estimation of the relationships between the ownership of public-owned enterprise and having R&D. In order to eliminate the impacts that come from the different province the enterprises located in and various forms of enterprises' organization they are, this study controls for the province fixed effect and forms of enterprise organization fixed effect in all of the estimations. When controlling for differences among provinces, this study uses data from the three provinces with the lowest per capita GDP (Guizhou, Yunnan, and Gansu) as a reference group. Furthermore, to get more accurate and robust estimation results, industry level clustered and robust standard errors are reported in the parentheses.

In column (1), the majority of the control variables are statistically significant. The coefficient for the age of the main owner is negatively significant, which indicates that young main owners tend to launch more R&D projects. With the increase in age, the main owners' management decisions may become more conservative.

For the variable with regard to work experience, it significantly and positively contributes to R&D, which implies that the longer the main owner manages the enterprise, the more he or she will realize the importance of R&D for the enterprise, since R&D is an act that cannot achieve immediate returns in the short period. Related work the main owner did before has a similar enhancement effect on R&D. In addition, the high educational background of the main owners, the master's degree or higher, is significantly positive to R&D. In terms of enterprise characteristics, the operational revenue and employee population are also positively associated with R&D, which suggests that enterprise with a stronger strength is more willing to conduct R&D. Meanwhile, industry and business scope of the enterprise affect the enterprise's R&D as well, as is statistically highly significant, R&D is more common in a high-tech enterprise.

Table 5 Results of regressions of ownership on having R&D

Dependent variable: Having R&D							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
State-owned enterprise		-0.924***					
		(0.314)					
Collective-owned enterprise			-0.235*				
			(0.133)				
Public-owned enterprise				-0.478***			
				(0.144)			
Private-owned enterprise					0.208**		
					(0.088)		
Foreign-owned enterprise						0.527**	
						(0.238)	
Non-public-owned enterprise							0.510***
							(0.144)
Constant	-2.176	-2.048	-2.154	-2.064	-2.337	-2.210	-2.610
	(2.475)	(2.442)	(2.484)	(2.483)	(2.491)	(2.473)	(2.453)
Owner's age	-0.037***	-0.036***	-0.037***	-0.037***	-0.037***	-0.037***	-0.036***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)
Squared_ownerage/100	0.025	0.024	0.025	0.025	0.025	0.024	0.024
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)
Gender	0.033	0.006	0.029	0.009	0.020	0.041	0.009
	(0.065)	(0.067)	(0.065)	(0.064)	(0.068)	(0.066)	(0.067)
Work experience	0.014***	0.013***	0.013***	0.013***	0.013***	0.014***	0.012***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Related work	0.109*	0.101	0.109*	0.105	0.107	0.110*	0.105
	(0.066)	(0.065)	(0.065)	(0.065)	(0.065)	(0.064)	(0.065)
Under graduate and some college	0.023	0.015	0.024	0.020	0.024	0.018	0.020
	(0.064)	(0.065)	(0.064)	(0.064)	(0.064)	(0.064)	(0.065)
Master degree or higher	0.429***	0.426***	0.429***	0.428***	0.437***	0.408**	0.429***
	(0.160)	(0.158)	(0.161)	(0.161)	(0.164)	(0.161)	(0.161)
Operating length	-0.079	-0.071	-0.076	-0.069	-0.075	-0.078	-0.069
	(0.069)	(0.069)	(0.069)	(0.067)	(0.069)	(0.069)	(0.067)
Total assets	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)

Operational revenue	0.036***	0.037***	0.036***	0.037***	0.037***	0.037***	0.037***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Employee population	0.519***	0.524***	0.519***	0.523***	0.523***	0.515***	0.524***
	(0.047)	(0.048)	(0.047)	(0.047)	(0.048)	(0.047)	(0.047)
High-tech enterprise	1.544***	1.545***	1.542***	1.540***	1.545***	1.538***	1.538***
	(0.146)	(0.145)	(0.147)	(0.146)	(0.146)	(0.146)	(0.146)
GDP per capita	0.037	0.035	0.035	0.032	0.035	0.037	0.033
	(0.044)	(0.044)	(0.043)	(0.044)	(0.043)	(0.044)	(0.043)
Marketization index	0.106	0.102	0.113	0.118	0.117	0.106	0.132
	(0.494)	(0.495)	(0.495)	(0.499)	(0.496)	(0.495)	(0.496)
Observations	5489	5489	5489	5489	5489	5489	5489
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.145	0.147	0.146	0.147	0.146	0.146	0.147

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. When controlling for differences among provinces, the three provinces with the lowest per capita GDP (Guizhou, Yunnan and Gansu) are used as reference group.

In column (2), the ownership of state-owned enterprise is significantly negative to R&D, so does the collectively owned enterprise in column (3), with its coefficient at 10% significance level. Thus, the results are identical to **H1**. To investigate further the relationships between the ownership of public-owned enterprise and the variable of having R&D, column (4) reports the estimation results of the regression of the public-owned enterprise on having R&D. For public-owned enterprise, the coefficient is significantly negative, which suggests that the enterprise owned by the public sector is less likely to conduct R&D, as the long-term development of the enterprise may not be its primary operating purpose. Therefore, the results are identical to **H3**. In column (5), it is suggested that the ownership of private-owned enterprise is positively associated with having R&D. And column (6) reports the foreign-owned enterprise's significantly positive impact on having R&D. Furthermore, combining the two types of enterprises together, column (7) shows that the non-public ownership of MSEs can induce R&D, as the coefficient is significantly positive. Hence, the results are still as hypothesized in **H2** and **H4**.

4.2.2 Ownership and Having an Output of R&D

The output of R&D is the transforming outcome from the input of R&D activities in product or technology. It is an important part of the long-term development of enterprise R&D and represents the efficiency of R&D. To investigate further the impacts of ownership on having an output of R&D for MSEs, this study utilizes the variable of having an output of R&D as a dependent variable to explore the impact of the ownership of the enterprise on R&D. Table 6 presents the results of regressions of ownership on having an output of R&D. Similarly, column (1) only contains the control variables. In columns (2) to (7), this study enters further for various types

of ownership, respectively. Moreover, the variables of the ownership of public-owned and non-public-owned enterprise are added as well.

In column (1) of Table 6, most of the control variables are statistically significant. In column (2), the variable of state-owned enterprise is entered. The results suggest that the ownership of state-owned enterprise is negatively associated with having an output of R&D, and the coefficient is at 1% significance level. In column (3), the coefficient on collective-owned enterprise for having an output of R&D is negative, though statistically insignificant. And in column (4), results show that there is a significantly negative relationship between the ownership of public-owned enterprise and having an output of R&D. Thus, the results are still identical to **H1** and **H3**, which implies that public-owned enterprises are counterproductive to R&D. In column (6), the results indicate that the ownership of foreign-owned enterprise plays a positive role in having an output of R&D, although its coefficient is less significant, the result is identical to **H2** to a certain degree. The reason for the low level of significance may come from the small sample of foreign-owned enterprise. In column (5), the relationships between the ownership of private-owned enterprise and having an output of R&D are insignificantly positive. With coefficient at 1% significance level, the result from column (7) about the relationships between the ownership of non-public-owned enterprise and having an output of R&D still supports **H4**.

Table 6 Results of regressions of ownership on having an output of R&D

Dependent variable: Having an output of R&D							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
State-owned enterprise		-0.998***					
		(0.280)					
Collective-owned enterprise			-0.121				
			(0.143)				
Public-owned enterprise				-0.414**			
				(0.164)			
Private-owned enterprise					0.151		
					(0.140)		
Foreign-owned enterprise						0.611*	
						(0.331)	
Non-public-owned enterprise							0.513***
							(0.160)
Constant	-1.613	-1.481	-1.602	-1.517	-1.725	-1.667	-2.047
	(2.065)	(2.040)	(2.068)	(2.066)	(2.084)	(2.053)	(2.046)
Owner's age	-0.056***	-0.055***	-0.056***	-0.056***	-0.056***	-0.056***	-0.055***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Squared_ownerage/100	0.043***	0.042***	0.043***	0.043***	0.043***	0.042***	0.042***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Gender	0.045	0.017	0.043	0.024	0.035	0.055	0.020
	(0.085)	(0.085)	(0.085)	(0.084)	(0.090)	(0.087)	(0.088)
Work experience	0.015***	0.014***	0.015***	0.014***	0.015***	0.016***	0.014***
	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)

Related work	0.168**	0.160**	0.168**	0.164**	0.166**	0.169**	0.164**
	(0.076)	(0.076)	(0.076)	(0.075)	(0.075)	(0.075)	(0.076)
Under graduate and some college	-0.051	-0.058	-0.050	-0.053	-0.050	-0.056	-0.053
	(0.061)	(0.063)	(0.061)	(0.062)	(0.062)	(0.062)	(0.063)
Master degree or higher	0.345	0.343	0.345	0.344	0.351	0.319	0.345
	(0.213)	(0.210)	(0.213)	(0.212)	(0.216)	(0.215)	(0.212)
Operating length	-0.093	-0.084	-0.091	-0.084	-0.090	-0.092	-0.083
	(0.070)	(0.069)	(0.070)	(0.068)	(0.070)	(0.069)	(0.067)
Total assets	-0.005	-0.006	-0.005	-0.006	-0.005	-0.006	-0.006
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Operational revenue	0.034***	0.034***	0.034***	0.034***	0.034***	0.034***	0.034***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Employee population	0.540***	0.544***	0.540***	0.543***	0.543***	0.536***	0.545***
	(0.048)	(0.049)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
High-tech enterprise	1.492***	1.491***	1.491***	1.488***	1.492***	1.486***	1.486***
	(0.178)	(0.177)	(0.179)	(0.176)	(0.177)	(0.180)	(0.175)
GDP per capita	0.042	0.040	0.041	0.038	0.041	0.042	0.038
	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)	(0.051)
Marketization index	-0.052	-0.056	-0.048	-0.042	-0.045	-0.051	-0.028
	(0.400)	(0.401)	(0.400)	(0.402)	(0.401)	(0.400)	(0.401)
Observations	5489	5489	5489	5489	5489	5489	5489
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.148	0.150	0.149	0.149	0.149	0.150	0.150

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. When controlling for differences among provinces, the three provinces with the lowest per capita GDP (Guizhou, Yunnan and Gansu) are used as reference group.

4.2.3 Ownership and Having Increasing Revenue of R&D

The variable of having increasing revenue of R&D means that the enterprise's R&D in new production process or technology can produce an increase in revenue. More specifically, this variable represents that the enterprise's R&D inputs and outputs have intuitive returns and conversions at the income level. The ability to bring continuous benefits is the decisive factor for the enterprise to conduct R&D without interruption. This study explores further the impacts of the ownership on having increasing revenue of R&D for MSEs. Table 7 presents the results of regressions. The entrance of variables is the same as those in the previous analysis mentioned above. In addition, the province fixed effect and forms of firm organization fixed effect are controlled in all of the estimations.

As is shown in Table 7, the coefficient for each explanatory variable is statistically significant except the variable of the ownership to a proxy foreign-owned enterprise. For state-owned and collective-owned enterprise, similar to previous estimation results, their ownership is negatively associated with having increasing revenue of R&D. Therefore, an enterprise owned by public sectors is inefficient in terms

of R&D input, output and profit conversion, and this consequence verifies that the public-owned enterprise's primary operating goal is not profitability again. Thus, the results are still identical to **H1** and **H3**. In columns (5) and (6), the ownership of private-owned and foreign-owned enterprise has a positive impact on having increasing revenue of R&D. However, the coefficient of private-owned enterprise is obviously significant, while that of foreign-owned enterprise is statistically insignificant. This situation is exactly opposite to the results in Table 6, which suggests that although the coefficient is not significant, this type of ownership does have a strong impact on the increased revenue from R&D. Foreign-owned enterprises can also lead to a positive impact on the increasing revenue, despite the insignificance of the coefficient. In addition, the coefficient with regard to non-public-owned enterprise is significantly positive. Hence, the results are still as hypothesized in **H2** and **H4**.

Table 7 Results of regressions of ownership on having increasing revenue of R&D

Dependent variable: Having increasing revenue of R&D							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
State-owned enterprise		-0.989**					
		(0.504)					
Collective-owned enterprise			-0.546**				
			(0.263)				
Public-owned enterprise				-0.711***			
				(0.231)			
Private-owned enterprise					0.438***		
					(0.134)		
Foreign-owned enterprise						0.125	
						(0.412)	
Non-public-owned enterprise							0.739***
							(0.191)
Constant	-4.627**	-4.489**	-4.595**	-4.469**	-4.914***	-4.650**	-5.251***
	(1.813)	(1.805)	(1.808)	(1.801)	(1.798)	(1.825)	(1.817)
Owner's age	-0.004	-0.003	-0.004	-0.003	-0.004	-0.004	-0.002
	(0.020)	(0.020)	(0.021)	(0.021)	(0.020)	(0.020)	(0.021)
Squared_ownerage/100	-0.013	-0.014	-0.013	-0.013	-0.012	-0.014	-0.015
	(0.017)	(0.017)	(0.018)	(0.018)	(0.017)	(0.017)	(0.018)
Gender	0.031	0.005	0.019	-0.005	-0.001	0.034	-0.005
	(0.124)	(0.122)	(0.122)	(0.119)	(0.124)	(0.124)	(0.124)
Work experience	0.009	0.008	0.008	0.007	0.007	0.009	0.007
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)	(0.009)
Related work	0.251***	0.244***	0.251***	0.246***	0.248***	0.251***	0.246***
	(0.082)	(0.084)	(0.082)	(0.082)	(0.083)	(0.082)	(0.082)
Under graduate and some college	-0.049	-0.056	-0.048	-0.054	-0.049	-0.049	-0.052
	(0.101)	(0.105)	(0.101)	(0.103)	(0.104)	(0.102)	(0.105)
Master degree or higher	0.271	0.266	0.270	0.267	0.283	0.266	0.266
	(0.260)	(0.260)	(0.258)	(0.257)	(0.262)	(0.271)	(0.257)
Operating length	-0.044	-0.037	-0.040	-0.033	-0.038	-0.044	-0.034
	(0.078)	(0.076)	(0.077)	(0.074)	(0.076)	(0.078)	(0.074)

Total assets	0.014*	0.014	0.014	0.014	0.014	0.014*	0.013
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Operational revenue	0.031***	0.032***	0.031***	0.031***	0.031***	0.031***	0.031***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Employee population	0.425***	0.427***	0.426***	0.428***	0.431***	0.424***	0.430***
	(0.040)	(0.041)	(0.040)	(0.041)	(0.041)	(0.040)	(0.041)
High-tech enterprise	1.317***	1.311***	1.314***	1.310***	1.317***	1.315***	1.306***
	(0.176)	(0.175)	(0.178)	(0.178)	(0.178)	(0.174)	(0.178)
GDP per capita	0.055	0.053	0.051	0.048	0.051	0.055	0.049
	(0.048)	(0.049)	(0.049)	(0.049)	(0.048)	(0.049)	(0.048)
Marketization index	0.216	0.211	0.230	0.229	0.232	0.216	0.245
	(0.362)	(0.364)	(0.362)	(0.364)	(0.361)	(0.362)	(0.362)
Observations	5489	5489	5489	5489	5489	5489	5489
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.125	0.126	0.126	0.127	0.126	0.125	0.128

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. When controlling for differences among provinces, the three provinces with the lowest per capita GDP (Guizhou, Yunnan and Gansu) are used as reference group.

4.3 Endogeneity Problem

In this study, we also realize that there may be the endogeneity problem in the regression models since the coefficients cannot determine the causal relationships between the ownership of MSEs and R&D. For some state-owned enterprises, the achievement gain from R&D output and conversion to profit may have an impact on the reform of the ownership. Therefore, it is necessary to analyze the potential endogeneity of R&D. In this section, we adopt the variables of the ownership of holding enterprises as instrumental variables, and conduct a 2SLS estimation to eliminate the influence of the endogeneity problem. The ownership of holding enterprises is correlated to the ownership, and it is obviously exogenous. This study firstly conducts a regression to investigate the relationships between the ownership of MSEs and that of holding enterprises. In the first stage of OLS regression, with regard to the ownership of public-owned enterprise, the statistics of F (43, 5445) = 125.370, which is much greater than 10. And for the ownership of non-public-owned enterprise, the statistics of F (43, 5445) = 22.180, which is still far beyond the critical value 10. Therefore, there is no need to worry about the issue of weak instrumental variables. Then we present further the estimation results with instrumental variables entered in Table 8. As is suggested from the estimation result, the coefficients of the ownership of public-owned enterprise are significantly negative, and the coefficients of the ownership of non-public-owned enterprise are all positive. For non-public-owned enterprise, coefficients of having R&D and having an output of R&D are at a significance level of 1%, yet the coefficient of having increasing revenue of R&D is insignificant. In conclusion, after eliminating the influence of the endogeneity problem, hypotheses in

this study are still supported.

Table 8 Endogeneity test using 2SLS estimation

Dependent variable	Having R&D		Having an output of R&D		Having increasing revenue of R&D	
	(1)	(2)	(3)	(4)	(5)	(6)
Public-owned enterprise	-0.788***		-0.683**		-1.218***	
	(0.239)		(0.281)		(0.365)	
Non-public-owned enterprise		4.173***		3.689***		2.283
		(0.982)		(1.143)		(1.477)
Constant	-1.976	-4.784*	-1.439	-3.905	-4.340**	-6.050***
	(2.428)	(2.601)	(2.042)	(2.402)	(1.769)	(2.071)
Owner's age	-0.037***	-0.028*	-0.056***	-0.048***	-0.004	0.001
	(0.014)	(0.014)	(0.010)	(0.011)	(0.020)	(0.019)
Squared_ownerage/100	0.025	0.019	0.043***	0.038**	-0.012	-0.016
	(0.018)	(0.018)	(0.015)	(0.015)	(0.017)	(0.017)
Gender	-0.003	-0.148*	0.014	-0.114	-0.016	-0.066
	(0.068)	(0.082)	(0.087)	(0.086)	(0.124)	(0.143)
Work experience	0.012***	0.002	0.014***	0.005	0.006	0.002
	(0.003)	(0.005)	(0.005)	(0.005)	(0.009)	(0.008)
Related work	0.101	0.059	0.161**	0.125	0.240***	0.224**
	(0.064)	(0.070)	(0.075)	(0.085)	(0.082)	(0.094)
Under graduate and some college	0.015	-0.015	-0.058	-0.085	-0.060	-0.069
	(0.065)	(0.063)	(0.062)	(0.062)	(0.105)	(0.105)
Master degree or higher	0.424***	0.409**	0.341	0.325	0.262	0.259
	(0.160)	(0.161)	(0.211)	(0.212)	(0.264)	(0.263)
Operating length	-0.063	-0.007	-0.080	-0.029	-0.024	-0.006
	(0.071)	(0.074)	(0.070)	(0.072)	(0.075)	(0.081)
Total assets	-0.005	-0.006	-0.006	-0.006	0.013	0.013
	(0.005)	(0.005)	(0.005)	(0.005)	(0.008)	(0.008)
Operational revenue	0.037***	0.035***	0.034***	0.033***	0.031***	0.031***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)
Employee population	0.523***	0.542***	0.543***	0.560***	0.430***	0.437***
	(0.047)	(0.043)	(0.048)	(0.044)	(0.041)	(0.038)
High-tech enterprise	1.535***	1.469***	1.484***	1.426***	1.302***	1.275***
	(0.147)	(0.151)	(0.178)	(0.174)	(0.179)	(0.175)
GDP per capita	0.034	0.032	0.039	0.037	0.050	0.052
	(0.043)	(0.042)	(0.052)	(0.049)	(0.048)	(0.046)
Marketization index	0.116	0.102	-0.044	-0.059	0.228	0.211
	(0.490)	(0.487)	(0.398)	(0.397)	(0.359)	(0.359)
Observations	5489	5489	5489	5489	5489	5489
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.147	0.148	0.149	0.150	0.127	0.126

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. The variables of the ownership types of holding enterprises are utilized as instrumental variable.[7)]

7) For the first stage of OLS regression with regard to public owned enterprises, the statistics of F (43, 5445) = 125.370, which is larger than 10. And for the first stage of OLS regression with regard to non-public owned enterprises, the statistics of F (43, 5445) = 22.180, which is also larger than 10. Therefore, the influence of weak instrumental variables can be negligible.

4.4 Robustness Check

To examine the robustness of the estimates, this study applies two kinds of methods. Firstly, we use the probit model to re-estimate the impacts of the ownership on R&D. If the identical results are reached, then we can conclude that our estimations are robust. Table 9 presents the estimation results of regressions of the ownership distinguished by whether the enterprise is owned by the public sector and their related R&D performance using the probit model. All control variables are entered, and the province fixed effect and forms of firm organization fixed effect are controlled. As is shown in Table 9, all of the coefficients are statistically significant, and the ownership of public-owned enterprises is negatively associated with having R&D, having an output of R&D and having increasing revenue of R&D, respectively. As for non-public-owned enterprise, it brings a positive influence on R&D. Therefore, in terms of robust results, there are robust relationships between the ownership of MSEs and R&D.

Table 9 Robustness check using probit regression

Dependent variable	Having R&D		Having an output of R&D		Having increasing revenue of R&D	
	(1)	(2)	(3)	(4)	(5)	(6)
Public-owned enterprise	-0.252***		-0.220**		-0.374***	
	(0.081)		(0.089)		(0.124)	
Non-public-owned enterprise		0.270***		0.271***		0.394***
		(0.081)		(0.090)		(0.098)
Constant	-1.265	-1.544	-0.921	-1.195	-2.476***	-2.897***
	(1.465)	(1.450)	(1.175)	(1.166)	(0.926)	(0.934)
Owner's age	-0.021**	-0.021**	-0.032***	-0.032***	-0.002	-0.001
	(0.008)	(0.008)	(0.007)	(0.006)	(0.010)	(0.011)
Squared_ownerage/100	0.014	0.014	0.025***	0.024***	-0.008	-0.009
	(0.011)	(0.011)	(0.009)	(0.009)	(0.009)	(0.009)
Gender	0.005	0.004	0.011	0.009	-0.007	-0.007
	(0.037)	(0.038)	(0.046)	(0.048)	(0.064)	(0.066)
Work experience	0.007***	0.007***	0.008***	0.008***	0.004	0.004
	(0.002)	(0.002)	(0.003)	(0.002)	(0.005)	(0.005)
Related work	0.064*	0.063*	0.100**	0.100**	0.127***	0.127***
	(0.038)	(0.038)	(0.045)	(0.045)	(0.044)	(0.044)
Under graduate and some college	0.014	0.014	-0.025	-0.025	-0.026	-0.025
	(0.036)	(0.036)	(0.032)	(0.033)	(0.055)	(0.056)
Master degree or higher	0.263***	0.263***	0.207	0.207	0.143	0.143
	(0.099)	(0.100)	(0.126)	(0.126)	(0.144)	(0.144)
Operating length	-0.031	-0.031	-0.041	-0.041	-0.017	-0.018
	(0.038)	(0.038)	(0.038)	(0.038)	(0.040)	(0.040)
Total assets	-0.004	-0.004	-0.004	-0.004	0.007*	0.007*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Operational revenue	0.022***	0.022***	0.020***	0.020***	0.018***	0.018***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)

Employee population	0.307***	0.308***	0.314***	0.314***	0.230***	0.231***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.020)	(0.020)
High-tech enterprise	0.934***	0.933***	0.891***	0.890***	0.748***	0.746***
	(0.088)	(0.088)	(0.102)	(0.102)	(0.102)	(0.102)
GDP per capita	0.019	0.019	0.020	0.020	0.025	0.026
	(0.025)	(0.024)	(0.027)	(0.027)	(0.024)	(0.024)
Marketization index	0.072	0.079	-0.020	-0.013	0.125	0.133
	(0.293)	(0.292)	(0.231)	(0.231)	(0.192)	(0.191)
Observations	5489	5489	5489	5489	5489	5489
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.147	0.147	0.150	0.150	0.128	0.129

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. When controlling for differences among provinces, the three provinces with the lowest per capita GDP (Guizhou, Yunnan and Gansu) are used as reference group.

The second way of robustness check is to remove the outliers from the estimation of regressions. Table 10 presents the new regression results. The results suggest that the new sample size is 3444. In the condition of the unchanging of other controlling factors, the vast majority of coefficients are significant and have the same positive or negative signs with the main analysis results. Although for the ownership of public-owned enterprise, the significance of the coefficient is not very strong, with two at the significance level of 10% and one insignificant, it does not affect the establishment of the conclusion. In summary, it can be concluded that the estimation results are robust through the two methods above. Thus, the results are still as hypothesized in **H1**, **H2**, **H3**, and **H4**.

Table 10 Robustness check through deleting outliers

Dependent variable	Having R&D		Having an output of R&D		Having increasing revenue of R&D	
	(1)	(2)	(3)	(4)	(5)	(6)
Public-owned enterprise	-0.319*		-0.272		-0.498*	
	(0.178)		(0.198)		(0.254)	
Non-public-owned enterprise		0.379**		0.382**		0.562***
		(0.171)		(0.177)		(0.195)
Constant	-2.697	-3.100	-2.030	-2.416	-5.129**	-5.725***
	(2.723)	(2.625)	(2.309)	(2.248)	(2.157)	(2.130)
Owner's age	-0.029*	-0.028*	-0.054***	-0.053***	-0.004	-0.003
	(0.016)	(0.016)	(0.016)	(0.016)	(0.043)	(0.044)
Squared_ownerage/100	0.015	0.014	0.038**	0.037**	-0.015	-0.016
	(0.017)	(0.017)	(0.018)	(0.018)	(0.043)	(0.043)
Gender	0.077	0.075	0.102	0.097	0.127	0.126
	(0.067)	(0.068)	(0.076)	(0.079)	(0.115)	(0.120)

Work experience	0.013***	0.013***	0.015**	0.015*	0.007	0.006
	(0.004)	(0.004)	(0.007)	(0.007)	(0.014)	(0.014)
Related work	0.128	0.128	0.157	0.157	0.240	0.242
	(0.091)	(0.091)	(0.104)	(0.104)	(0.152)	(0.152)
Under graduate and some college	0.017	0.018	-0.079	-0.079	-0.108	-0.105
	(0.088)	(0.088)	(0.073)	(0.073)	(0.095)	(0.096)
Master degree or higher	0.364*	0.361*	0.257	0.254	-0.025	-0.029
	(0.191)	(0.191)	(0.183)	(0.183)	(0.205)	(0.206)
Operating length	-0.183*	-0.181*	-0.176*	-0.174*	-0.192*	-0.191*
	(0.099)	(0.098)	(0.096)	(0.096)	(0.101)	(0.101)
Total assets	0.008	0.008	0.004	0.004	0.027**	0.027**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.013)	(0.012)
Operational revenue	0.088***	0.088***	0.128***	0.128***	0.145***	0.146***
	(0.027)	(0.027)	(0.033)	(0.033)	(0.049)	(0.049)
Employee population	0.421***	0.423***	0.432***	0.435***	0.303***	0.305***
	(0.077)	(0.077)	(0.080)	(0.080)	(0.072)	(0.072)
High-tech enterprise	1.470***	1.471***	1.388***	1.388***	1.153***	1.153***
	(0.191)	(0.190)	(0.222)	(0.220)	(0.185)	(0.186)
GDP per capita	0.017	0.016	0.012	0.012	0.026	0.026
	(0.054)	(0.053)	(0.067)	(0.066)	(0.056)	(0.055)
Marketization index	0.118	0.127	-0.107	-0.098	0.196	0.207
	(0.574)	(0.571)	(0.497)	(0.495)	(0.457)	(0.455)
Observations	3444	3444	3444	3444	3444	3444
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.108	0.108	0.113	0.113	0.092	0.093

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. When controlling for differences among provinces, the three provinces with the lowest per capita GDP (Guizhou, Yunnan and Gansu) are used as reference group.

4.5 Discussion for Heterogeneity

In this study, we also realize that the effect of the ownership of MSEs on R&D may depend on whether the enterprise is profitable or even it is non-profitable and losing-free, the degree of economic development of various provinces that the enterprise locates in, so does the level of marketization of various provinces. Therefore, this study investigates further the heterogeneous effect of the ownership of MSEs on R&D.

4.5.1 Heterogeneity to Enterprises' Profitability

This study firstly constructs interactive variables using the independent variable of ownership and different profitable status, and the results are reported in Table 11 respectively according to whether the enterprise is profitable. In this part, only the coefficient of independent variables, and the industry level clustered and robust standard errors are reported. All of the control variables are included, and province fixed effect and forms of firm organization fixed effect are controlled as well[8].

8）If the readers are interested in the result in detail, he or she is encouraged to contact with the authors.

Panel A of Table 11 presents the estimation results of heterogeneity with restricting the samples to profitable enterprises. The ownership of public-owned enterprise is negatively associated with R&D, and the ownership of non-public-owned enterprise has an unchanged positive association with having an output of R&D and having increasing revenue. For enterprise gained profit in 2014, the relationships between the ownership and R&D are significant, and verify the analysis results of this study sufficiently. In Panel B of Table 11, this study continues the heterogeneity test with enterprises that incurred losses in the previous year. The result suggests that the negative or positive relationships are still unchanged between the ownership of public-owned or non-public-owned enterprise and R&D, yet their coefficients are statistically insignificant for three out of six, the significance level of the remaining three coefficients is not very high either. The insignificant estimation results may come from the loss on profit, which may lead those enterprises to reduce the related input on R&D. Moreover, Panel C of Table 11 reports the estimation results of regressions of the ownership categorized by public-owned and non-public-owned on the R&D of enterprises that are non-profit and loss-free. Five out of six coefficients are insignificant. Furthermore, the ownership of public-owned enterprise is positive to having R&D and having an output of R&D, while non-public-owned enterprise is negatively associated with having an output of R&D, which is contrary to the results mentioned above. In summary, although the signs and significance level of some coefficients are changed, the primary results keep unchanged. Therefore, it can be concluded that all of the hypotheses are still supported to a certain degree.

Table 11 Heterogeneity test to the profitability of enterprises

Dependent variable	Having R&D		Having an output of R&D		Having increasing revenue of R&D	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. profitable enterprise						
Public-owned enterprise	-0.626***		-0.648***		-0.753***	
	(0.197)		(0.202)		(0.284)	
Non-public-owned enterprise		0.635***		0.788***		0.899***
		(0.169)		(0.203)		(0.275)
Observations	2442	2442	2442	2442	2442	2442
Pseudo R^2	0.131	0.131	0.134	0.136	0.123	0.124
Panel B. losing enterprises						
Public-owned enterprise	-0.432*		-0.710**		-1.536	
	(0.261)		(0.325)		(1.067)	
Non-public-owned enterprise		0.346		0.448		0.903*
		(0.248)		(0.374)		(0.492)
Observations	929	929	926	926	911	911
Pseudo R^2	0.166	0.166	0.171	0.169	0.157	0.155
Panel C. non-profit and loss-free enterprises						

Public-owned enterprise	0.252		0.569**		-0.300	
	(0.163)		(0.241)		(0.287)	
Non-public-owned enterprise		0.015		-0.239		0.417
		(0.205)		(0.238)		(0.291)
Observations	1521	1521	1516	1516	1487	1487
Pseudo R^2	0.104	0.104	0.106	0.105	0.115	0.115
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization fixed	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. When controlling for differences among provinces, the three provinces with the lowest per capita GDP (Guizhou, Yunnan and Gansu) are used as reference group.

4.5.2 Heterogeneity to Enterprises' Differentiating Location

Meanwhile, this study constructs interactive variables using the independent variable of ownership and the degree of economic development specific to the provinces they locate in. Differentiating provinces by the level of economic development, the result of the heterogeneity test is shown in Panel A and Panel B of Table 12. In detail, if the GDP per capita to a specific province is greater than the mean value, this province will be categorized as a developed province, and developing province otherwise. The province fixed effect and forms of firm organization fixed effect are controlled as well. For enterprises locating in the developed provinces, the relationships between the ownership and R&D are still unchanged. As public-owned enterprise is negatively associated with R&D related variables, with the highly significant coefficients, the coefficients of non-public-owned enterprise for R&D are still significantly positive, which is consistent with the primary conclusions. For enterprises locating in the developing provinces, the significance of coefficients is not so strong compared with those in the developed provinces. It can be concluded that the negative relationships between the ownership of public-owned enterprise and R&D, and positive relationships between the ownership of non-public-owned enterprise and R&D, are still unchanged. However, coefficients for public-owned enterprise in columns (1) and (3) and the coefficient for non-public-owned enterprise in column (2) are statistically insignificant, but the signs are still unchanged. Therefore, although there is heterogeneity specific to the level of economic development, the results still support hypotheses put forward in this study.

Table 12 Heterogeneity test to the enterprises' location with different level of economic development and marketization

Dependent variable	Having R&D		Having an output of R&D		Having increasing revenue of R&D	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. developed provinces						
Public-owned enterprise	-0.840***		-0.682**		-0.948***	
	(0.252)		(0.308)		(0.327)	
Non-public-owned enterprise		0.858***		0.770***		0.876**
		(0.233)		(0.271)		(0.356)
Observations	2713	2713	2713	2713	2713	2713
Pseudo R^2	0.152	0.153	0.160	0.161	0.142	0.142
Panel B. developing provinces						
Public-owned enterprise	-0.153		-0.161		-0.516**	
	(0.211)		(0.176)		(0.231)	
Non-public-owned enterprise		0.215		0.295*		0.641***
		(0.210)		(0.173)		(0.228)
Observations	2776	2776	2776	2776	2776	2776
Pseudo R^2	0.148	0.148	0.148	0.149	0.125	0.126
Panel C. provinces with high marketization						
Public-owned enterprise	-0.636***		-0.463*		-0.699**	
	(0.204)		(0.237)		(0.312)	
Non-public-owned enterprise		0.656***		0.526**		0.564**
		(0.187)		(0.224)		(0.282)
Observations	2844	2844	2844	2844	2844	2844
Pseudo R^2	0.137	0.137	0.146	0.147	0.130	0.130
Panel D. provinces with low marketization						
Public-owned enterprise	-0.360*		-0.394**		-0.811*	
	(0.201)		(0.192)		(0.424)	
Non-public-owned enterprise		0.435*		0.566***		1.083***
		(0.222)		(0.213)		(0.406)
Observations	2645	2645	2645	2645	2645	2645
Pseudo R^2	0.163	0.163	0.159	0.160	0.133	0.135
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed	Yes	Yes	Yes	Yes	Yes	Yes
Forms of firm organization fixed	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Reference category is high school or lower. ***, ** and * represent 1%, 5% and 10% significance level, respectively, and the data in parentheses is industry level clustered and robust standard error. When controlling for differences among provinces, the three provinces with the lowest per capita GDP (Guizhou, Yunnan and Gansu) are used as reference group.

In addition, this study uses the degree of marketization of provinces where the MSEs locate as the probable source of the heterogeneous effect. Panel C and Panel D of Table 12 report the estimation results. Coefficients in Panel C all significantly correspond with the main results that the ownership of public-owned enterprise is negative to R&D and that of non-public-owned enterprise is positive. A similar situation occurs in Panel D. All of the six coefficients are significant and three out of them are at significance level of 5% or higher. Therefore, it implies that although there is the disparity of the marketization degree among provinces, the results are

still unchanged. Therefore, the heterogeneity of marketization does not change the main results, which are still as hypothesized.

5. Conclusion and Implications

The MSE is an important source of driving power that fosters socio-economic development, and R&D plays a significant role in promoting the long-term sustainable growth of enterprises. The ownership of an enterprise may bring certain impacts on R&D. In this study, in order to explore the relationships between the ownership and R&D, using the dataset from 2015 CMES, we employ a logistic model to analyze how the different types of the ownership of MSEs are associated with having R&D, having an output of R&D and having increasing revenue of R&D. For state-owned and collective-owned enterprise, the ownership is significantly negative to having R&D, having an output of R&D and having increasing revenue of R&D. Implying that state-owned and collective-owned MSEs have low innovation efficiency, which is negative to R&D. For enterprise owned by foreign sectors, the coefficients for having R&D and having an output of R&D are significantly positive, which suggests that foreign-owned MSEs have higher innovation efficiency, while the coefficient for having increasing revenue of R&D is statistically insignificant. In addition, the ownership of private-owned enterprise is significantly positive to having R&D and having increasing revenue of R&D, however, the relationships between the ownership of private-owned enterprise and having an output of R&D is insignificant.

This study examines further the influence of the endogeneity problem on estimation results. 2SLS estimation is utilized to eliminate the influence of the endogeneity problem, and the results suggest that the hypotheses in this study are still supported. Based on the results of the robustness check, it can be concluded that the estimates are robust through using probit regression and deleting outliers. To explore the possible heterogeneous effect, this study constructs interactive variables using the independent variable of ownership and the profitability of the enterprise, the degree of economic development and marketization of various provinces the enterprises locate in, respectively. The discussion for heterogeneity implies that although the signs and significance of some coefficients are not identical, the main results keep unchanged.

Based on the conclusion, the relationships between the ownership of MSEs and R&D can bring the following enlightenments. First, promote the reform of mixed ownership of public-owned MSEs better and faster, to remove the negative impact due to the public ownership on R&D. Second, unleash fully the efficiency advantages of foreign-owned MSEs in R&D, and promote the emergence of new products and technologies with the development of foreign-owned MSEs, and thereby facilitating rapid socio-economic progress. Third, urge private-owned MSEs to remove possible restrictions on R&D, so as to use R&D to achieve better long-term sustainable development.

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