An Empirical Study on the Effects of Enterprise Ownership on R&D Efficiency

Jie Han[*] Ziying Liu

School of Economics and Management, North China University of Technology, Beijing, China
*Corresponding Author: Jie Han

Abstract:

The aim of this paper has been to investigate the effects of Enterprise Ownership on R&D Efficiency. With China still being in transition from its central planning legacy, R&D efficiency could be potential channels through which the ownership effect on productivity is transmitted. Using R&D production frontier function, this paper tested the R&D efficiency for a sample of large and medium size Chinese industrial enterprises from different ownership sectors during 2004-2017. Ownership factors are important determinants of R&D efficiency. The presence of state ownership is negatively related to R&D performance. Foreign firms are technical leader in Chinese industries and have advantage in R&D efficiency. These points out the fact that while the firms possessing more government support - the state-owned enterprises, they are not the ones performing better technically. This paper contributes to the research of R&D efficiency of firms under various forms of ownership in transition economy. Because conditions in China were similar in many ways to other transition economies, these results provide important information about the process of economic transformation more generally.

Keywords: R&D Productivity, Efficiency, Ownership.

I. INTRODUCTION

The aim of this paper has been to investigate the effects of Enterprise Ownership on R&D Efficiency - for a sample of large and medium size Chinese industrial enterprises from different ownership sectors during 2004-2017.

It is well known that R&D has become increasingly important not only for individual firm's survival and growth, but also the development of the whole economy. Ownership structure and its concentration have important role in the firm's strategy of R&D investment [1], due to it representing a source of power that can either support or oppose manager's long- or short-term orientation [2,3]. With China still being in transition from its central planning legacy, Chinese government might be anticipated to play an active role in financing and directing R&D. R&D efficiency could be potential channels through which the ownership effect on productivity is transmitted.

The ownership structure has become more diversified since China started its economic

reform from 1979 - state owned enterprises (SOEs), privates owned enterprises and joint ventures. There is a distinct hierarchy of financial and technical capabilities among these different types of firms [4,5].With state subsidies, protection, and easy access to bank debts, SOEs face smaller bankruptcy pressure than other ownership type firms. Lack of operation monitor and soft budget constraint, the efficiency performance of R&D investment in SOEs sector may not look very optimistic.

While there have been a number of studies examine the impact of ownership type on productive efficiency in developed economy, empirical analysis of ownership impact on firm R&D performance in transition economy is relatively rare [6-8]. This paper contributes to the empirical research of R&D efficiency of firms under various forms of ownership in transition economy.

Using R&D production frontier function, we tested the R&D efficiency of large and medium Chinese industrial firms and found that the presence of state ownership is negatively related to R&D performance. Foreign firms are technical leader in Chinese industries and have advantage in R&D efficiency. These points out the fact that while the firms possessing more government support -- the state-owned enterprises, they are not the ones performing better technically.

This paper is organized as follows. Section 2 contains review of the relevant literatures and background and revolution of ownership structure in Chinese industries. Econometric model and variables are chosen in Section 3. In section 4, empirical results are explained. We conclude the paper in Section 5.

II. LITERATURE REVIEW AND INSTITUTIONAL BACKDROP

In this section, we would like to provide a concise picture of background and revolution of ownership structure in China first and then investigate the influence of ownership on firms' R&D behaviour from existing research.

2.1 Ownership Reform in China

Under central planning system, state sector was the heart of China socialist economy and dominated the economy in all the key aspects, including resource, production, and employment. State owned enterprises (SOEs) are the provider of variety social welfare, such as medical insurance, housing. In order to improve Chinese industry efficiency without changing the nature of socialist economy and the leading role of the state, ownership reform was implemented gradually.

At the early stage of China reform, in order to clarify the rights and responsibility of enterprises, contract responsibility system was introduced to SOEs. SOEs were allowed to maintain certain percentage of their residual income, which helps improve the autonomy and address the problems with incentives. Profitability and cost of investment have become the most important factors to be considered by firms in their short-run and long-run production plans. In a study of the emerging managerial market in China, Groves et al. examine the incentives of SOE managers and find that managerial compensation is more closely linked to firm profit after the reform [9].

The scope of restructuring was gradually enlarged, Chinese communist party still

maintained the ultimate control authority of personnel selection and dismissal and when the business went under pressure, the state absorbed any financial losses. With the evolution of economic reform, government found it becoming more and more difficult to subsidize SOEs simply by budgetary resources or designated policy loans, especially when a tight monetary policy was adopted.

As a means to improve the ability of SOEs to raise funds independently and subject SOEs to market discipline, the stock market was developed by the Chinese government and SOEs had been encouraged to restructured into joint stock and shareholding companies during 1990s. Industries and enterprises were allowed to practice shareholding system and certain degree of shares were allowed to transfer to private and foreign investors. But it was strictly regulated by the policy statements and legal documents. The large SOEs were corporatized into 'national enterprises groups', which helped the state control the production output from key industrial sectors, such as heavy machinery, steel and iron, energy, telecommunication, metal, automobile, airplane, space and finance, and therefore, they helped the state fulfil its macroeconomic policies.

In the meanwhile, spectacular expansion of non-state sector had attracted the notice of policy makers and economists. The private sector grows much faster than the state sector and provides most of the economy's growth [10]. In 1980 contribution of Private Sector firms was almost negligible, but in 2018 it was 30% of total industrial output. Even some of the small loss-making SOEs from non-key industries were sold to the private owners when policy of 'seizing on the big and letting go the small' was implemented in 1990s. Private sector had been becoming an important source for employment opportunities, with total employees numbering at 210 million in 2018. As part of China's open policy, first appeared in special economic zones, foreign and joint venture capital had become inseparable part of Chinese economy. China had become the one of the biggest FDI recipient and received $135 billion in 2018.

The aim of China's ownership reform is to enhance the role of the market and competition without changing the nature of the socialist economy [11]. Although the ownership system has become more diversified, the state remains in control of most of the resources and basic industries. The essential features of their governance structure (soft budget constraint, government intervention, and the employment relationship) have remained intact [12].

2.2 Literature Review

Previous studies of influence of ownership structure on productivity differences between firms focused on controls, incentives and agency costs.

Ownership can play important role in the firm's strategy of R&D investment due to it represents a source of power that can either support or oppose manager's long- or short-term orientation [13].Hill and Snell theorize thatownership structure affects productivity both directly and indirectly through the mediators of diversification strategy, R&D expenditure, and capital intensity [3]. This result which is based on data from a cross-sectional set of 122 Fortune 500 firms suggests that ownership affects a firm's posture toward diversification and investment in R&D. Those factors and capital intensity in turn explain differences in

productivity between firms. Leech and Leahy give empirical support to the theory that the ownership structure and its level of concentration have an important role in the growth of the company by studying data from British companies [1]. They describe ownership structure in terms of both control and incentive factors. They explain that structure of share ownership may have an important role in determining a firm's performance because if ownership is widely dispersed there is no individual (or group) with either the voting power or the incentive to exercise control and enforce profit maximization. The behaviour and performance of the firm are affected by managerial discretion to pursue other goals.

Zhang et al. find public sector has lower R&D efficiency than do the non-public sectors [14]. Ownership type should affect the R&D efficiency of firms because managerial incentives, project screening mechanisms, project financing methods, and the hardness of the budget constraint may be different across ownership sectors. For example, Huang and Xu explain that centralized economies make R&D inefficient due to lack of competitive financing sources with effective monitoring mechanisms [7]. As a result of soft budget constraint, state owned enterprises lack the commitment to stop bad R&D projects through effective ex-post screening mechanisms.

Much research has also been done to test the different innovation performance of indigenous and foreign-owned plants. Griffith et al. find foreign owned multinationals are frequently technological leaders within UK industries and that technology transfer from these technological leaders makes a substantial contribution to productivity growth in domestic-owned establishments [15]. Similarly, Love et al. analyze a sample of manufacturing plants located in Scotland with the conclusion that foreign ownership has positive effect on the likelihood of innovation [16].

These conclusions raise several issues about the reasons for the productivity advantage of foreign firms and the effects of their presences in the domestic market.Griffith et al. believe that it is typically more costly for firms to operate abroad than domestically [15]. Local firms have superior knowledge of local market, consumer preferences and business practices. Foreign firms must therefore have some other advantages over domestic firms in order to compete. This can be in the form of higher productivity level or through greater market power.

III. ECONOMETRIC MODEL AND VARIABLES

The empirical analysis in this paper concentrates on how the different variables impact on the R&D output and efficiency of the firms.

3.1 Econometric Model

R&D productivity test-Frontier function is considered in this section.

Using a frontier model, Farrell defines the technical efficiency of any firm as being determined by the distance between the realized output of the firm and maximum possible output on the production frontier, given the set of the firm's inputs [17]. Allocative efficiency is determined by the difference between the actual input bundle and the optimal input bundle along the production frontier, given input prices. The production function frontier is taken to be the production function of the most efficient firms. The firm's

technical efficiency reflects the quality of its input and the efficiency of its management. Forsund and Hjalmarsson define the concept of efficiency as, in a broad sense, being used to characterize the utilization of resources, i.e. efficiency is a statement about the performance of processes transforming a set of inputs into a set of outputs [18]. Efficiency is a relative concept: the performance of an economic unit must be compared with a standard.In practice, production functions are not known and actual observations of firms are not on the frontier. Furthermore, the observed performance of a firm is affected by exogenous shocks over which the firm has no control in addition to endogenous factors relating to inefficiencies [14].

Specifically, Aigner et al., Meeusen and Van den Broeck propose the following stochastic specification of the production frontier:

$$Y = X\beta + (\upsilon - u) \tag{1}$$

Where Y is the output, X is the vector of inputs, and β is the vector of unknown parameters defining the production function. In this specification, the random variable υ has a standard normal distribution that captures the effects of omitted variables and measurement errors. The random variable u characterizes the difference between the maximum output on the frontier and the realized output; therefore, u should be non-negative [19,20].

In this paper, the R&D production function is converted to the following stochastic specification:

$$\ln V_{it} = \alpha_0 + \alpha_K \ln K_{it} + \alpha_L \ln L_{it} - u_{it} + \varepsilon_{it}, \quad u_{it} \geq 0 \tag{2}$$

where u_{it} denotes technical inefficiency and $\varepsilon \sim N(0,\sigma^2)$ is the idiosyncratic error.

Technical inefficiency u_{it} has a truncated normal distribution, with mean explained by ownership

$$u_{it} \sim N^+(\mu_{it}, \sigma_u^2), \quad \mu_{it} = \theta_0 + \sum \theta_j 1[Own_{it} = j] \tag{3}$$

3.2 Variables Choosing

The value of a firm's R&D output, V, is measured by the value added to the new products (Ln_R&D_Y). A firm's R&D inputs, L and K, are measured, respectively, by the total number of the firm's R&D personnel (Ln_R&D_L) and by its total expenditure on non-personnel R&D expenditure (Ln_R&D_K). The latter includes both internal and external R&D expenditures but excludes production cost and loan payment.

SOEs, PVTs, HKTs and FORs are 4 ownership dummies used to represent State Owned Enterprises, Private Owned Enterprises, Hong Kong, Macao and Taiwan Investors' Owned Enterprises and Foreign Owned Enterprises. We assume there are different characters of R&D efficiency across different ownership sectors. Investigated in the literature reviews section, ownership structure can influence the firm's objectives, reduce bureaucratic intervention, and realign managerial incentives, which in turn affect the firm's performance. In state sector, politicians often choose not to maximize profits and may lack strong incentives to monitor the managers. Agency problem might be higher in state sector than other sectors, which may lead to R&D inefficiency in state sector. It is typically more costly for firms to operate abroad than domestically. Local firms have superior knowledge of local market, consumer preferences and business practices. Foreign firms must therefore have

some other advantages over domestic firms in order to compete. This can be in the form of higher productivity levels or through greater market power [15].

IV. THE EMPERICAL RESULTS

4.1 Data and Model Estimates

The test data is derived from the Statistics on Science and Technology for Industrial Enterprises 2004-2017, which record R&D data for large and medium size industrial enterprises, published by China's National Bureau of Statistics and National Development of Reform Commission. This resource divided by the firm size, ownership type, industries, contains information including basic economics activities, R&D personnel, R&D funding raise, R&D expenditure, R&D activities, new products innovation and production, patents, etc.

Large and medium size means that a firm satisfies the following standards: employment is more than 300, sales revenue is more than 30 million Yuan and assets value is more than 40 million Yuan.

The empirical results are presented at table I. In the TABLE I, results of R&D production frontier function regression have been reported, from which information of R&D output and efficiency can be found. Based on the Wald χ^2 value, we are able to reject the null hypothesis, again indicating that the coefficients for the model are not simultaneously equal to zero and the overall significance of the regression model.

TABLE I. Model Estimates

VARIABLES	Ln_R&D_Y
R&D Input	
Ln_R&D_K	0.6010** (83.45)
Ln_R&D_L	0.1622** (18.65)
Cons	7.5471** (748.47)
μ(Inefficiency)	
SOEs	5.1122** (4.06)
PVTs	4.9424** (3.92)
HKTs	4.5649** (3.60)
Wald χ^2	3.82e+6
Prob﹥χ^2	0.0000

Source. National Bureau of Statistics and National Development of Reform Commission of China, Statistics on Science and Technology for Industrial Enterprises 2004-2017.

z-scores in parentheses; **, * and + singnificant at 1%, 5% and 10% level respectively.

4.2 Results Explanation

We are going to explain the regression results of R&D production frontier function in two parts as in TABLE I. First part includes the variables that influence the R&D output level which is represented by variable Ln_R&D_Y. Second part includes variables that influence R&D inefficiency which is represented by variable μ.

(1) Factors influence the R&D output level:

R&D output, measured by value added to the new products, is positively related to R&D inputs such as capital and labor input.

R&D output elasticity of R&D capital (Ln_R&D_K) and labor (Ln_R&D_L) input are statistically significant at 0.60 and 0.16. The intuition behind this result is straightforward.

Technological innovations are typically embodied in new machinery (embodied technological change). Further, De Long and Summers argue that countries with high capital investment rates tend to be those with high productivity growth [21]. Howitt demonstrates how the introduction of capital in the intermediate production can establish a positive correlation between innovation and capital intensity [22].

The number of employees in the R&D sector is considered as the measure of human capital in the empirical work. The ability to envision, design and implement a R&D project strongly depends on the level of formal and informal skills of its employees and managers, the firm's stock of human capital. These skills affect the ability of a firm to generate new ideas as well as to take advantage of and use the existing common pool of technological or scientific knowledge, whether basic or applied [23,24].

(2) Factors influence the R&D inefficiency (μ):

Ownership factors are important determinants of R&D inefficiency (μ). Compared to foreign firms, R&D inefficiency level is higher for state sector and private sector. Use foreign sector as benchmark, the coefficients of state sector, private sector and Hongkong and Taiwan sector are 5.11, 4.94 and 4.56 respectively. These results imply that firms from state sector who possess more innovation resources and government support are not the ones performing more efficiently and foreign firms are leading at R&D research and more productive in new product production.

The reason might be in state sector, politicians often do not focus only on maximizing profits and may lack strong incentives to monitor managers. Agency problems may be higher in state sector, which leads to R&D inefficiency. Since a typical R&D project involves a large sunk cost due to the low liquidation value of the projects, the moral hazard and adverse selection problems accompanying state sector are more severe and harder to be solved in R&D projects. Due to lack the monitoring mechanism, the use of the R&D funding from government is not efficient.

Under foreign ownership, managers may face stronger incentives to reduce costs and to innovate. Thus, we expect these sectors to have higher R&D efficiency and productivity.

Soft budget constraint is an useful concept for analyzing problems in centrally planned and transition economies, particularly those associated with state-owned firms. Soft budget constraint may make a centralized economy inefficient in R&D. As a result of soft budget

constraints, SOEs lack the commitment to stop bad R&D projects. R&D termination rate for the diseconomy project in foreign sector is much higher than the termination rate of state sectors [14].

V. CONCLUSION

The aim of this paper has been to investigate the effects of Enterprise Ownership on R&D Efficiency - for a sample of large and medium size Chinese industrial enterprises from different ownership sectors during 2004-2017.

Undoubtedly, firms have strong incentives to compete over time to develop new products or reduce their production costs and so improve market performance. Innovation through spending on R&D is a well-recognized means of developing these new technologies and products, but, just as firms have incentives to lower production costs, so too they have incentives to undertake innovation as efficiently as possible.

The period 2004-2017 was a period of transition for the Chinese economy, so alongside traditional state-owned enterprises there were private enterprises and foreign-owned enterprises. Consequently it is important to understand how ownership affects the level of R&D efficiency of enterprises.

R&D efficiency of Chinese industrial firms is investigated by dividing firms into different ownership groups. The hierarchy of financial and technology capacities of firms cross different ownership sectors has been maintained and even enlarged with the deepening of macro economy liberalization since economy transformation in China.

This paper contributes to the empirical research of R&D efficiency of firms under various forms of ownership in transition economy. While there have been a number of theoretical works show that R&D activities in centralized economies are less efficient than those in decentralized market economy, and some empirical studies examine the determinants of inter-firm differences (including ownership and institutional factors) in productive efficiency in developed economy, empirical analysis of ownership impact on firm R&D performance in transition economy is relatively rare.

We undertake a study of R&D efficiency for large and medium Chinese industrial firms from 2004 to 2017. The dataset we use contains panel data which allows studying dynamics and reflecting the recent economy situation, compared with work by Zhang et al. (2003) which find ownership to be a contributing factor of R&D efficiencies by using a cross-section database of Chinese large and medium industrial enterprises in 1995.We found that the presence of state ownership is negatively related to R&D performance. Foreign firms are technical leader in Chinese industries and have advantage in R&D efficiency.These points out the fact that while the firms possessing more innovation resources and government support - the state-owned enterprises, they are not the ones performing better technically.

This research has potentially important policy implications because R&D have become increasingly important not only for individual firm's survival and growth, but also the whole economy development. It contributes to the research of R&D efficiency of firms under various forms of ownership in transition economy. Because conditions in China were similar in many ways to other transition economies, these results provide important information

about the process of economic transformation more generally.

ACKNOWLEDGEMENT

REFERENCES

[1] Dennis Leech, John Leahy (1991) Ownership structure, control type classifications and the performance of large British companies. The Economic Journal 101: 1418-1437

[2] Gerald Salancik, Jeffrey Pfeffer (1980) Effects of ownership and performance on executive tenure in U.S. corporations. The Academy of Management Journal 23: 653-664

[3] Charles Hill, Scott Snell (1989) Effects of ownership structure and control on corporate productivity. The Academy of Management Journal 32: 25-46

[4] Charles Goodhart, Chenggang Xu (1996) The rise of China as an economic power. National Institute Economic Review 155: 56-80

[5] Alessandra Guariglia, Sandra Poncet (2008) Could financial distortions be no impediment to economic growth after all? evidence from China. Journal of Comparative Economics 36: 633-657

[6] Yingyi Qian, Chenggang Xu (1998) Innovation and bureaucracy under soft and hard budget constraints. Review of Economic Studies 65: 151-164

[7] Haizhou Huang, Chenggang Xu (1998) Soft budget constraint and the optimal choices of research and development projects financing. Journal of Comparative Economics 26: 62-79

[8] Anming Zhang, Yimin Zhang, Ronald Zhao (2001) Impact of ownership and competition on the productivity of Chinese enterprises. Journal of Comparative Economics 29: 327-346

[9] Theodore Groves, Yongmiao Hong, John McMillan, Barry Naughton (1995) China's evolving managerial labor market. The Journal of Political Economy 103: 873-892

[10] Franklin Allen, Jun Qian, Meijun Qian (2005) Law, finance, and economic growth in China. Journal of Financial Economics 77: 57-116

[11] Michael Bell, Kalpana Kochhar, Hoe Ee Khor (1993) China at the threshold of a market economy. IMF Occasional Paper No.107

[12] Xiaoyuan Dong, Louis Putterman (2003) Soft budget constraints, social burdens, and labor redundancy in China's state industry. Journal of Comparative Economics 31: 110-133

[13] Barry Baysinger, Rita Kosnik, Thomas Turk (1991) Effects of board and ownership structure on corporate R&D strategy. The Academy of Management Journal 34: 205-214

[14] Anming Zhang, Yimin Zhang, Ronald Zhao (2003) A study of the R&D efficiency and productivity of Chinese firms. Journal of Comparative Economics 31: 444-464

[15] Rachel Griffith, Stephen Redding, Helen Simpson (2002) Productivity convergence and foreign ownership at the establishment level. CEPR Discussion Paper No.22

[16] James Love, Brian Ashcroft, Stewart Dunlop (1996) Corporate structure, ownership and the likelihood of innovation. Applied Economics 28: 737-746

[17] M. J. Farrell (1957) The measurement of productive efficiency. Journal of the Royal Statistical Society 120: 253-290

[18] Finn Forsund, Lennart Hjalmarsson (1974) On the measurement of productive efficiency. The Swedish Journal of Economics 76: 141-154

[19] Dennis Aigner, C.A.Knox Lovell, Peter Schmidt (1977) Formulation and estimation of stochastic frontier production function models. Journal of Econometrics 6: 21-37

[20] Wim Meeusen, Julien van den Broeck (1977) Efficiency estimation from Cobb-Douglas production functions with composed error. International Economic Review 18: 435-444

[21] Bradford De Long, Lawrence Summers (1993) How strongly do developing economies benefit from equipment investment. Journal of Monetary Economics 32: 395-415

[22] Peter Howitt (1999) Steady endogenous growth with population and R&D inputs growing. Journal of Political Economy 107: 715-730

[23] Wesley Cohen, Daniel Levinthal (1989) Innovation and learning: the two faces of R&D. The Economic Journal 99: 569-596

[24] Iain Cockburn, Rebecca Henderson (1998) Absorptive capacity, coauthoring behavior, and the organization of research in drug discovery. Journal of Industrial Economics (46): 167-182