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Research Article

The Effect of Government Subsidies on Firm R&D Investment in China: From Perspectives of Ownership and Market Power

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This study examines the effects of government innovation subsidies under different combinations of market power (i.e., the relationship between enterprises, upstream suppliers, and downstream customers) and different types of ownership from the perspective of the contemporary marketing microenvironment. Based on the panel data of listed Chinese manufacturing companies from 2009 to 2018, the empirical results show that, in the case of higher buyer power, government subsidies will significantly promote the R&D investment of enterprises and the positive effect is not affected by nature of the enterprise's ownership. In the case of lower buyer power and seller power, government subsidies significantly promote the R&D investment of nonstate-owned enterprises, but have no effect on state-owned enterprises. The conclusions of the study further verify that, under different combinations of market power, there are significant differences in the effects of innovation subsidies for enterprises with different forms of ownership, and these provide a theoretical point of reference for the government to implement innovation subsidies. This study not only fills the theoretical black box of the relationship between government subsidies and enterprise innovation but also provides relatively new empirical evidence for the related research on innovation subsidies in developing countries.

1. Introduction

In the context of high-quality development, how to stimulate the innovation vitality of microeconomic entities, promote enterprises' reform and innovation, improve the innovation quality of microenterprises, and further play the role of innovation as the "engine" driving China's economic transformation and upgrading? These have become important practical issues for China in order to implement an innovation-driven development strategy. In recent years, China's government subsidies in stimulating enterprise innovation have shown an increasing trend. According to data from the Wind Database, over the period 2009–2018, the amount of government subsidies received by all A-share listed companies increased from 30.14 billion yuan to 167.17 billion yuan, and the proportion of A-share listed companies receiving government subsidies increased from 44.7% to 98.2%. The intensity and breadth of government subsidies in China are certainly increasing.

The effect of government innovation subsidies has always been an important research issue and has been of wide concern in academia. The externality theory of R&D activities proposed by Arrow [1] laid the foundation for the economic theory of government intervention in R&D innovation activities of enterprises. Market failure is widespread as a result of the externality and uncertainty of such activity[2]. Earlier research demonstrated that such market failure will prevent enterprises from achieving the socially optimal level of R&D [1, 3]. To solve the problems of market failure in R&D and the insufficient supply of effective

innovation, the government has often adopted a policy of innovation subsidies to compensate for the economic losses caused by the "market failure" of enterprises, reducing the innovation risk of enterprises, and encouraging enterprises to improve innovation [4]. Government subsidy is also a common policy means to encourage enterprise innovation, and is the most direct form of a government's "helping hand".

However, there has not been a broad consensus on the effect of government innovation subsidies. Some scholars believe that government subsidies can effectively alleviate financing difficulties and market failures faced by enterprises in the process of innovation. From the viewpoint of resources, government subsidies can increase the R&D investment of enterprises by directly supplementing innovative resources [5, 6]. In addition, based on the signal theory, government subsidies may serve as a certification signal to further help enterprises obtain external investment [7]. Meanwhile, since technology and knowledge are characterized by the spillover of public goods, nonexclusivity of results and nonexclusivity of benefits, enterprises' investment in R&D will inevitably be affected by market failure and underinvestment. Government subsidies can also, to some extent, rectify the externality and exclusivity of enterprise innovation [1]. In other words, government subsidies can share the R&D costs and risks of enterprises, make up for the costs of innovation activities caused by externalities, and then promote enterprise innovation [8].

In addition, government subsidies can stimulate innovation competition among enterprises and produce an "incentive effect" and "seed effect" [9]. Others suggest that government subsidies will distort the allocation of market resources: they may stifle enterprises' private investment in innovation, hence impeding the sponsored firm's innovation capabilities [10, 11]. The government usually grants innovation subsidies for subsidy-designated projects. Therefore, for the consideration of marginal cost, enterprises will choose to apply for R&D projects in the subsidy category formulated by the government, resulting in the government-subsidized projects replacing the R&D innovation projects planned by enterprises themselves, and thus crowding out those enterprises' R&D [12]. Enterprises that receive government subsidies do not need to invest too much money in government-subsidized R&D and innovation projects, and the marginal cost of innovation is almost zero. This may lead to enterprises' dependence on government subsidies, thus crowding out their independent innovation to an extent [13]. At the same time, due to asymmetry of information, the government will inevitably encounter aberrations in the selection of subsidy objects, and a "wrong" subsidy will lead to "subsidy-type development", rather than innovation-type development of subsidized enterprises or industries [14].

Due to the immature institutional environment and rapidly transforming factor and product markets, this contradiction is especially pronounced in economies in transition [15]. Accordingly, the first objective of our research is to investigate whether or not government innovation subsidies in China are efficient.

After reviewing a large volume of relevant literature, Zúñiga-Vicente et al. [16] point out that the main reasons for the differences in research conclusions may be differences in variable selection, research background (countries, industries, time periods), and empirical methods. Based on this conclusion, academia has begun to explore the mechanism of government subsidies from different perspectives. Market power and ownership are the two research perspectives focused on in this study.

Market power and enterprises' innovation activities (i.e., the effect of government innovation subsidies) are inseparable. Each element of a product's production is closely linked. Enterprises, upstream suppliers, and downstream customers comprise a significant component of the contemporary marketing micro-environment. At the same time, upstream and downstream industrial relations (i.e., market power) will inevitably affect the innovation decisions of enterprises. In addition, market power largely determines the profit realization and distribution of innovation activities, thus affecting the decision-making of enterprise innovation activities [17]. It has been pointed out that the effects of government innovation subsidies and R&D activities of enterprises are affected by different degrees of market power [18–23].

However, existing research has some obvious limitations. First, previous studies have only focused on a single aspect of market power (buyer power or seller power), rarely considering both two types of market power together. The reality is that, with the continuous refinement of the social division of labor, an enterprise will face both buyer power and seller power in the market. Thus, these cannot be easily separated in the analysis of the relationship between market power and innovation subsidies. Second, these studies are all carried out in the context of less government intervention. In fact, developing countries rely heavily on government intervention to promote the development and innovation capability of enterprises and industries, such as with the telecommunication equipment provider industry in China [24]. When we consider government intervention (government subsidies), the impact of market power on R&D activities is not fully demonstrated. This leads to the second objective of this research, which is to explore whether government innovation subsidies enhance enterprise R&D intensity under different market power in China.

In emerging economics, enterprises of varying ownership, such as state-owned enterprises, collectively owned enterprises, privately owned enterprises, and foreign-owned enterprises, coexist in the market [25]. The management and resource acquisition capacities of enterprises with different types of ownership vary considerably [26]. The Chinese market has been evolving towards a more mature-free market through reforms for over a decade and, therefore, this inevitably leads to the typical phenomenon of the coexistence of enterprises with multiple ownership forms, which also leads to a very complicated relationship between government subsidies and enterprise innovation. State-owned enterprises and nonstate-owned enterprises have very distinct resource endowments and institutional logics and these may result in their divergent responses to

government subsidies. In other words, the form of enterprise ownership is an especially key factor in the utility of government subsidies [27].

As one of the fastest-growing transitional economies, China has a large number of state-owned enterprises. State-owned enterprises are controlled and managed by the local or central government and have natural links with the government. As a pillar of the national economy, state-owned enterprises shoulder the important task of economic development and maintaining social fairness and stability. Therefore, when state-owned enterprises face losses, the government will lend a helping hand by giving them additional subsidies or tax incentives to tide them over. State-owned enterprises in China are always criticized for their privileges in the case of bank loans, investment and financing, government subsidies, and so on [28]. From the perspective of subsidy tendency, in large industrial enterprises the government usually provides tax reduction or various types of subsidies for state-owned enterprises, and that subsidy is relatively large–much higher than that of enterprises with other ownership properties [29]. However, previous studies have shown that state-owned enterprises have received more innovation subsidies, but they have not reached a corresponding level of R&D investment [30, 31]. In addition, nonstate-owned enterprises will also be subsidized by the government for innovation, but the effect of those subsidies has not been effectively demonstrated. Therefore, the third objective of our research is to investigate the efficiency of government subsidies between state-owned enterprises and nonstate-owned enterprises with regard to market power.

In general, previous research investigating the relationship between market power, ownership, and the efficiency of government innovation subsidy is limited in the following respects. First, whether Chinese government innovation subsidies can increase the R&D intensity of enterprises remains a question worth discussing. Second, it is of great significance to test the effect of market power on innovation subsidy efficiency. However, the effect of market power on innovation subsidy efficiency has not been fully tested in previous literature. As far as we are able to determine, our study is the first to explore the effect of government innovation subsidies for both buyer power and seller power in China. Last, but not least, most studies only focus on the relationship between market power and innovation subsidy efficiency, or ownership and innovation subsidy efficiency. There is no literature that simultaneously considers the innovation subsidy effect of different ownership enterprises in response to different market forces.

This study takes Chinese manufacturing A-share listed companies during a specific period (2009–2018) as research samples, in order to further investigate the effect of government innovation subsidies on enterprises with different ownership forms under different market power conditions (buyer power and seller power), on the basis of existing research on market power. All enterprises are divided into two groups, according to their nature of ownership: SOEs and non-SOEs. The empirical results show that, in the case of higher buyer power, government subsidies will significantly promote the R&D investment of enterprises, and the positive effect is not affected by the nature of ownership. In the case of lower buyer power and seller power, government subsidies significantly promote the R&D investment of non-SOEs, but have no effect on SOEs. This research will enhance our knowledge of the effects of government innovation subsidy in China. Our findings will also provide a theoretical basis for policymakers in developing countries to formulate innovation subsidy policies.

The remainder of the study is organized as follows. Section 2 constructs the theoretical model for the study. Section 3 presents the regression model, data sources, and variable definitions. Section 4 shows the descriptive statistics of the main variables and the empirical analysis results. Section 5 contains concluding remarks, including policy implications and research directions for the future.

2. Theoretical Model Design

Based on the conceptualization of González and Pazó [32]; this study introduces market power and ownership as explanatory variables in the empirical study of government subsidies and enterprise innovation, and constructs a theoretical model of government subsidies and market power on R&D investment of enterprises with different ownership models.

Let us suppose there is an industry that is composed of n enterprises, and each enterprise is producing heterogeneous goods whose output is denoted by q_i ($i = 1, 2, \ldots, n$), and product quality is s_i. The utility function of the consumer is as follows:

$$U(q,s) = \left[\sum_{i=1}^{n} \left(q_i s_i^{\delta}\right)^{\rho}\right]^{1/\rho}, \quad 0 < \rho < 1,\ \delta > 0, \tag{1}$$

where, in accordance with previous research [33]; δ is the sensitivity coefficient of consumers to product quality, and p_i represents the product pricing of the enterprise. On the premise that consumer consumption level Y is given, the demand function of the enterprise can be obtained from the condition of consumer utility maximization as follows:

$$q_i(p,s) = y p_i^{-\eta} s_i^{\varepsilon} M, \tag{2}$$

where $p = (p_1, \ldots, p_n)$, and $\eta = 1/(1-\rho)$ represents the price elasticity of consumer demand. Therefore, $1/\eta$ is the Lerner index, i.e., market power. $\varepsilon = \delta(\eta - 1)$ represents the quality elasticity of consumer demand. Assuming that y is the total number of products that consumers can purchase, then

$$y = Y p^{-1}, \tag{3}$$

where $p = \sum_{i=1}^{n} (p_i / s_i^{\delta})^{1-\eta}$ is the overall price index after considering quality factors. Since demand is positively and monotonically decreasing with quality ($\partial q_i / \partial s_i \rangle 0$, $\partial^2 q_i / \partial s_i^2 \leq 0$); from this, we can obtain $\delta \leq 1/(\eta - 1)$. If we assume that the number of firms that operate in an industry is sufficient for the price and quality decisions of a single firm to have minimal effects on the aggregate price index p, then

the price and quality elasticity perceived by each firm will be identical to η and ε.

Quality can be improved by incurring R&D expenditure, according to some technological rules. Assume that $\overline{x}$ is the effective point of investment in innovation. Enterprises improve their product quality through technological innovation activities, and when their innovation investment is below this specific level $\overline{x}$, the improvement in product quality is not significant (R&D activities have no effect) and product quality is at the same level as it would be without innovation investment (s_0). When the investment in innovation exceeds a specific level $\overline{x}$, product quality is improved and the law of diminishing marginal returns is satisfied. Therefore, the relationship between innovation input and product quality is as follows:

$$s(x_i) = \begin{cases} \overline{x}^{\theta}, & 0 \le x_i \le \overline{x}, \\ x_i^{\theta}, & x_i \ge \overline{x}, \end{cases} \tag{4}$$

where θ is the qualitative elasticity of innovation inputs ($\theta \le 1$). That is, quality can be enhanced, albeit at a declining pace, by incurring extra expenditures in excess of a minimum level $\overline{x}$ (set-up costs) necessary to affect quality.

It is believed that each product can be manufactured at a unit cost c. Assume that, given the activities of the competitors, the enterprise simultaneously picks the price of the product and the degree of R&D expenditure to influence quality. The objective function of the enterprise is as follows:

$$\max_{p_i, x_i} \pi_i = (p_i - c) q_i [p_i, s(x_i)] - x_i. \tag{5}$$

The government will provide subsidies to selected enterprises in order to encourage them to engage in innovative activities. The purpose of the subsidy is to reduce the production cost of enterprises and to stimulate their investment in R&D. Enterprises generally employ a portion of the subsidies for production and a portion for R&D. Thus, the government subsidies have two effects: the cost reduction effect (the unit production cost of the enterprises changes to αc, $0 \le \alpha \le 1$) and R&D incentive effect (after obtaining the subsidies, the total R&D investment of the enterprises is x_i', of which, the investment of the enterprises' own fund is $\beta x_i'$, $0 \le \beta \le 1$). At this stage, the maximization criteria of the enterprises are as follows:

$$\max_{p_i, x_i} \pi_i = (p_i - \alpha c) q_i [p_i, s(x_i)] - \beta x_i'. \tag{6}$$

In the face of government subsidies, rational enterprises will determine the optimal product price p_i^* and the amount of innovation investment x_i^* according to equation (6). Enterprises may also opt not to engage in innovation activities, in which case the quantity of innovation input $x_i^* = 0$. Combining the above two cases, the enterprise will choose the optimal price and innovation input combination (p_i^e, x_i^e) to achieve the goal of profit maximization, such that

$$\pi_i(p_i^e, x_i^e) = \max\{\pi_i(p_i^*, x_i^*), \pi_i(p_i^{**}, 0)\}, \tag{7}$$

where p_i^{**} is the product price that the enterprise will set if it decides not to undertake R&D activities.

It will be observed that the firm only invests in R&D when doing so is the most profitable option. Enterprises choose to increase their R&D investment when the benefits from their choice of innovation activities are higher than if they do not undertake innovation activities, i.e., $\pi_i(p_i^*, x_i^*) > \pi_i(p_i^{**}, 0)$. Taking the derivative of p_i and x_i' in equation (6), the price and innovation input level in equilibrium can be calculated as follows:

$$p_i^* = \frac{\eta \alpha c}{(\eta - 1)}, \tag{8}$$

$$x_i^* = \left(\frac{\theta \varepsilon}{\eta \gamma \beta}\right)^{1/1-\theta\varepsilon} \overline{x}, \tag{9}$$

where $\gamma = \overline{x}/p_i^* q_i(p_i^*, s_0)$ is the ratio of the effective point of innovation investment to sales revenue at an optimal price and standard quality. At this point, $p_i^* = p_i^{**}$. Substitute p_i^* into equation (5), and the following equation can be obtained according to the Dorfman–Steiner condition:

$$x_i^{\theta\varepsilon - 1} = \frac{\eta - 1}{c\theta\varepsilon y p^{-\eta}}. \tag{10}$$

By substituting equation (10), we can obtain:

$$\pi_i(p_i^*, x_i') = \left(\frac{1 - \theta\varepsilon}{\eta}\right) y p_i^{*\,-\eta+1} x_i^{\theta\varepsilon}, \tag{11}$$

$$\pi_i(p_i^{**}, 0) = \frac{1}{\eta} y p_i^{*\,-\eta+1} \overline{x}^{\theta\varepsilon}. \tag{12}$$

According to equations (11) and (12), when $x_i^{**} = \overline{x}/(1 - \theta\varepsilon)^{1/\theta\varepsilon}$, enterprises will receive the same benefits from innovation activities as they would have if they had not done so. As a result, an enterprise must satisfy $x_i^* \rangle x^{**}$ when choosing innovation initiations. That is, to convert to the following condition:

$$\frac{1}{\eta\gamma\beta} > (\theta\varepsilon)^{-1} (1 - \theta\varepsilon)^{-1 - \theta\varepsilon/\theta\varepsilon}. \tag{13}$$

According to equation (13), when the government subsidy is 0, $\beta = 1.\beta < 1$ means that the enterprise receives subsidies, and the R&D cost of the enterprise decreases. Therefore, the probability of innovation in the enterprise will be increased. At the same time, it can be seen that the probability of enterprise innovation activities is positively correlated with market power $1/\eta$ (i.e., the Lerner index).

When an enterprise decides to invest in R&D, it will determine the optimal level of R&D investment. Accordingly, an enterprise's optimal R&D intensity (i.e., the ratio of R&D investment to sales revenue) can also be calculated.

$$R_i^* = \frac{x_i^*}{p_i^* q_i^*}. \tag{14}$$

According to equation (2), the following equation can be obtained:

$$q^* = yp^{*-\eta}x_i^{*\theta\varepsilon}. \tag{15}$$

Substitute equations (8), (9), and (15) into equation (14) to obtain the R&D intensity of the enterprise when the market is in equilibrium:

$$R_i^* = \frac{\theta\varepsilon}{\beta\eta}. \tag{16}$$

As can be seen from equation (16), when an enterprise decides to invest in R&D, its R&D intensity is affected by government subsidies and market power: the greater the government subsidies are, the smaller the coefficient β is, and the greater the R&D intensity of the enterprise will be. At the same time, the stronger the market power $1/\eta$, the greater the intensity of R&D expenditure.

It is important to note that, among the determinants of R&D investment, market power $1/\eta$ and product quality elasticity of demand ε are both closely related to industry attributes. The R&D capability θ and threshold $\overline{x}$ of an enterprise are all dependent on the individual characteristics of the enterprise, such as enterprise scale, profitability, financial status, and operating years. Of these, the nature of ownership is a core element that needs special consideration.

Therefore, based on the theoretical models mentioned above, two theoretical hypotheses can be obtained in this study:

H1: The stronger the market power, the more obvious the effect of government subsidies.

H2: Under different market power, enterprise ownership will affect the effect of government subsidies.

3. Research Design

3.1. Sample Selection and Data Sources. This study uses data from China's A-share listed manufacturing enterprises as research samples to investigate the effect of innovation subsidies for enterprises of different ownership in the face of different market power. All sample data were downloaded from the Wind Database. In China, manufacturing enterprises are the main objects of government innovation subsidies. Moreover, the sample number of listed manufacturing companies is relatively large, the listing time is the longest, and the data of annual reports are more mature. Since 2009, the China Securities Regulatory Commission (CSRC) has required listed companies in China to disclose the names of their top five customers and suppliers in their annual reports. However, due to the impact of COVID-19, data disclosure in the 2019 and 2020 annual reports is incomplete and the data quality is questionable. Therefore, this study determined the research period to be from 2009 to 2018. Before the empirical analysis, the initial data were processed, and the sample observation objects that did not meet the requirements were eliminated according to the following criteria. First, enterprises with ST marks were removed: the ST mark means "Special Treatment"; listed companies with such markings frequently experience abnormal financial conditions or are at risk of delisting. Second, enterprises with fewer than 10 employees were removed: listed companies with too few employees are typically "shell companies," and their pertinent statistics are unworthy of examination. We removed enterprises lacking important financial indicators: samples lacking crucial financial indicators required for this research are atypical and must be discarded. As a result of these decisions, a total of 5697 observations were obtained from 1503 listed companies.

3.2. Variable Selection and Description

(1) *Explained variable*: This study mainly investigates the incentive mechanism of government subsidies on enterprise R&D. Therefore, the explained variable in this study is expressed by the intensity of enterprise R&D investment. R&D investment intensity represents the degree of effort made by an enterprise to improve its innovation capability. Considering the large gap between listed companies in terms of enterprise scale and income level, in order to reduce the estimation bias caused by enterprise heterogeneity, this study uses the proportion of enterprise R&D investment in the main business income of enterprises to measure the intensity of enterprise R&D investment.

(2) *Explanatory variables and moderating variables*: The explanatory variables selected in this study include government subsidy intensity (GOV) and enterprise ownership nature (SOE). In order to investigate the different effects of government subsidies for enterprises of different ownership in the face of different market power, this study takes market power as a moderating variable. The government subsidy intensity (GOV) is expressed by the ratio of government subsidy income to the main business income in the annual report of listed companies. One advantage of using a ratio measure is that it reduces the statistical bias caused by large differences in the amount of government subsidies given to firms of different sizes. Business ownership is a 0-1 variable. According to the nature of listed companies registered, central SOEs, provincial SOEs, prefectural SOEs, and other SOEs are all classified as SOEs, and the value is 1. Other enterprises, as private enterprises, are assigned a value of 0.

Market power refers to the ability of enterprises to control the price of goods when they trade. According to the upstream and downstream relations of commodity trading, market power can be divided into buyer powers for upstream enterprises and seller powers for downstream enterprises. In this study, the proportion of total sales of the top five customers (MC) and the proportion of total procurement of the top five suppliers (MS) are adopted as the proxy variables of seller power and buyer power, respectively. It is worth noting that the larger the value of MC and MS, the smaller the corresponding market power is. For example, the higher

the proportion of the total sales of the top five customers (MC), the higher the dependence of the enterprise on the major customers is, the worse the bargaining power and negotiation ability of the enterprise is, and the stronger the customer's control over the enterprise is, and thus the weaker the seller power of the enterprise is. Therefore, it is feasible to use these two proxy variables to represent the market power.

(3) *Control variables*: In order to minimize the bias of empirical results, several control variables are also selected. The control variables used in this study mainly include: (i) enterprise scale (SIZE), measured by the natural logarithm of employees; (ii) enterprise profit ratio (PROFIT), measured by the ratio of total profits to total assets; (iii) enterprise age (AGE), measured by the year minus the year of establishment plus one; (iv) enterprise debt ratio (DEBT), measured by the ratio of total debts to total assets; (v) enterprise industry (Industry), divided by two-digit SFC industry code; (vi) data year (Year), in order to separate the influence of enterprise size, profitability, establishment period, solvency, industry and year.

3.3. Regression Model Specification. In this study, the intensity of enterprise R&D investment is taken as the dependent variable. Market power and the nature of enterprise ownership are the moderating variables. Further, control variables such as enterprise asset scale, asset–liability ratio, profit margin, age of establishment, industry, and year are added to construct the regression model as follows:

$$\begin{aligned} RD_{i,t} = {} & \beta_0 + \beta_1 \mathrm{GOV}_{i,t} + \beta_2 \mathrm{SOE} + \delta_1 \mathrm{SOE}_{i,t} \times \mathrm{GOV}_{i,t} \\ & + \beta_3 MS + \delta_2 MS \times \mathrm{GOV}_{i,t} + \beta_4 MC \\ & + \delta_3 MC \times \mathrm{GOV}_{i,t} \\ & + \varphi X_{i,t} + v_i + \varepsilon_{i,t}, \end{aligned} \tag{17}$$

where i is the enterprise, t is the year, β_0 is the constant term, GOV is the variable of government subsidy intensity, X is the corresponding control variable, V represents the individual unobservable effect, that is, the heterogeneity among enterprises, and $\varepsilon_{i,t}$ represents the random error term. In formula (17), MC and MS are respectively the proxy variables of the seller and buyer power of the enterprise, as stated above. This study defines market power from the perspective of buyer power and seller power. Therefore, in order to reveal in more depth the innovation subsidy effect of enterprises of different ownership under different market power combinations, this study divides the market power combinations into four different combinations according to the median of market power. At the same time, the enterprises in the sample data are divided into SOEs and non-SOEs, according to the differing ownership of enterprises. After the empirical regression, the regression results are compared and analyzed.

Table 1: Descriptive statistics of main variables.

Variables	Obs	Mean	SD	Median	Min	Max
RD	5697	0.05	0.04	0.037	0.000	0.627
GOV	5697	0.01	0.02	0.006	0.000	0.424
MS	5697	0.34	0.18	0.303	0.001	0.997
MC	5697	0.31	0.20	0.262	0.009	1.000
AGE	5697	16.57	5.30	16.000	1.000	58.000
SIZE	5697	7.58	1.05	7.516	4.248	12.186
PROFIT	5697	0.14	0.27	0.102	0.000	13.276
DEBT	5697	0.04	0.02	0.037	0.001	0.181
SOE	5697	0.24	0.43	0.000	0.000	1.000

4. Empirical Results and Analysis

4.1. Descriptive Statistics and Correlation Analysis. Table 1 shows descriptive statistics of the main variables used in this study. As can be seen from Table 1, the mean value of R&D investment intensity (RD) of enterprises is 0.05, which is relatively low, and the standard deviation is 0.040, indicating a relatively stable quality of the data. In general, China's listed manufacturing enterprises spend relatively less on R&D. However, the fact that some enterprises can spend 62.7% of their main business income on R&D shows that the intensity of R&D investment is very different across enterprises. The average value of government subsidy (GOV) is 0.01, which indicates that the intensity of government subsidy for listed manufacturing companies in China is still at a low level. It can be seen from the mean value of the enterprise ownership (SOE) variable that the number of non-SOEs in the sample data is relatively large, which is in line with the actual development of listed companies in China. The extreme values of MC and MS are also very different. Across the variation of market power, both buyer power and seller power have a maximum value close to 1, indicating that the top five suppliers or customers have absolute control over the enterprise, that is, the market power of these enterprises is relatively small. The variables adopted in this study have also passed correlation analysis, and the correlation coefficients between explanatory variables are all less than 0.5, which eliminates the estimation bias caused by multi-co-linearity between explanatory variables. The result of the correlation analysis is shown in Table 2.

4.2. Empirical Results and Analysis

4.2.1. Regression Results of Market Power, Enterprise Ownership, and R&D Subsidy Effect. Table 3 shows the regression results of market power, enterprise ownership, and R&D subsidy effect. The random effect model of panel data is adopted for model regression (according to the results of the Hausman test). Column (1) is mainly the regression result after adding all control variables, which serves as the reference for other models. On the basis of Column (1), the interaction term between government subsidies and enterprise ownership is added in Column (2), which is used to investigate the R&D investment of enterprises of different

Table 2: The result of correlation analysis.

	RD	GOV	MS	MC	lnAGE	Size	Profit	Debt	SOE
RD	1								
GOV	0.346*	1							
MS	−0.034	0.0129	1						
MC	0.082*	0.0427*	0.2050*	1					
lnAGE	−0.061*	−0.0566*	−0.0425*	−0.0393*	1				
Size	−0.217*	−0.1429*	−0.3302*	−0.1818*	0.1605*	1			
Profit	0.180*	0.1063*	0.0394*	0.0660*	−0.0176	−0.1450*	1		
Debt	−0.1883*	−0.0542*	−0.1192*	−0.00420	0.1011*	0.4008*	−0.0458*	1	
SOE	−0.0476*	0.0154	−0.0402*	0.0210	0.1578*	0.2891*	−0.0682*	0.2417*	1

Table 3: Regression results of market power, enterprise ownership, and R&D subsidy effect.

	(1)	(2)	(3)	(4)
GOV	0.295***	0.296***	0.295***	0.187**
	(0.061)	(0.081)	(0.082)	(0.112)
SOE	0.001	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
GOV#SOE		−0.003	−0.004	0.011
		(0.115)	(0.115)	(0.123)
MS			−0.011***	−0.010**
			(0.004)	(0.005)
MC			−0.002	−0.008**
			(0.004)	(0.005)
GOV#MS				−0.135
				(0.284)
GOV#MC				0.395*
				(0.242)
Age	−0.001***	−0.001***	−0.001***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Size	−0.002***	−0.002***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Profit	0.010***	0.010***	0.010***	0.009***
	(0.004)	(0.004)	(0.005)	(0.005)
Debt	−0.086***	−0.086***	−0.089***	−0.086***
	(0.028)	(0.028)	(0.028)	(0.027)
_cons	0.019***	0.019***	0.028***	0.030***
	(0.008)	(0.007)	(0.008)	(0.008)
N	5697	5697	5697	5697
R^2	0.104	0.104	0.108	0.114
Wald chi2	859.99***	862.60***	883.39***	886.69***
Hausman test	139.91***	172.33***	174.64***	180.91***

Standard errors in parentheses; industry, location, and year are controlled in all models. $^{*}p < 0.15$, $^{**}p < 0.1$, $^{***}p < 0.05$.

ownership with different government subsidies. Column (3) adds market power on the basis of Column (2), and Column (4) adds the interaction term between government subsidies and market power on the basis of Column (3). As can be seen from Table 3, the regression coefficient of government subsidy intensity (GOV) is positive, and both are significant at the statistical level of 0.01. This result shows that the greater the level of government subsidies, the higher the intensity of enterprise R&D, that is, there is a certain crowding effect of government subsidies on enterprise R&D, which is consistent with most existing research findings on the effect of government subsidies in China.

The empirical regression results show that both buyer power and seller power are negatively correlated with enterprise R&D investment. The regression results of buyer power in Column (3) and Column (4) are significant, that is, the lower the total proportion of the top five suppliers of an enterprise, the greater the buyer power of an enterprise, and its R&D investment will increase: when an enterprise has a large buyer power, it is more likely to occupy a dominant position in the transaction process, thus reducing its negotiation cost, and thus allocating more energy and resources to the innovation stage to consolidate its market position. As can be seen from the regression results of Column (4), when the seller's market power is small, the effect of innovation subsidy is better. The smaller the seller's market power is (the larger the MC is), the more government subsidies are invested, which will lead to more R&D investment. This may be due to the fact that, with a small seller's market power, enterprises can better understand the needs of existing customers and increase R&D spending to better serve customers with the help of government subsidies. However, the regression coefficient between buyer power and government subsidies is not statistically significant. From the regression results of Column (2) to Column (4), the regression coefficients of enterprises of different ownership are not significant.

Next, in order to more deeply analyze the R&D subsidy effect of enterprises with different ownership in the face of different market power, this study divides different market power into groups and investigates the relationship between enterprise ownership and government subsidy effect under different combinations of market power.

4.2.2. Comparative Analysis of the Effect of Government Subsidies under Different Combinations of Market Power. In order to reveal the difference in innovation subsidy effect of enterprises with different ownership in the face of different market power combinations, this study divides the sample into four groups of different market power combinations based on the median of buyer power and seller power and performs regression on them one by one according to different ownership nature of enterprises. Specifically, we first calculate the medians of MS and MC to distinguish different market power. The median of MS is 0.3027 and the median of MC is 0.2617. Second, all enterprises are divided into SOEs and non-SOEs, according to

Table 4: Regression results of the influence of different market power combinations.

State-owned enterprise				Nonstate-owned enterprise			
Buyer	Large	0.287***	0.432***	Buyer	Large	0.196**	0.287***
		(0.040)	(0.093)			(0.107)	(0.082)
Power	Low	0.339	0.050	Power	Low	0.542***	0.075*
		(0.250)	(0.072)			(0.119)	(0.051)
		Low	Large			Low	Large
		Seller power				Seller power	

Table 5: Results of robustness checks.

State-owned enterprise				Non-state-owned enterprise			
Buyer	Large	0.286***	0.401***	Buyer	Large	0.212***	0.250***
		(0.050)	(0.034)			(0.065)	(0.019)
Power	Low	0.289***	−0.027	Power	Low	0.405***	0.073***
		(0.084)	(0.038)			(0.037)	(0.036)
		Low	Large			Low	Large
		Seller power				Seller power	

Standard errors in parentheses; industry, location, and year are controlled in all models. $^{*}p < 0.15$, $^{**}p < 0.1$, $^{***}p < 0.05$.

forms of ownership. For comparison, Table 4 only shows the regression coefficients of government subsidy intensity in each case.

The regression results in Table 4 show that, in the case of large buyer power, government subsidies will significantly promote the R&D investment of enterprises, regardless of whether they are SOEs or not. Such large buyer-power enterprises are generally large enterprises with core competitive advantages, and they have the capital and strength to compete with upstream enterprises. By taking advantage of such advantages, such enterprises can ensure their R&D investment and continue to invest in the innovation stage, thereby maintaining their leading position in the market competitive advantage. At the same time, the government continues to subsidize such enterprises, and this can send a positive signal to society and attract the attention of investors, thus ensuring the sustainable development of enterprises. This virtuous cycle of the innovation process is also expected by the government and society.

When both buyer power and seller power are low, the effect of innovation subsidy is significantly different among enterprises with different forms of ownership. For non-SOEs, government subsidies significantly promote R&D investment, but the effect of government subsidies on SOEs is uncertain. This is a topic that future research could explore. Enterprises with small seller power and buyer power are usually enterprises at a small scale, and non-SOEs among such enterprises are often faced with problems such as insufficient resources and insufficient innovation incentives. At this time, government subsidies can help these enterprises overcome capital constraints and increase their ability to resist risks.

SOEs face the opposite situation. Due to the defects of the system, small SOEs generally have shortcomings such as weak innovation and incomplete innovation incubation processes. Even if the government gives innovation subsidies, such enterprises are still prone to "living in the past" and are unable to attract and hire high-level technical talents, which leads to low innovation efficiency.

In cases where the seller has a large influence and the buyer has a small influence, the regression coefficient before the government subsidy (GOV) of the two types of enterprises is not significant. It is a task for the academic community to reveal the effect of different ownership on innovation subsidies under such market power. This is a problem worthy of discussion. However, it is beyond the scope of this study, and should be referred to in future research.

4.3. Robustness Checks. In this section, we test the robustness of our empirical results in this study. We performed several robustness tests by substituting independent variables, including control variables, and demonstrated the robustness of our results. To save space, we present one of these robust checks in Table 5 by controlling a firm-specific factor. From the regression results, the coefficient signs and significance of the variables investigated in this study, including government subsidy intensity, ownership, and market power, are basically consistent with the regression results in Table 4. The nature of SOEs is not certain in the two types of regression. In view of this, it may be necessary to exclude other types of enterprises for group regression, so as to obtain more conclusive conclusions. Meanwhile, the coefficient signs and significance of control variables such as enterprise age (AGE), enterprise size (SIZE), profit margin (PROFIT), and debt ratio (DEBT) are consistent with the results in Table 4, proving that our research results hold.

Endogeneity is also a matter of concern. There is a possible cause and effect between government subsidies and R&D investment. However, after many attempts, we have not found a suitable way to deal with the endogeneity problem in this study. There is also no mention of a feasible attempt in the relevant literature. Therefore, this also

becomes an issue left for further research. Further explanation will be provided later if there is a suitable method to deal with the endogeneity problem in this study.

5. Conclusion and Discussion

Enterprises, upstream suppliers, and downstream customers are essential components of the contemporary marketing micro-environment. Every enterprise in the marketplace has complicated upstream and downstream industrial relationships. Government subsidy, as the "helping hand" of government, is an effective way to solve technological innovation and reduce innovation risk. In order to reveal the complex influence of market power and enterprise ownership on the effect of government innovation subsidy under the micro-environment of contemporary marketing, this study constructs a random effect model based on the sample data of Chinese listed manufacturing companies from 2009 to 2018. The empirical results show that there are great differences in subsidy effects of different ownership enterprises under different market power combinations. Specifically, in the case of large buyer power, government subsidy will significantly promote the R&D investment of enterprises, and this promotion effect has nothing to do with the ownership nature of enterprises. When both buyer power and seller power are small, government subsidies significantly promote R&D investment for nonstate-owned enterprises, but this effect is not significant for state-owned enterprises. In the case of large seller power and small buyer power, the effects of government subsidies on both state-owned and nonstate-owned enterprises are not significant. This is a question worthy of further discussion in future research.

The research contributions of this study are as follows. First, due to lack of data, most existing studies only study the impact of government subsidies on enterprise innovation in general and do not subdivide the effect of innovation subsidies on enterprises under different market power and different ownership. Considering that enterprises face both upstream and downstream enterprises in the market, each enterprise has two kinds of market power: seller power and buyer power. This study innovatively adopts the proportion of top five customers' total sales and the proportion of top five suppliers' total purchase as the proxy variables of seller power and buyer power, respectively. Based on the group investigation and comparative analysis of different market power and enterprise ownership, the study reveals in greater depth the effect of innovation subsidy when enterprises of different ownership face different market power. This study further opens up the theoretical black box of the relationship between government subsidies and enterprise innovation, which fills the theoretical gap in this aspect.

Second, the theory of industrial organization pays more attention to the problems of market power and enterprise innovation. Research on government subsidies and market power, however, seems to be split. The research on government subsidy mainly focuses on empirical analysis, while the research on market power mainly focuses on the derivation of a mathematical model. At the same time, the data used in existing studies are relatively old. Based on the transaction data published in the annual reports of Chinese listed companies from 2009 to 2018, this study examines the market power faced by enterprises, which not only provides empirical support for the relationship between market power and enterprise innovation but also provides relatively new empirical evidence for the empirical analysis of the effect of innovation subsidies.

Third, the empirical results show that there are significant differences in the effect of innovation subsidies for enterprises of different ownership under different types of market power. In the case of large buyer power, government subsidies will significantly promote the R&D investment of enterprises, regardless of whether or not they are SOEs. When both buyer power and seller power are low, the effect of innovation subsidy is significantly different among enterprises with different forms of ownership. For non-SOEs, government subsidies significantly promote R&D investment, but the effect of government subsidies on SOEs is not significant. This study provides an important theoretical point of reference for governments of developing countries seeking to implement innovation subsidy policies by classification. When formulating subsidy policies, the government should comprehensively consider the ownership nature of enterprises and the market environment of enterprises, and carry out targeted subsidies, so as to achieve "precise" subsidies.

5.1. Policy Implications. The policy implications of this study are as follows. First, given that government innovation subsidies are incentive based to a large extent, they should be further increased to encourage firms to actively engage in innovation activities. At the same time, the government should strengthen supervision and assessment to avoid information asymmetry between government and enterprises, so as to reduce the phenomenon where some enterprises pursue rent-seeking behavior and release false signals of innovation to misdirect government subsidies but do not then carry out R&D innovation.

Second, considering the positive impact of government subsidies on R&D investment of enterprises, when buyer power is large, the government should introduce the market competition mechanism in an orderly manner, gradually reduce the entry threshold of the upstream monopoly industry, and weaken the seller's market power of the upstream enterprises, thus increasing the buyer's counterweight power of the downstream enterprises, and promote the R&D investment of the downstream enterprises. Since the weakness of the seller power is not conducive to enterprise innovation, the government should introduce appropriate policies to encourage the formation of vertical innovation alliances between upstream and downstream enterprises, in order to eliminate the negative impact of the weakness of the seller's power.

Third, under the influence of market power, the effects of government innovation subsidies vary widely according to different forms of enterprise ownership. In view of this, the government should formulate different subsidy policies for

enterprises with different forms of ownership. The direction of government subsidies should be further adjusted to appropriately reduce subsidies to large, well-funded SOEs, in favor of private enterprises that are highly motivated to innovate and more in need of R&D funding supplements. Non-SOEs should be guided toward making "long-term" R&D decisions. The policy focus should be to reduce the uncertainty and risk of innovation, to continuously cultivate and accumulate R&D capabilities, and to improve their competitive advantages. As previous studies point out, the R&D input of SOEs is higher than that of other types of enterprises, but their R&D output is relatively poor. Therefore, for SOEs, corresponding technological development goals should be formulated to promote the optimization of the R&D input–output ratio guided by innovation output.

5.2. Limitations and Future Directions. This study investigates the effect of government innovation subsidy under different market power and different ownership, but there remain limitations. Future research can be carried out from the following aspects. First, it is necessary to further differentiate the methods of government subsidies. Government subsidies can be divided into presubsidy and postsubsidy, R&D subsidy and non-R&D subsidy, so as to further investigate the response of enterprises of different ownership to government subsidies in different ways under market power.

Second, since 2009, the China Securities Regulatory Commission (CSRC) has required listed companies to disclose the transaction shares of the top five upstream and downstream trading partners of enterprises, which has provided a more reliable data source for this study to investigate the buyer power and seller power. However, many listed companies do not disclose the names of upstream and downstream enterprises in their data disclosure. With more standardized data disclosure of listed companies in China, some new methods to measure market power can be introduced into the approach in this study.

Third, this study uses manufacturing enterprises in the database of listed companies as samples, because these enterprises are much more likely to receive government subsidies than nonlisted enterprises. However, the number of nonlisted companies subsidized by the government still accounts for the majority, which may lead to sample selection problems in studies that only select listed companies as samples. At the same time, after more industrial enterprises are taken into account, the measurement of upstream and downstream market power of manufacturing enterprises will be more accurate. However, the existing database of Chinese industrial enterprises is relatively poor in the data quality of government subsidies, upstream and downstream market power, etc. With the continuous opening and improvement of this database or related databases, the relevant conclusions of this study can be further tested.

Data Availability

After the publication of this study, data are available upon request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest or personal relationships that could have appeared to influence the work reported in this study.

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