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SD Policy, Political Connection and R & D Expense: Firm-Level Evidence from China

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Abstract

This paper aims to answer whether super deduction of R & D expense policy (SD policy), a preferential tax policy, effectively stimulates a firm's R & D in the first place and whether the policy is affected by the firm's political connections in the second. By theoretically exploring how SD policy and political connection influence a firm's R & D expense behaviour, the paper then empirically examines the effects using firm-level data in China. Results show that SD policy stimulates firms' R & D significantly, which was, however, mitigated by political connections. Besides, the types of political connections of a firm's CEO have heterogeneous effects on the SD policy-R & D expense nexus in the way that CEOs with CPC and NPC backgrounds have a *promotive effect* but are statistically insignificant. In contrast, CEOs with government and CPPCC backgrounds have an *inhibitive effect*.

Keywords

Super Deduction, Political Connection, Firm's R & D, China

1. Introduction

The new growth model has it that innovation is the main driving force of economic growth, and technology is not exogenous but endogenous (Romer, 1990). Theoretically, R & D (Research and Development) is conducive to enhancing economic transformation and upgrading the economic structure. The determinants of firms' R & D can be divided into internal and external factors. The former is internal institutional arrangements made by firms in the pursuit of profit maximization, including property rights arrangement, governance structure, etc., while the latter is external shocks firms face, such as market competition, government policy, etc.

China has issued quite a few public policies to encourage firms to increase in-

vestment in R & D, among which the SD policy (*R & D expense super deduction*) is one of the most typical policies in current *Corporate Income Tax Law*. SD policy means the qualified R & D spending can be super deducted at the rate of 50% before tax when computing the corporate income tax base. For instance, if a firm spends 100 Yuan on R & D, then 150 Yuan can be deducted when computing the taxable income. Hence the tax paid by a firm would be reduced. The effect of SD policy on firm innovation has been of concern for over a decade (Yuan et al., 2016). Studies, however, have not reached robust and consistent conclusions.

Political connection is an informal institution that significantly impacts business decision-making, firm value, and even social equity (Hillman et al., 2004; Zhang & Guo, 2010; Tang & Sun, 2014). In China, a political connection of firms mainly refers to senior managers who are/were members of the Communist Party, government officials, members of the CPPCC, i.e., the Chinese People's Political Consultative Conference, and deputies to the NPC, i.e., the National People's Congress, which are often called "the Four". Political connections enable firms to procure additional financial subsidies, financing facilities, and social capital, which also enable them to enjoy more preferential tax policies and thus create a better R & D environment (Chen et al., 2011). Furthermore, political connections can facilitate firms to have exceptional communication channels, which maybe not be conducive to the specific formal institution/policy to play its due role (Yuan et al., 2015; Li, 2017; Wang et al., 2019).

To our best knowledge, few papers have examined the relationship between SD policy, political connection, and R & D. Therefore, the contribution of this paper is to examine whether the firm's political connection affects the effect of SD policy on R & D expense. The following parts are structured: Part 2 reviews a strand of literature on SD policy, political connection, and innovation expense. Part 3 is to describe the institutional background and presents the research hypothesis. Part 4 is the methodology. Part 5 is to perform empirical analysis and robustness check, and Part 6 is to conclude.

2. Literature Review

There is a strand of literature on firm's R & D over the past decades. Until recently, much research has been done on the firm's R & D behaviour from the perspective of SD policy and political connections.

Researchers have varied arguments regarding the effect of SD policy on a firm's R & D expense. Some argue that the SD policy has a positive effect. For instance, Czarnitzki et al. (2011) suggested that the SD policy stipulates that firms increase R & D expenses by examining Canadian companies using a non-parametric method. Yang et al. (2012) found that the SD policy encouraged firms to invest more in R & D by analyzing manufacturing companies in Taiwan using the propensity score matching (PSM) technique. While other researchers argue that the effect of SD policy on a firm's R & D expense is insignificant. Eisner et al. (1984) argued.

There is no substantial evidence of SD policy's positive effect on R & D. Wallsten (2000) found that the SD policy might bring about a crowding-out effect by examining the R & D of small firms in the US. Besides, Researchers also paid attention to the factors which recently influenced the SD policy's effect. For example, Li & Chen (2017) pointed out that regional environmental heterogeneity significantly impacted the SD policy's effect. Based on questionnaires, Guo (2017) studied the obstacles to the effect of SD policy, including implementation agencies, target groups, and environmental factors. Environmental factors, social and institutional environment, in particular, have a far more critical effect on SD policy's effectiveness. An excellent institutional environment will reduce the transaction costs in policy implementation and improve the effectiveness of the policy.

The effect of political connection as an informal institution on the firm's R & D has been a concern by researchers (Tian & Zhang, 2013), while conclusions are inconsistent. Some argued that political connections have a significant *positive* impact on R & D in the way that political connections avail firms of more financing opportunities, lower financing cost, and a better environment (Yu & Pan, 2008; Liu et al., 2013). Moreover, political connections bless firms to obtain government financial resources, such as direct subsidies. Cai et al. (2014) using firm-level data found that political connections helped to improve the innovation. Pan & Zhang (2016) believed that the political connection of independent directors was conducive to firm innovation by empirically examining firm-level data in China. Some other researchers argued political connections have a significant *negative* effect on R & D. For instance, it proposed that political connections and *Guanxi* (relationship culture) cost firms much, which reduces firm's R & D incentives. Zhou (2013) concluded that political connections might lead to organizational inertia. Xie et al. (2014) believe that firms are not interested in R & D to gain a competitive advantage with the support and protection of the government. Yuan et al. (2015) found that higher political connections hinder R & D expense, which verified the curse effect of firm political resources. Su & Chen (2017) demonstrated that entrepreneurs' local political connections are not conducive to R & D by analyzing firm-level data in China.

Some researchers have begun to pay attention to the role of political connection in the implementation of SD policy. For example, some believe that political connections weaken the incentive effect of tax policy on R & D by squeezing the production resources of firms (Han & Liu, 2017). Others argue that political connections can *positively* affect the effect of tax incentives on R & D because it gives firms a better reputation, thus reducing the financing constraints (Yang & Yu, 2014). These two contrary views open the question of whether political connections promote or inhibit the effect of the SD policy on a firm's R & D.

The marginal contribution of this paper lies in explaining the mechanism of political connection within the effect of SD policy on R & D behaviour. Particularly, this paper investigates the effect of SD policy in terms of the personal political connection of firm leaders (actual controllers, senior managers). Within

the framework of political connection, SD policy, and firm's R & D, this paper tries to make policy implications for innovation accordingly.

3. Institution Background and Hypothesis

3.1. Institutional Background

To encourage firms to increase R & D expense and improve independent innovation capability, China implemented the pre-tax deduction policy for R & D expenses in 1996. Initially, this policy was confined to state-owned enterprises, and the policy is simply that when computing the taxable income, the firm's R & D can be super deducted by 50% of the actual amount. Thus, the policy is usually called R & D Super Deduct Policy, i.e., SD policy in this paper, as we can see that the SD policy is born politically connected. In 2003, to create a fair play market for all agents, the preferential policy expanded to various companies in terms of ownership domestically. In 2006, the policy further expanded to the companies owned by foreign investors and colleges and universities.

In 2008, the *Corporate Income Tax* (*CIT*) *Law* of China was newly enacted, confirming SD policy in legal form. For instance, Article 30 of CIT Law stipulates that R & D expenses incurred in developing new technologies, new products, and processes can be super deducted when calculating the taxable income. If the expenses incurred are not included in the profits and losses of the current period, they shall be deducted based on actual deductions, and 50% of the research and development expenses shall be added and deducted. If the expenses are incurred in the development of intangible assets and the intangible assets are formed, they shall be amortized to 150% of the cost of the intangible assets.

SD policy is a critical tax incentive policy to support a firm's technological innovation and promote industrial transformation and upgrading. Theoretically, it can save R & D funds and encourage firms to increase their R & D expense.

Broadly speaking, the firm political connection is a special kind of relationship between the government and firms. Generally, it refers to the situation in which the senior managers of firms serve (d) in the government or related departments with political power or the informal connections that they have established with the government and other political power departments. This paper studies the former that the senior managers of firms in the Communist Party committee, the government, the NPC or the CPPCC. The political connection does not imply corruption in all its forms, such as bribery, but is legally recognized. The managers serve or once served as "government civil servants", "deputies to the NPC" and "members of the CPPCC". As an informal institution, a political connection affects the operation of firms.

Communist Party is the ruling party, and it is the most powerful group in China. Being a CPC member does not necessarily mean a man or woman has political power but a member of the committee. Government has no doubt political power. It regulates, implements, and it has a large extent of discretion. Usually, communist party members account for most government officials. NPC

is the group that enacts the law and regulation, like the assembly or parliament in western countries. Its function is to check and balance the government. Thus, NPC has political power. CPPCC is jointly ruling the country. It is made up of democratic party members as well as celebrities (actors, writers, entrepreneurs, *etc.*) from various industries. Its primary function is to inspect the government budget most of the time. The Four are closely related, so if a firm is managed by a person who is/was one of the Four, it would be seen as politically connected.

It is worth warning that according to *Decisions on forbidding party members and government officials to do market business* (*1986*) issued by CCP central jointly with the State Council in China, those who are working in party committee, government, departments of justice, and affiliates are strictly forbidden to do business in the market unless retired or resigned their post, and their family members must not take advantage of their power when doing business either.

We are now concerned about whether the firm political connection impacts the implementation of the tax statute law-SD policy.

3.2. Hypotheses

Hypotheses 1: SD policy stimulates firms' R & D

Innovation has positive externalities. Firms undertake all the R & D costs, but they cannot exclusively obtain all the benefits of innovation. Besides, because of the information asymmetry problem, which leads to the R & D of firms being lower than the optimal level from the Pareto efficiency perspective, government intervention is thus expected to improve the inefficiency of firm resource allocation. R & D direct subsidies and tax incentives are commonly used as policy instruments. Studies have shown that tax has a more substantial incentive effect on R & D than direct subsidies (Zhang et al., 2017). The tax provides firms with greater autonomy and can indirectly guide their behaviour through market mechanisms. To promote R & D expense, China has issued many innovative incentive tax policies to reduce R & D costs and increase R & D enthusiasm. Among these policy initiatives, the SD policy is perceived as the most supportive and achieves the best policy effect (Wang & Chen, 2016).

With SD policy, the more R & D expense, the greater the pre-tax deduction amount, and the more tax burden reduced. Therefore, firms can save more funds for R & D activities, which can encourage them to increase their R & D expenses. Therefore, we put forward the first hypothesis: *the SD policy encourages firms to increase investment in innovation in China.*

Hypotheses 2: Political connections inhibit the effect of SD policy on firms' R & D

Political connection is an informal institution, while SD policy is formal. Informal institutions may have complementary or substitute effects (Luo & Tang, 2009). On the one hand, political connections can encourage firms to use SD policy, increasing R & D and exerting a *promotive effect*. The reasons for that are as follows. Firstly, politically connected firms can access tax credit more easily, and local governments are motivated to exercise the taxing power to achieve

political and economic benefits (Yang, 2011). Besides, the implementation of the SD policy has certain flexibility (Wu, et al. 2009). The tax authorities have greater discretion in offering a tax credit. Governments tend to use resources to enable the tax to achieve the overall goal of increasing fiscal revenue but then inadvertently weaken the independence of the tax authorities (Wang & Liu, 2004; Li & Xu, 2013). Political connections help firms avoid possible income tax discrimination and obtain first-hand information about the SD policy to gain more tax benefits.

Secondly, politically connected firms usually receive more government subsidies. The government usually gives subsidies unevenly, i.e., the recipients of financial subsidies are often limited to specific areas. Politically connected firms make it easier to pass the examination and approval to become a specific target of subsidies when applying for government subsidies (Yu et al., 2010). A large number of subsidized resources obtained by the politically connected firms from the government can often relieve firms' financial pressure and provide strong financial support for firms to make better use of the SD policy and increase R & D.

Thirdly, generally political connected firms can obtain more external financing. R & D activities featured high risk, time-consuming, large investment, asymmetric information make it difficult for many firms to procure external financing, such as bank loans (Zhang et al., 2012). The political connection is equivalent of a signal to the society and market, which conveys the trust that firms have been approved and endorsed by the government (Liu et al., 2018). Thus, politically connected firms are often considered to be lower financial risk and reflect a positive image (Chen & Zhu, 2009), which enables them to obtain a favourable positive market response resulting in more external financing such as bank loans, and other resources. Political connections enhance the availability of external financing for R & D activities, alleviate the inadequacy of insufficient R & D with limited resources when firms can enjoy the SD policy, weaken the negative effect of insufficient external financing on firms, and promote firms to make use of the SD policy to invest technological innovation.

Finally, the political background of senior executives reflects that they are more likely to be the elites of society. They have a broader vision, a long-run plan, a stronger sense of innovation and ability and are therefore perceived as being more aware of the importance of innovation and are more than likely to put it into practice. Generally speaking, current or former Party Committee members, Party representatives, government officials, deputies to the NPC, or senior executives of the CPPCC members may have in-depth knowledge of firms, suitable practical experience, and strong working ability to make up innovative plans and implement them effectively. Furthermore, they usually have strong decision-making and risk-taking ability, and dare to take bold decisions and are good at innovation.

On the other hand, the political connection may also have an *inhibitive effect*, i.e., inhibiting the incentive of SD Policy to firms' R & D behaviour because po-

litical connections bring about privileges and resources to firms. At the same time, it also imposes heavy cost shackles on firms. Specifically, establishing or maintaining political connections usually consume a lot of staffing, material resources, and funds, such as entertainment and transportation costs in the rent-seeking process (Cai et al., 2018) and non-transparent charges as well (Du et al., 2009). To meet the needs of local governments to achieve GDP growth goals, firms may deviate from the primary business investment blindly to help the government achieve job growth and social stability. To do that, Firms implement unnecessary enrollment of employees and salary increases (Liang & Feng, 2010) or make more charitable donations to *buy* government credit resources. The firms do these things to maintain or enhance their relationship with the government. These rent-seeking activities themselves will squeeze a large number of productive resources. Secondly, political connections increase the *irrational* behaviour of firms, which further brings a heavy burden to firms indirectly. For example, politically connected firms are more likely to obtain resources, so their managers are more likely to blindly confident, optimistic, and underestimate the market risks (Heaton, 2002), meanwhile, because they bear more policy burdens, their performance sensitivity is reduced (Liu et al., 2010), it expands inefficient investment, wastes firm resources. It can be said that political connections squeeze the staffing, material resources, financial resources, and energy of firms and weaken the ability of firms to expand R & D expenses by using the SD policy. Thirdly, political connections encourage the inertia of firms (Han & Liu, 2017), thus weakening the incentive for firms to increase R & D expenses by utilizing the SD policy. The better the political relationship between firms and the government, the more likely they are to enter high-barrier industries (Luo & Liu, 2009). High-barrier industries mean low competition. Firms tend to breed inertia and are lazy in technological innovation. Even in general industry, a political connection is a signal that the market considers the firm to have a promising future (Tao & Li, 2012), thus enabling the firm to access more investment and develop markets without cost and not requiring R & D expense super deductions to make technological innovation to gain market recognition.

Because of the possible coexistence of *promotive effect* and *inhibitive effect*, it is impossible to directly tell the overall effect of political connection on the implementation of the SD policy. We believe that in the existing institutional environment, the *inhibitive effect* may gains the upper hand, but we should also be aware of the heterogeneity of political connections. Therefore, we propose the second hypothesis: *political connection will inhibit the incentive effect of SD policy on firms' R & D, and the heterogeneity of executives' political connections have different effects on this policies*.

4. Research Framework

4.1. Model

To test the hypothesis of whether the SD policy can promote firms' R & D effec-

tively and whether political connections can influence the implementation effectiveness of the SD policy. Following Xie et al. (2014), Zhang et al. (2015), and Wang & Li (2017), we set up Equation (1) as a base model:

$$RD_{it} = \beta_0 + \beta_1 Deduct_{it} + \beta_2 Deduct_{it} * PC_{it} + \sum_{j=3}^{10} \beta_j X_{jit} + v_i + \delta_t + \varepsilon_{it} \quad (1)$$

where RD_{it} is the R & D expense, $Deduct_{it}$ is the super deduction. PC_{it} is the political connections. The subscript it denotes the firm i in year t, $v_i + \delta_t$ is the time and firm fixed effect. β_1 denotes the effect of SD policy on R & D, while β_2 denotes the effect of political connections on SD policy effectiveness.

4.2. Variables and Measurements

Regarding the dependent variable RD, most studies use a firm's R & D expense as the proxy of variable R & D. While there are many indicators to measure a firm's R & D expense, including the absolute number of R & D expense, its logarithm form, and R & D expense intensity as well. R & D expense intensity also has many forms, such as the ratio of R & D expense/turnover, the ratio of R & D expense/prime operating revenue, the ratio of R & D expense/total assets, the ratio of R & D expense/the number of employees, etc. To eliminate the influence of firm size on R & D and ensure the comparability of R & D in different periods, R & D in Equation (1) used the firm's R & D expense density which is the ratio of R & D expense to prime operating revenue of the year.

Following Liu et al. (2012), the explanatory variable $Deduct_{it}$, which denotes R & D expense super deduction, is measured by

$$\frac{\text{R\&D expense} \times 50\% \times \text{Corporate income tax rate}}{\text{Total assets}}$$

According to Zheng et al. (2014), Political connections include the relationship between the firm and the government or Communist Party. In this paper, however, a political connection is defined as at least one or more of the senior executive team members or board of directors serving (d) as the Party's representatives, the deputies to the NPC, the members of the CPPCC, or government officials.

Political connection is usually measured with the dummy variable. I.e., if management team member (s) is (are) connected to the Four, then the PC is 1, otherwise 0 (Wang & Li, 2017). Some researchers use the proportion of executives with political connections to measure the intensity of political connections. We argue that the former approach hardly reflects the true political background of the firm, so in this paper, we propose an alternative approach which was once used by Zhang & Zhang (2013), i.e., if one or more board of directors or executives meet one of the following conditions, former Party member representatives or Party Committee members, former government officials, current or former deputies to the NPC, and current or former CPPCC members, then the firms will be seen as politically connected. In this way, PC Equation (1) is 1; otherwise is 0. Secondly, the political connections of firm leaders often have a direct and

significant impact on the operation of firms. Therefore, this paper classifies the political connections of the firm Chief Executive Officers (CEOs). If they experienced multiple political backgrounds, we take a priority approach to determine CEOs' ultimate political backgrounds. The specific approach is as follows; first, we suggest only the four types of political connections considered in this paper, so the best form of political connection is the non-political connection. For example, this paper does not consider the political connection when working in a social organization or a democratic Party. Secondly, if two or more forms of political connection are met in the Four discussed in this paper, the higher administrative level is considered. Thirdly, if the administrative levels of the two forms of political connection are equivalent, the ultimate political connection of the CEO is determined by the way that the Party is superior to the government over the NPC and the CPPCC in order.

Upon reviewing the literature, it can be found that R & D is affected by a wide range of factors other than tax incentives and political connections, so the following main variables are used as control variables in our model.

Firm size (*Size*). Generally speaking, large-scale companies can allocate more resources to R & D activity. Studies measure firm size by total assets. While in this paper, because the denominator of the intensity of R & D expense super deduction is total assets, we use the logarithm of the number of employees to measure it to mitigate the collinearity between the variables.

Firm profitability (*ROA*). We choose the total return on assets to measure firms' profitability. The higher the ROA, the stronger the profitability of firms, and the more financial support will be provided for R & D expenses.

Firm competitive pressure (*Compete*). Faced with the pressure of market competition, firms tend to make technological innovations to explore market opportunities. Therefore, competitive pressure is also an important factor that can affect R & D expense. Referring to Nie et al. (2008) and Liu et al. (2012), we use advertising density, i.e. the proportion of advertising expenditure to business income to measure the competitive pressure of firms. Considering the low disclosure of advertising expenditure, we use the ratio of sales expenses to main business income as the proxy.

Executive shareholding (*Holder*). Executives' shareholding has an impact on R & D expense. Some studies suggest that executive shareholding can alleviate the principal-agent problem and promote R & D expense. This paper uses dummy variables to measure whether executives hold shares, if executives hold shares, the holder is 1, otherwise, it is 0.

High-tech qualification (*High*). If a firm is a qualified high-tech firm, it enjoys a lower tax rate, so to maintain the high-tech qualifications, firms manipulate R & D expenses. To reduce the interference of high-tech qualification to the issue discussed in the paper, variable High is measured by a dummy variable. If the firm is qualified high-tech, High is 1; otherwise, it is 0.

Firm age (*Age*). Firms have a life cycle. The firms' behaviors of R & D differ in terms of age. We measure firm age by computing "year-registered year + 1".

Firm industry (*Industry*). Different industries have different demands for innovation, which results in the average R & D expense being different amongst various industries. Generally, the high-tech industry's average R & D expense is relatively high. According to the *classification of high-techindustry* (*manufacturing industry*) *by the National Bureau of Statistics* (*2017*) and *the classification of high-tech industry* (*service industry*, *Pilot implementation*) (*2013*), the industry belongs to the high-tech industry is 1, otherwise is 0.

Firm location (*Region*). Firms in different regions are faced with different market and regulatory environments, and the level of economic development is positively correlated with the regional institutional environment. Therefore, we assign values 2, 1, and 0 to the eastern, middle and western regions according to the level of economic development to show the region where the firms are located. The regions grouped in this paper are consistent with the central government's official publication.

All the variables and their definitions are shown in Table 1.

4.3. Data

To ensure the continuity and availability of the data, we use the data of A-share market listed companies in China from 2014-2018 collected from CSMAR and the CNINFO database.

There are 1024 listed companies' relevant information obtained after preliminary screening, and we further eliminate the special treatment firms such as

Table 1. Definition of variables.

Variable	Variable	Definition
Explanatory variables	RD	The ratio of R & D investment to the main business income of that year.
Core explanatory variables	Deduct	R & D input × 50% × (firm income tax rate/total assets of the current period).
	PC	One or more members of the executive team or board of directors work or ever worked as the Party's representatives, the deputies to the NPC, the members of the CPPCC, and government officials.
Control variables	Size	The logarithm of the number of employees.
	ROA	The ratio of net profit to total assets.
	Compete	The ratio of sales expenses to main business income.
	High	Dummy variable.High-tech firms are 1, otherwise are 0.
	Holder	Dummy variable. Executives holding shares is 1, otherwise is 0.
	Age	Current year minus registration year
	Industry	Dummy variable. The firm that belongs to the high-tech industry is 1, otherwise is 0.
	Region	2, 1 and 0 for the eastern, middle and western regions, respectively.

firms headed with ST, * ST, S * ST, SST, S, NST. Eventually, 614 firms from 2014-2018 with 2444 observations remained in the sample (Including 548 firms in primary industries). The main industry categories of sample firms are shown in Table 2.

5. Regression

5.1. Descriptive Statistics

Table 3 reports that the sample's average R & D expense intensity is 0.03, and the median is about 2%, which indicates that most of the listed firms in China have a low level of R & D expense. Also, it should be noted that the R & D expense gap between firms is enormous. Among them, the R & D expense of the lowest firms is 2.21E−06, and the highest is 0.028. As for the SD policy intensity, the average level of 614 listed companies reached 0.003, but the gap between firms are significant.

The mean value of the variable PC is 0.15, and the median is 0.13. It shows that the distribution seems reasonable. However, the deviation between firms is quite significant for the maximum is about 0.67, and the minimum is 0. Regarding the executives serve in the "the Four", it appears that former government

Table 2. Main industries.

Industry category	Number	Proportion
Computer, communications, and other electronic equipment manufacturing	109	17.69%
Software and information technology services	66	10.71%
The special equipment manufacturing industry	65	10.55%
Electrical machinery and equipment manufacturing	64	10.39%
Pharmaceutical Industry	60	9.74%
Medical institution, manufacturing of wiring and equipment.	43	6.98%
General equipment manufacturing	42	6.82%
Automobile manufacturing	19	3.08%
Nonmetallic Mineral Products	15	2.44%
Instrument manufacturing	14	2.27%
Metal products industry	13	2.11%
Rubber and plastic products industry	12	1.95%
Railways, ships, aerospace, and other transport equipment manufacturing industry	10	1.62%
The nonferrous metal smelting and calendaring processing industry	8	1.30%
Professional technology service industry	8	1.30%
Total	548	88.96%

Table 3. Descriptive statistics.

Variables	Description	Observations	Mean value	Standard deviation	Minimum	Median	Maximum
RD	R & D	2444	0.03	0.02	0.000017	0.02	0.22
Deduct	R & D expense super deduction (SD policy)	2444	0.003	0.002	2.21e−06	0.002	0.028
PC	The intensity of the political connection	2444	0.15	0.12	0	0.13	0.67
CEOParty	CEO worked as Party members or Party committees is 1, otherwise is 0.	2444	0.01	0.10	0	0	1
CEOgovt	CEO worked as government official is 1, otherwise is 0.	2444	0.03	0.16	0	0	1
CEOnpc	CEO work or worked as NPC member is 1, otherwise is 0.	2444	0.08	0.27	0	0	1
CEOcppcc	CEO work or worked as CPPCC member is 1, otherwise is 0	2444	0.07	0.25	0	0	1
size	Firms' size	2444	7.32	1.08	4.68	7.23	11.08
age	Firms' age	2444	14.71	4.76	4	14	35
high	High-tech is 1; otherwise is 0.	2444	0.44	0.50	0	0	1
holder	Executives hold shares; the holder is 1, otherwise is 0.	2444	0.81	0.40	0	1	1
industry	The industry belongs to the high-tech industry is 1; otherwise is 0.	2444	0.52	0.50	0	1	1
roa	Return on assets	2444	0.04	0.05	−0.64	0.03	0.28
compete	Competition	2444	0.09	0.09	0.002	0.058	0.73
nature	Property rights	2444	0.15	0.36	0	0	1
region	Region	2444	1.52	0.75	0	2	2

civil servants account for the highest portion, with an average of 73%, while former Party members' or representatives of the Party Committee accounted for the lowest proportion, with an average of 15%. It seems that the retired or resigned government official is much more likely to go to business than the party representatives in the committee. The current or former NPC deputies or CPPCC members accounted for about 33% and 31%.

From the perspective of the CEO's political connections, the average is 0.18, which indicates that the proportion of firms with political connection is 18% on average. Concerning the specific type of political connection, the proportion from highest down to lowest is NPC deputies, CPPCC members, government civil servants, and Party representatives or Party Committee members.

Besides, the average age of firms is 14.71 years which is fairly young. Medium-size companies account for a large proportion, with an average return on assets of 4% and strong profitability. High-tech firms account for a higher proportion. Among them, the proportion of executives holding shares is 81%, which indi-

cates that executives holding shares is quite common in the samples. So intuitively, the executives of firms are more likely to invest in R & D. Regarding regions, the firms are primarily located in the eastern region, facing a better institutional environment, and a higher degree of marketization, which is more likely conducive to the R & D activity.

5.2. Results

5.2.1. Regression Analysis on the Effect of SD Policy on R & D

Referring to the analysis earlier, we proposed that the tax policy of R & D expense super deduction stimulates firms to invest in R & D. To test the hypothesis, we made regression analysis by using OLS as well SYS-GMM techniques which tackle the heterogeneity. The results are shown in Table 4.

As reported in Table 4, SD policy has a significantly positive effect on R & D, and the marginal effect of SD policy intensity is about 8, which confirms hypothesis 1 proposed earlier fairly well.

Regarding the effect of political connections, regression (1) reports that the estimated coefficient of interaction Deduct × PC is −0.633 and statistically significantly negative, which indicates that the SD policy harms R & D when taking political connection into account. In other words, the political connection has an *inhibitive effect* on the effectiveness of SD policy. Regressions (2) and (3) report the dynamic regression of R & D expense and the effect of political connection under the control of other factors, respectively.

Because of the continuity of R & D expense, we used a dynamic panel data model applying the system-GMM technique. Regression (2) shows that the RDt_1 estimated coefficient is −0.0306, confirming that R & D expense has a viscous effect. The firm's R & D expense will be inhibited by that of the previous year, which may not be good news for decision-makers. The coefficient of Deduct × PC, which we are more concerned about, is estimated to be −0.988. It shows that political connection has an inhibitive effect on the effectiveness of SD policy. Regression (3) includes more control variables, and the results show that the estimated coefficient of Deduct × PC is −0.802. It again proves that political connection harms the effectiveness of SD policy. Estimated coefficients of control variables show that firm age significantly negatively impacts R & D expense. That is to say, the longer firms' life is, the less R & D expense is. Hightech firms, high-tech industries, firm competition, and region significantly positively impact R & D expense. It shows that high-tech firms, more competition and firms located closer to the coastal regions drive R & D expenses.

Since the regional variable is significantly positive, we attempt to further analyze the firms in different regions. Therefore, we separate the samples into three sub-samples according to their registered locations. Regression (4) - (6) reported regression results of eastern, middle and western regions, respectively. The coefficient of Deduct × PC is significantly negative in the eastern regions and positive in the middle and western regions. Nevertheless, in the western regions, the coefficient fails to pass the significance test. The results reveal that in the eastern

Table 4. Regression results for political connections, SD Policy, and R & D expense.

	Full Sample			Eastern	Middle	Western
				Sub-sample	Sub-sample	Sub-sample
	(1)	(2)	(3)	(4)	(5)	(6)
Deduct	7.771***	7.878***	8.278***	8.236***	8.004***	8.546***
	(91.00)	(76.49)	(113.28)	(87.82)	(51.28)	(53.54)
RDt−1		−0.0306***	−0.0104*			
		(−2.93)	(−1.92)			
Deduct × PC	−0.633*	−0.988***	−0.802**	−1.387***	1.318*	0.109
	(−1.66)	(−2.82)	(−2.44)	(−3.33)	(1.75)	(0.15)
size			0.000077	0.00012	−0.000130	−0.0000525
			(0.60)	(0.72)	(−0.45)	(−0.21)
age			−0.0000971***	−0.0000982**	−0.0000692	−0.000124
			(−2.89)	(−2.26)	(−0.93)	(−1.63)
high			0.00725***	0.00724***	0.00659***	0.00679***
			(27.25)	(21.53)	(12.65)	(9.23)
holder			0.0000597	0.000103	−0.000371	0.000973
			(0.19)	(0.24)	(−0.72)	(1.60)
industry			0.000657**	0.00109***	−0.0000505	−0.000242
			(2.12)	(2.67)	(−0.07)	(−0.38)
roa			0.00187	0.00299	−0.00408	−0.000394
			(0.83)	(1.04)	(−0.79)	(−0.08)
compete			0.00476***	0.00811***	0.00431	−0.00633**
			(2.85)	(3.60)	(1.20)	(−2.03)
nature			0.000159	0.000625	−0.000558	−0.000707
			(0.47)	(1.32)	(−0.90)	(−1.12)
region			0.000402*			
			(1.81)			
Constant	0.00549***	0.004 92***	0.0000535	0.000279	0.00242	0.00255
	(16.59)	(12.84)	(0.05)	(0.19)	(1.04)	(1.17)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	No	Yes	Yes	Yes
AR (2)		5.326	3.216			
Hansen J-Statistic		109.38	99.58			
N	2444	1833	2444	1648	420	376
adj. R^2	0.8835	0.8963	0.9272	0.9182	0.9398	0.9483

Note: t values are in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

region, political connections inhibit the effectiveness of SD policy, while in the middle and western regions, it augments the effectiveness. We explain that political connections provide easier financing, more government subsidies, and even more intellectual property protection for firms, which is conducive to firms to increase R & D expenses. Reversely, the more R & D expense, the more incentives for firms to take advantage of SD policy, and then the more incentives for firms to make R & D expense expand. But SD policy also costs. Political connections can make up for the imperfection of the formal institution (financial market, legal intellectual property protection system, etc.). In other words, the more imperfect the formal institution is, the more political connections can encourage the local firms to use the super deduction policy and increase R & D expenses. In eastern China, where the formal institution is rather good, firms can obtain sufficient external financing through an efficient financial market, and their R & D achievements can be better protected. In such conditions, the positive effect of political connection on firms is greatly weakened (diminishing marginal utility). Whereas the degree of marketization in the middle and western regions is lower, the governments have a strong ability to control and allocate resources and intervene in the economy. Therefore, local firms can obtain more resources through political connections. While in the eastern region, the market plays a decisive role in resource allocation. Therefore, local firms procure lesser resources through political connections.

As for the control variables, the results of control variables in the eastern sub-sample and full-sample regression are consistent, while there are great differences between the middle and western regions. According to the competition pressure variable (Compete), the results of the eastern sub-sample and the whole sample are consistent, which show that with the increase of competitive pressure, the firms tend to increase R & D expense. However, the western region is exactly the opposite, which shows that when the firms there were faced with more pressure, they cut their R & D expense.

5.2.2. CEO Political Connections, SD Policy and R & D Expense

The previous regression results show that if firms have a political connection, their conduct in using the SD policy will be inhibited.

To further consider the heterogeneity in the effect of the different political connections, we need to analyze the types of political connections of actual controllers of a firm. We believe Chief Executive Officer often plays the most powerful role in the firm, so we use the CEO's background as the proxy of a firm's political connection. Because the CEO's political background may be varied, the priority method is adopted to determine the CEO's final political connection. Firstly, the political background of the four forms of political connections in this paper is reserved, while the rest of the political background is regarded as a non-political connection. Secondly, if two or more forms of political connection meet in the four forms considered in this paper, the form of political connection with a high administrative level shall prevail. Thirdly, if the administrative levels

of the two forms of political connection are consistent, the ultimate political background of the CEO is determined by the way that the Party prefers the government over the NPC and the NPPCC. Four types of CEO political connections are represented by dummy variables (1, yes; 0, no): CEOParty, CEOgovt, CEOnpc, and CEOcppcc. The effect of different types of political connections is shown in Table 5.

Table 5. Heterogeneity of CEO political connection, SD policy, and R & D expense.

	(1)	(2)	(3)	(4)
Deduct	7.420***	7.439***	7.429***	7.482***
	(89.80)	(91.16)	(90.69)	(91.59)
Deduct × CEOParty	0.306			
	(1.28)			
Deduct × CEOgovt		− 1.865***		
		(−2.78)		
Deduct × CEOnpc			0.447	
			(1.31)	
Deduct × CEOcppcc				− 1.243***
				(−5.13)
size	0.000220	0.000235	0.000220	0.000229
	(1.17)	(1.25)	(1.17)	(1.23)
high	0.00505***	0.00502***	0.00506***	0.00509***
	(14.77)	(14.68)	(14.79)	(14.97)
holder	−0.0000133	0.0000333	−0.0000111	0.000000842
	(−0.04)	(0.09)	(−0.03)	(0.00)
industry	−0.00367**	−0.00368**	−0.00376**	−0.00339**
	(−2.21)	(−2.21)	(−2.26)	(−2.05)
roa	−0.00214	−0.00213	−0.00225	−0.00197
	(−0.81)	(−0.80)	(−0.85)	(−0.75)
compete	0.00131	0.000931	0.00130	0.000590
	(0.36)	(0.26)	(0.36)	(0.16)
constant	0.00401**	0.00399**	0.00407**	0.00391**
	(2.36)	(2.35)	(2.39)	(2.31)
Year Fixed Effects	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes
N	2444	2444	2444	2444
adj. R^2	0.762	0.763	0.762	0.765

Note: t values are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Columns (1) to (4) in Table 5 show the regression results of the CEO's Party Committee connection, Government connection, NPC connection, and NPPCC connection as explanatory variables. It can be found that the effect of SD policy shows robustness in the four regressions. The policy effectively encourages firms to increase R & D expenses, and the incentive multiplier is about 7.4. While the effect of different political connections has obvious heterogeneity. Specifically, the coefficient of Deduct × CEO Party is positive, which indicates that the CEO who used to serve in the Party Committee has a positive effect on the implementation of the policy. We believe that this is inseparable from the socialist theory and altruistic belief upheld by the Party committee, but unfortunately, the coefficient doesn't pass the significance test at the level of 10%. The coefficient of Deduct × CEO govts is −1.865, which indicates that the CEO who used to serve in the government has a negative effect on the implementation of the policy. In other words, the multiplier of super deduction policy on R & D expense is 7.439, holding other variables constant. However, if the CEO served in government, the marginal effect of the policy would be reduced to 5.574. We believe that the main reason for this is that the CEO's political experience enables him or her to know the preferential policies better. Therefore, Firms can obtain other forms of tax preferences directly from the government tax authorities instead of using the provisions of tax policy. The coefficient of Deduct × CEO npc is 0.447, similar to the result of Deduct × CEO Party, the experience of CEO (formerly) serving in the National People's Congress (NPC) has a positive effect on the implementation of policy, but the effect is not statistically significant. The coefficient of Deduct × CEO cppcc is −1.243, which indicates that the CEO's experience in CPPCC harms the implementation of the policy. We believe that the CPPCC's experience in participating in and discussing political affairs make CPPCC members familiar with the process of formulating and implementing the national budget. Therefore, The CPPCC CEO's experience will enable them to bypass the complicated statutory tax law and obtain economic benefits by applying for direct subsidies from the government, so the CPPCC CEO's experience will lead to the effect decrease from 7.482 to 6.239.

5.3. Robustness Check

R & D expense ratio to business income is used as the explanatory variable RD. The relative value index will reduce the pertinence of the explanatory variable because it contains too much noise. To address the robustness problem, we adopt the absolute value of R & D expense as an alternative to the robustness test. Besides, this paper's sample firms include both state-owned and private firms. The particularity of the property rights of state-owned firms makes them naturally have a political background. We then removed the sample of state-owned firms in the robustness test, focusing on the analysis of the effect of the political connection of private firms.

In Table 6, regression (1) uses the natural logarithm of the absolute value of R & D expense as the explanatory variable, and regression (2) excludes the sample

of state-owned firms. In these two regression analyses, the core explanatory variables Deduct × PC is the interaction of the super deduction and the firm's political connection which is completely consistent with the meaning and measurement above. The results of regression (1) and (2) show that the SD policy has a significant positive impact on firms' R & D expenses, which indicates that the policy is helpful in increasing the R & D expense. However, a political connection will reduce the positive impact of SD policy on R & D expense of firms. This robustness test result is consistent with the previous analysis, which confirms the hypothesis of this paper. Regressions (3) and (4) further analyze the influence of the CEO's political connection on the incentive effect of SD policy. It can be seen that the CEO's personal political experience has a different influence on the effect of SD policy. The experience of serving in the Party Committee and NPC has a positive influence; the rest have a negative effect. The results are consistent with the conclusion of previous parts of the paper.

Table 6. Robustness check.

	Political connection		CEOs' political connections				
	(1)	(2)	(3)				(4)
	The logarithm of R & D expense (lnRD)	Sample without SOEs	The logarithm of R & D expense (lnRD)				Sample without SOEs
Deduct	109.5*** (8.26)	8.261*** (105.70)	240.9*** (17.98)	241.2*** (17.91)	239. 1*** (17.87)	243.5*** (18.07)	
Deduct × PC	−278.4*** (−4.99)	−0.791*** (−2.34)					
Deduct × CEOParty			7.095 (0.06)				
Deduct × CEOgovt				−8.343*** (−4.21)			
Deduct × CEOnpc					136.7*** (2.48)		
Deduct × CEOcppcc						−61.23* (−1.66)	Omitted
constant	13.92*** (60.05)	0.000147 (0. 11)	13.42*** (33.21)	13.43*** (33. 18)	13.42*** (33.34)	13.43*** (33.32)	
Control	Yes	Yes	Yes	Yes	Yes	Yes	
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	
N	2444	2068	1833	1833	1833	1833	
adj. R^2	0.270	0.290	0.269	0.269	0.272	0.270	

Note: t values are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6. Concluding Remarks and Policy Implications

By investigating the data of listed companies from 2014-2018 in China, this paper empirically examined SD policy's effect on a firm's R & D expense. Our innovation lies in explaining the mechanism of political connection within the effect of SD policy on R & D behaviour. In general, as a formal institutional, the SD policy has a significant *promotive effect* on a firm's R & D expense. As an informal institution, the firm political connections have a significant *inhibitive effect* on the SD policy. From a regional perspective, the firm political connections have an inhibitive effect on the eastern region, while it has a *promotive effect* in the middle and western regions. The business environment in the eastern region is superior to that in the middle and western regions. A political connection has its costs, which will reduce firms' business performance. A further subdivision of the political connections found that the political working experience of the Party committee and National People's Congress of the firm CEO had a positive promotive effect on the effect of the SD policy. However, this promotive effect failed to pass the significance test, while the working experience in the government and the CPPCC had an inhibitive effect. We, therefore, argue that it reflects the ideals and beliefs of the CEO and the binding force of the public budgets.

The policy implications of the above are mainly summarized in the following two aspects. Improving policy design and encouraging firm research and development come in the first place. The SD policy can save R & D funds for firms and stimulate them to invest more in R & D. So, the super deduction of R & D expenses must be well implemented and constantly improved to be more operational and predictable.

To improve the institutional environment and encourage a firm to innovate, come to the second. Above all, direct control and intervention of the government (or public power) on market resources must be reduced. Let the market play a decisive role in resource allocation. In the context of socialism in the new era, China needs to constantly strengthen the sense of social responsibility and actively increase the awareness of legal frameworks for firms. Lastly, we suggest that the commercial legal system must be further established and improved to gradually reduce the informal institution in economic operation and bring the trading behaviors of market players onto the institutional track. Only in the strict environment of the formal institution will the SD policy be more effective in its outcomes. The firm, in turn, through the market mechanism, obtains the required R & D resources by itself, increasing firm innovation expenses to carry out more research and development activities and improving the ability of independent innovation and market competitiveness.

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Conflicts of Interest

We all declare that we have no conflict of interest. We have no financial and personal relationships with other people or organizations that can inappropriately influence this work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled *SD Policy*, *Political Connection and R & D Expense*: *Firm-level Evidence from China.*

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Abbreviations

SD policy: Super Deduction policy, which is a preferential tax policy in calculating taxable income.

R & D: Research and Development.

CPC: Communist Party Committee.

CPPCC: Chinese People's Political Consultative Conference.

NPC: The National People's Congress.

CEO: Chief Executive Officer.