

## Article

# Bonding or Indulgence? The Role of Overborrowing on Firms' Innovation: Evidence from China

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**Abstract:** This paper examines the innovation spending gap associated with overborrowing in China's state-owned enterprises (SOEs). Based on the double agency problem of the banking sector, the authors hypothesize that SOEs are more inclined to a higher level of overborrowing and therefore worsen firms' debt governance system for innovation. We argue that obtaining excessive bank loans has an indulgence effect and is used by firms' managers as an entrenchment strategy for underinvestment in innovation. We test our theoretical model under the unique institutional setting of China's banks, in particular the administrative-economic governance. Using a longitudinal panel dataset that contains a cross section of Chinese listed companies from 2012 to 2018, we confirm overborrowing's mediating role between state ownership and firm innovation expenditure, implying that enhancing the delegated monitoring of banks is also essential to firm innovativeness in transition economies. Additionally, we further test the role of political connections and managers' R&D functional experience to leverage the benefits of SOEs' innovation resource endowment. Our study demonstrates another debt governance channel through which government intervention has a negative impact on firm innovation resource allocation. It expands the understanding of the debt governance role for innovation in transition economies.

**Keywords:** bank debt; corporate governance; innovation; overborrowing; state ownership



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## 1. Introduction

To compete effectively, a country's enterprises must continuously innovate their competitive advantages [1]. Innovation comes from sustained investment in physical as well as intangible assets [2,3]. China has the largest number of state-owned enterprises (SOEs) in the world, which have played a pivotal role in the economy, though the innovation profile of these firms is as appealing as their corporate governance. On the one hand, many high-tech entities in China are created and managed in the form of SOEs. On the other hand, previous studies show that the expenditure and performance of R&D in SOEs remain significantly lower than that in non-SOEs [4]. It is generally acknowledged that under state dominance, the control rights rest with bureaucrats who have only an indirect interest in profit, which leads to inefficiencies [5]. Latter theoretical work by Huang and Xu (1999) and Zhang et al. (2003) also show that the state sector has significantly lower R&D efficiency than the non-state sector, which may be attributed to their differences in ownership structure and associated agency problems [6,7]. Similarly, Le and O'Brien (2010) found that SOEs were inefficient in R&D activities because of the conflict of interest between shareholders and governments, with a higher likelihood for the latter to pursue social objectives and political objectives rather than profit maximization [8]. If this is the case, we can reasonably expect a decrease in R&D expenditure or efficiency with the increase in state ownership of firms. However, there exists evidence showing that the introduction of state-owned shareholders to financing-constrained non-SOEs also helps increase their R&D expenditure [9,10]. Regarding the financing constraints, state-owned

shareholders not only contribute to expanding the equity capital but also facilitate firms' access to finance, which is called the certification effect.

A consensus has yet to be reached on the way to finance corporate innovation efficiently in transition economies, which is very different from motivating routine tasks [11]. Although direct financing has been verified to have significant positive impacts on a firm's innovation [12], firms' proportion of direct financing in China is still lower than in many emerging markets. Indeed, debt financing, especially bank loans, is still the manifest financing source of SOEs, even if most have already been significantly deleveraged. While there is some empirical evidence regarding the relationship between bank loans and firm innovation, they produce mixed results. Some studies have shown that bank loans can theoretically bring tax benefits [13,14], thereby encouraging firms to increase R&D expenditure. However, the Chinese banking sector features poor corporate governance and government-oriented financial allocation, under which the government tends to transfer funds from productive sectors and regions to less productive sectors and regions [15,16]. In addition, in the process of promoting economic transition, the government could legally exert their formal shareholder's rights or supervision authority on local banks to intervene in their decision of loan granting.

Some observers argue that capital misallocation or financing frictions would worsen a firm's productivity and innovation [17,18]. Scholars including Huang and Xu (1999), Demetriades and Fattouh (2006), and Mian et al. (2017) have analyzed the negative effect of debt overhang to investment [6,19,20], whereas the relationship between firm-level overborrowing and innovation has not been investigated in detail. Previous studies on state ownership have paid much attention to various external governance determinants on firms' economic performance, such as market structure [21], soft budgets [22], or credit discrimination [23]; however, there is an ongoing debate and a lack of convincing evidence regarding whether and how banks' credit discrimination is driven by state ownership and its exact negative effect on firms' R&D expenditure, and to the best of our knowledge, there has to date been no empirical investigation of it in emerging economies in general, and in China in particular where the institutional environment is significantly different.

In this context, we shall refer to the measurement of overinvestment [24,25] to capture a firm's overborrowing as the statistical discrepancy between the actual bank loan the firm obtains and the forecasted value the firm demands from an econometric model. Focusing on the interplay of internal and external governance, we analyze the firm-level conditions through which overborrowing would manifest its negative impact, shedding light on potential ways to reduce the adverse impact of overborrowing and facilitate the innovation capability of SOEs. What makes our study more interesting is that a significant variation of governance profile exists between different-level SOEs in China [26]. Even if under the control of the same governmental agency, different management mechanisms in SOEs of different administrative levels matters in China. Therefore, China's unique institutional settings provide a good opportunity to test whether the overborrowing associated with state ownership would polarize the innovation ability of SOEs.

The remainder of this study is organized as follows. In the second section, we provide an overview of the relevant literature on banks' monitoring and corporate innovation and present the research hypotheses. The next section outlines our samples, measures, and analytical techniques. Section four further discusses the empirical results and provides further analysis of the moderating effect of a firm's political connection level and top managers' R&D functional experience, while section five concludes this study.

## 2. Theory and Hypotheses

### 2.1. *Overborrowing and Firms' Innovation Behaviour: Bonding or Indulgence?*

The development of the banking system benefits corporate governance and innovation [27,28]. From the perspective of agency, bank debt is generally acknowledged to be an alternative governance mechanism for firms [29–34]. In the general context of corporate governance, the monitoring for corporate governance provided by banks helps alleviate the

agency costs of asset substitution or underinvestment in the focal firms [35,36]. Specifically, the cash disbursement of debt would limit the manager's discretionary cash flow and inappropriate decisions about capital expenditure [30]. Therefore, Grossman and Hart (1982) described the issuing of risky debt by the entrepreneur or manager as a means of "bonding" his or her behavior [29]. Regarding R&D activities with high technology risks and information asymmetry, the monitoring benefits are more likely to exceed the cost of the debt itself, which will facilitate promoting firms' innovation [37]. Bank loans thus can be viewed as "insider" debt—that is, compared with bonds and equity, bank loans provide inside information about the firms [38,39]. Along this line of thinking, Friend and Lang (1988) found that debt financing decisions were consistent with the decline of focal firms' agency costs [40]. In addition, the threat of bankruptcy and compulsory interest payment obligations based on debt covenants would help jointly activate a firm's innovation behavior [41]. Shahzad et al. (2021) found evidence of an inverted U-shaped relationship between debt financing and corporate innovation, which implies that firms undertake external debts at the start and decline their debt financing in the long run [42].

While banks may possess capacities to control agency conflicts within the focal firms, they are subject to an agency dilemma themselves. Thus, the delegated monitoring of banks is a double-agency problem in itself [43]. One agency problem of the banks' administrative-economic governance lies in the administrative appointment of its top managers [44]. Government owners can send bureaucrats to banks as top managers or directors through which government policies about firms are executed. With the nature of "quasi-bureaucrats", these top managers of state-owned banks are usually restricted in executive compensation and more inclined to pursue political promotion [45,46]. More generally, the relationship between the government and banks can lead to harmful dependencies and interactions. In particular, there is the danger of regulatory capture [47]. Research on bank loan granting decision also proves that state-owned banks not only charge lower interest rates than privately owned banks, but also inflate credit in the political election cycle [48]. Allen et al. (2005) and Fan et al. (2008) have reported evidence on the rent-seeking hypothesis in emerging markets [16,49]. As a result, the incentives and intervention effects of administrative governance would accrue excess debt in focal firms.

Another agency dilemma exists when state-owned banks' monitoring is not transparent to outside investors. Governmental owned banks are usually accountable only to the government, and the disclosure requirements are minimal. As a result, the moral hazard in focal firms will arise. With a long duration of technological innovation and high risks, top managers in focal firms are generally reluctant to take risks in long-term R&D projects, because such investment often means a higher failure rate and occupational risks [50,51]. To protect themselves against such "expropriation", top managers tend to invest less in innovative projects that are difficult for outside investors to understand, and more in routine projects with quicker and more certain returns [52]. Empirical evidence also verifies that SOEs tend to have easier access to bank credit funds in a state-controlled banking system [53]. Overborrowing, as one form of resources redundancy which defends top managers of SOEs from competition in the market, would in turn urge them to give up valuable R&D investment opportunities and choose a relatively "safe" policy [54]. Given the higher agency costs associated with overborrowing, SOEs are not likely to devote a large amount of capital to R&D projects. Thus, we hypothesize the following:

**H1:** *SOEs are more inclined to a higher level of overborrowing, which leads to decrease in firms' R&D spending.*

## 2.2. Political Connection and the Impact of Overborrowing on Firms' R&D

One prominent feature of China's banking system is that state ownership is pervasive. This is particularly true for the state-owned commercial banks. State-owned banks, as a worldwide phenomenon, are inevitably accompanied by government intervention and influence [5]. De Haan and Vlahu (2016) and Hopt (2021) provide evidence that the significant influence exercised by the government is accompanied by a negative impact on

the quality of corporate governance in banks as well as on their performance [55,56]. More importantly, it is worth mentioning that firms controlled by the state do not necessarily incur a connection relationship, simply because their shares are controlled by the state according to the Company Law of China (Article 126/2018). There thus exist potential transactions that lead to the transfer of the interest of firms and can be exempted from monitoring and information disclosure. In this context, SOEs have strong incentives to participate in building political connections in order to acquire easier access to bank loans.

The existing viewpoints of a firm's political connections impacting bank governance can be roughly divided into the "signal effect" and "resource effect". From the perspective of the signal effect, access to political connections provides a positive signal about the quality and creditworthiness of focal firms and reduces information asymmetry for private investors [57]. It can reduce a bank's dependence on a focal firm's financial statements and facilitate its access to bank loans [58]. Houston et al. (2014) names it the implicit insurance effect of political connections [59]. From the perspective of the resource effect, having political connections can also enable firms to obtain credit resources, acquire contracts, avoid coercive treatment as well as fines from regulators, acquire fiscal assistance, and enjoy other advantages since the loan granting decisions of state-owned banks will be led by political consideration [60–62]. Many studies have shown that politically connected firms can obtain more bank loans and reduce their financing constraints [63,64]. It is also easier for local bureaucrats to channel funds in the form of loans to firms with which they have connections through banks they control [65].

The promotion tournament is an important incentive mechanism for top management of SOEs in transition economies. Taking further analysis, the role of political connections may be contingent due to different administrative levels. Top managers' cash compensation, equity ownership, and perquisites are usually linked to job titles and position ranks. Lazear and Rosen (1981) show that the pay gap between the CEO and other executives is a reward for the promotion tournament, which stimulates these executives to compete intensively with each other [66]. Moreover, there is a strand of literature on the positive impact of pay dispersion for innovation in China. Jia et al. (2016) find that higher pay gap between CEOs and other executives can promote corporate innovation by attracting talent and reducing excessive board intervention [67]. Xu et al. (2017) examine the pay dispersion between executives and ordinary employees, and find a positive impact on corporate innovation of Chinese listed firms [68]. More importantly, the supervision intensity for bureaucrats or SOEs' "quasi-bureaucrats" managers is closely proportional to their administrative level, too. The lower the level of managers' political connection, the less supervision they are subject to. In the case of strong motives and weak supervision, managers with political connections below the provincial level in SOEs are more inclined to exert their political intervention on loan acquisition. As a result, firms become easily overborrowed. Thus, hypothesis 2 is proposed:

**H2:** *The lower the political connection level of focal firms' top managers, the more significant the mediating effect of overborrowing.*

### 2.3. R&D Background of Managers and the Impact of Overborrowing on Firms' R&D

There are already a handful of studies that have examined the association of various top managers' characteristics with innovation [69,70]. Much of this research started with a study by Dearborn and Simon (1958), who argued that experience with the goals, rewards, and methods of a particular functional area causes managers to perceive and interpret information in ways that suit and reinforce their functional training [71]. Top managers' biases and dispositions do have their greatest influence on organizational outcomes in complex and uncertain conditions, whereas these unobservable psychological traits of top managers are inherently related to their personal characteristics [72,73]. As key firm capability for innovation, R&D capability is particularly influenced by top management experience because it depends on perceptions of organizational and industry environments [74]. R&D functional experience will provide managers with expertise knowledge,

increase team heterogeneity, and reduce short-sightedness, thus promoting the firm's innovation [75]. More importantly, top managers with functional experience in R&D often possess more private information in specified R&D projects, which would enable them to make innovation-related financing decisions prudentially and appropriately as well.

In innovation activities it is often impossible to accurately measure inputs into the innovation process [51], and one can hardly write complete contracts when one does not even know what the output might be [76–78]. In such cases, when making an innovation decision, top managers are generally more risk-averse than investors, since they cannot diversify the risk of their specified investment across different companies [50,51,79]. Notwithstanding the foregoing problems, some researchers argue that managers with R&D experience would contribute to increasing firms' R&D expenditure. Several studies support this line of reasoning. Special purpose investments entail asset specificity, such as the R&D expenditures considered here [80,81]. Research has shown firms engaged in innovation have a high percentage of intangible assets, where knowledge is embedded in the human capital of the firms' managers. This key resource is lost if managers leave or are laid off [82]. Managers therefore tend to smooth R&D spending over time to avoid being laid off, leading R&D spending at the firm level to behave as if it has high adjustment costs. In addition, the innovation process contains knowledge management at various levels; such a process would also lead to dynamic changes in firms' asset specificity [83,84]. Andreou and Bontis (2007) argue that knowledge management affects the components and structure of human capital [85]. If the top managers have a higher degree of knowledge specificity, such as more specialized knowledge of R&D, the firms can achieve greater specific human capital [86]. These conditions allow for chances that agency costs in financing innovation be significantly weakened when top managers have R&D functional experience. Therefore, we propose that top managers with R&D functional experience have greater incentives in R&D spending that may help mitigate the impact of overborrowing.

**H3:** *Top managers with R&D functional experience contribute to weakening the mediating effect of overborrowing.*

### 3. Methods

#### 3.1. Data and Sampling Approach

This study uses samples that are Chinese listed A-share firms on the Shanghai and Shenzhen stock exchanges from 2012 to 2018. The sample period was set between 2012 and 2018. The sample period starts from 2012 to avoid influence of easing monetary measures during the financial crisis from 2008 to 2011. The central bank of China lowered the required reserve and interest rate since 2008, which led to rapid growth of bank credit. In September 2018, the General Office of the State Council announced the "Guidance on Strengthening the Asset-Liability Constraints of SOEs", requiring SOEs to reduce leverage ratio by about two percentage points by the end of 2020. As a result, SOEs have been set annual leverage debt limits by the government, which disrupted the usual debt increment mechanism. Therefore, we exclude samples after 2019. Compared with financial firms, non-financial firms are different in governance and technology features. Following general studies, we first exclude financial firms from our samples. The second sampling stage is intended to exclude special treatment firms (which have made losses for two or three consecutive years) as well as firms with data outliers to avoid any biased estimation. After data screening, a total panel date of 19,822 "firm-year" observations are obtained. All the financial data come from the China Stock Market & Accounting Research (CSMAR) Database and the Chinese Research Data Services (CNRDS) database. The data for this study are processed by Stata15.

#### 3.2. A Framework to Measure the Construct of Overborrowing

According to the theory of corporate finance, firm's financing choice depends on a tradeoff between different financing alternatives. Without loss of generality, we assume that the firm faces a project with positive net present value, and the financing alternatives



comprises two ways, namely, the bank loans and retained earnings. Bank loans represents debt financing, while retained earnings are a proxy of direct financing. If the cost of bank loans is greater than that of retained earnings, the firm tends to adopt retained earnings instead of bank loans. Otherwise, the firm will increase bank loans. When the financing demand is fixed, firm's bank loans would depend on the expected weighted average capital cost (WACC) for the project. Bank loans (BL) thus can be expressed as follows:

$$BL = \mathcal{F}(WACC)$$

Theoretically, there is an optimal point of borrowing level, at which the weighted average capital cost for the project is the lowest. We mark the ideally optimal borrowing level as  $\mathcal{F}(WACC^*)$ , where  $WACC^*$  corresponds to the optimal capital structure. When there is overborrowing or underborrowing, the actual bank loans will inevitably deviate from the optimal level, leading the weighted average capital cost away from the optimal point  $WACC^*$ . Real bank loans can then be split into two main components:

$$RBL = \mathcal{F}(WACC^*) + \Delta BL$$

The deviation from the ideal value ( $\Delta BL$ ) can be negative or positive. Negative (positive) values corresponds to under (over)borrowing. The focus of the empirical analysis in this study is on the overborrowing. Hence, the analysis will focus on the firms with positive values. There is an extensive literature in economics and finance that have examined firm level borrowing decisions [36,86,87]. The overborrowing will eventually lead to increment in firm's risk but without extra net cash inflow, and thus impairs the firm's value. It could reflect management engaging in additional investment on self-serving projects rather than distributing the cash to shareholders [25].

From the perspective of equilibrium in credit market, the ideal bank loans (BL) firm demands is always the same as the optimal lending volume bank approves. By examining the bank loans-setting mechanism we can obtain the empirical estimation of overborrowing described in this framework.

### 3.3. Analysis Model and Variables

Based on the above theoretical analysis, this study first constructs a model to calculate the ideal bank loans (BL). The bank loans estimation model is mainly inspired by Berger and Udell (2006) [88]. The authors propose a complete conceptual framework for bank credit determination. In that framework, the main factors affecting credit availability are divided into eight lending technologies: financial statement lending, small business credit scoring, asset-based lending, factoring, fixed-asset lending, leasing, relationship lending, and trade credit. Among these technologies, some are suitable for banks' general lending decisions. As for financial statement lending, bank's lending decision is based on a firm's financial ratios reflecting its financial condition in financial statements. Credit scoring is a transaction technology based primarily on hard information about the firm's owner as well as the firm. Asset-based lending is a lending technology which banks make lending decisions with by focusing on a subset of the firm's assets. This technology provides working capital financing secured primarily by accounts receivable and inventory. Fixed-asset lending technologies involve lending against assets that are long-lived and are not sold in the normal course of business. Accordingly, firm's liquidity, profitability, growth, ownership, are common determinants in bank lending. These indicators are closely associated with firm's short-term or long-term ability of repayment [89,90].

The bank loan estimation model is as follows:

$$\text{Loan}_{it} = \alpha_0 + \alpha_1 \text{Cash}_{it-1} + \alpha_2 \text{Size}_{it-1} + \alpha_3 \text{Lev}_{it-1} + \alpha_4 \text{Liquid}_{it-1} + \alpha_5 \text{ZJ}_{it-1} + \alpha_6 \text{Roe}_{it-1} + \alpha_7 \text{Growth}_{it-1} + \alpha_8 \text{Top1}_{it-1} + \alpha_9 \text{Herfindahl}_3_{it-1} + \sum \text{Ind} + \sum \text{Year} + \varepsilon_{it} \quad (1)$$

As described above, overborrowing ( $\Delta BL$ ) corresponds to extra bank loans the firm actually obtains that exceeds the estimation value. Referring to the measurement of overinvestment [24,25], we measure firm-level overborrowing as the statistically significant discrepancy between the actual bank loan the firm obtains and the estimated bank loan calculated by the model (1).

Secondly, we employ the following model to test the factors affecting overborrowing:

$$\text{Overloan}_{it} = \eta_0 + \eta_1 \text{State}_{it} + \eta_2 \text{Politic}_{it} + \eta_3 \text{Occupy}_{it} + \eta_4 \text{Market}_{it} + \eta_5 \text{Financeback}_{it} + \sum \text{Ind} + \sum \text{Year} + \varepsilon_{it} \quad (2)$$

Thirdly, to verify the mediating effect of overborrowing on ownership type and R&D expenditure, this study sets up the following regression model:

$$\text{R\&D\_ratio}_{it} = \sigma_0 + \sigma_1 \text{State}_{it} + \sigma_2 \text{Overloan}_{it} + \sigma_3 \text{Governsci}_{it} + \sigma_4 \text{Stock\_incentive}_{it} + \sigma_5 \text{Independent}_{it} + \sigma_6 \text{Assign}_{it} + \sigma_7 \text{Herfindahl\_3}_{it} + \sum \text{Ind} + \sum \text{year} + \varepsilon_{it} \quad (3)$$

Here, R&D\_ratio denotes the R&D spending intensity. A number of researchers have used R&D spending divided by firm sales as a measure of R&D intensity [91,92]. The innovation intensity indicator has advantages in the consistency of dimensions and is directly related to a firm's financing, so it is suitable to reflect a firm's innovation performance. To ensure the stability of this indicator, we also use R&D expenditure scaled by the total assets as an alternative measure for a firm's innovation performance in the robustness test section. All missing values for R&D intensity are replaced with zero, and the upper bound for R&D intensity is set at 1.

From the standpoint of corporate governance, Li et al. (2019) pointed out that the key feature of current Chinese SOEs governance is the coexistence of administrative governance and economic governance [93]. The administrative governance factors, such as implicit as well as explicit guarantees for SOEs' financial crisis and the prevalence of soft-budget, are thought to be the main causes of firms' misconduct in investment [24,94]. Therefore, many state-owned banks can hardly treat firms equally in loan granting, but show some degree of discrimination. Previous studies have shown that SOEs generally obtain more loans than non-SOEs, and the gap increases significantly during periods of austerity and recession [95]. The state ownership type (State) is a dummy variable where one represents those firms ultimately owned by the government, and zero represents those not. Following Petersen and Rajan (1994), La Porta et al. (1999), Faccio and Lang (2002), Anderson et al. (2004), Bigelli and Mengoli (2004), Armstrong and Vashishtha (2012), Ben-Nasr et al. (2015), and Grosman et al. (2016) [96–103], we control for main financial and governance variables in our analysis. The main variables involved in the above models are defined in Table 1.

**Table 1.** Variables and Definitions in Models (1) to (3).

Models	Variables	Definition
(1)	Loan	Long-term bank loans/total assets
	Cash	Cash balance scaled by total assets
	Size	Logarithm of total assets
	Lev	Debt to total assets ratio
	Roe	Ratio of return on equity
	Growth	Revenue growth rate
	Liquid	The net value of fixed assets scaled by total assets
	ZJ	Net value of construction in process scaled by assets
	Top1	The proportion of shares held by the firm's largest shareholder

Table 1. Cont.

Models	Variables	Definition
(1),(3)	Herfindahl_3	Degree of share concentration, measured by the sum of the squares of the shareholding ratio held by the firm's top three shareholders
(2),(3)	Overloan	The positive residual of model (1) regression
	State	Type of ownership, equal to 1 when the firm is state-owned, otherwise equal to 0
(2)	Politic	Political background, equal to 1 when the chairman of the board of directors or the general manager has administrative levels, otherwise 0
	Occupy	The large shareholders' expropriation, measured by percentage of other receivables to total assets
	Market	The marketization of credit allocation, measured by the natural logarithm of the year-end loan balance of local small loan firms
	Financeback	The financial background of top managers, equal to 1 if the chairman of the board of directors or general manager has a financial background, otherwise equal to 0
(3)	R&D_ratio	The proportion of R&D investment to revenues
	Governsci	Basic research expenditure, measured by the government's scientific and technological expenditure scaled by the total fiscal expenditure budget
	Stock_incentive	The proportion of the firm's stock owned by the managers
	Independent	The proportion of independent directors on the board
	Assign	Equal to 1 if the chairman and general manager are one person, otherwise equal to 0
(1), (2), (3)	Ind *	Dummy variable for industry
	Year	Dummy variable for year

\* According to the China Securities Regulatory Commission "China-listed companies Industry Classification guidelines (2012)", we exclude the financial industry and divide the manufacturing industry into two-digit industry categories. In addition, other industries are subdivided into single-digit industry categories.

## 4. Results

### 4.1. Descriptive Statistics

Table A1 shows the descriptive statistics of the main variables. All continuous variables are winsorized by 1% to mitigate the impact of outliers. Before examining the overborrowing of the sample firms, it would be useful to generally discuss the financial structure of firms in China. The leverage ratio of Chinese firms is higher than reported by Fan et al. (2008) [49], which indicates there is no fundamental change in the financial structure during the past decade. Moreover, the average percentage of long-term bank loans to total assets of listed companies is 0.04 and its standard deviation is 0.08. The average proportion of long-term loans to total assets for SOEs is 0.07, whereas the proportion for non-SOEs is only 0.03, significantly lower than SOEs. The average overborrowing for listed companies is 0.05, accounting for 56% of the average loan for the same firms with overborrowing (whose average bank loan of total assets is 0.09), indicating that the overborrowing for listed companies in China is significant. In the table, about 19% of all firms have political connections. This indicator is lower in SOEs, thus showing that non-SOEs in China are more inclined to seek political connections, giving evidence that more efficient firms are more likely to build connections to secure their access to finance. The average administrative level of the chairman or general manager is 76.6. Furthermore, the average administrative level for SOEs is much higher. In summary, it provides consistent evidence that the ban on officials' holding concurrent posts in firms issued by the government in 2014 has not been strictly enforced with lower administrative level officials. Table A2 shows that the average overborrowing levels from 2012 to 2018 are 0.0547, 0.0547, 0.0497, 0.0481, 0.0475, 0.0463 and 0.0441, respectively, which means that the overall overborrowing for Chinese listed companies shows a gradual downward trend. In addition, the average percentage of overborrowing for SOEs is 0.07, while it is 0.04 for non-SOEs, which indicates



that SOEs' overborrowing is significantly higher than that of non-SOEs. These results lend additional support to our conjecture that overborrowing is associated with ownership attributes and closer with lower political connections relative to firms' economic factors. Moreover, multicollinearity was diagnosed by examining the variance inflation factors (VIFs) for the predictors (See Table A3). The VIF values for the predictors, all substantially lower than the rule-of-thumb cutoff of 10 [104], revealed that multicollinearity is not a problem in this study.

#### 4.2. Regression Analysis

The empirical test of this study comprises three steps. The first step is to calculate the annual overborrowing level for each firm by the residual of Model (1). The result of the regression analyses regarding the bank loans is shown in Table 2. Regarding the explanatory capability of model (1), the chi-squared test of fitting degree is 0.402, which indicates a suitable model specification. In terms of the impact of independent variables, the level of share concentration (Herfindahl\_3) is positively related to a firm's long-term bank loan (Loan). In other words, instead of a diversified ownership structure, high ownership concentration works for firms to obtain bank loans under the administrative-economic governance mode. Of course, this does not necessarily mean that the mixed ownership reform associated with ownership decentralization is ineffective.

**Table 2.** Regression results of Model (1).

Variable	Expected Symbol	(1) Loan
Cash <sub>it-1</sub>	–	–0.009 ** (0.004)
Size <sub>it-1</sub>	+	0.008 *** (0.001)
Lev <sub>it-1</sub>	+	0.104 *** (0.004)
Liquid <sub>it-1</sub>	+	0.060 *** (0.005)
ZJ <sub>it-1</sub>	+	0.237 *** (0.013)
Roe <sub>it-1</sub>	+	0.002 (0.002)
Growth <sub>it-1</sub>	+	–0.000 *** (0.000)
Top1 <sub>it-1</sub>	–	–0.046 *** (0.013)
Herfindahl_3 <sub>it-1</sub>	–	0.048 *** (0.017)
Constant	?	–0.180 *** (0.013)
Year		yes
Ind		yes
Obs.		17,948
R-squared		0.402

**Notes:** Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

The long-term trend (Figure 1) suggests that Chinese firms gradually improve the degree of diversification in ownership structure over the period of 2012–2018. Evidence also indicates that ownership decentralization does contribute to mitigating the potential expropriation by large investors of other investors and stakeholders in the firm [102]. However, existing large investors of SOEs can still expropriate substantial gains from the firms, resulting in severe agency costs. In addition, the coefficient for profitability and a firm's long-term bank loan is positive but not significantly (coefficient = 0.002); the growth capability is negatively related to the long-term bank loans of firms also. We can thus

deduce that banks have not fully considered the profitability and growth of firms in their loan-granting decisions.

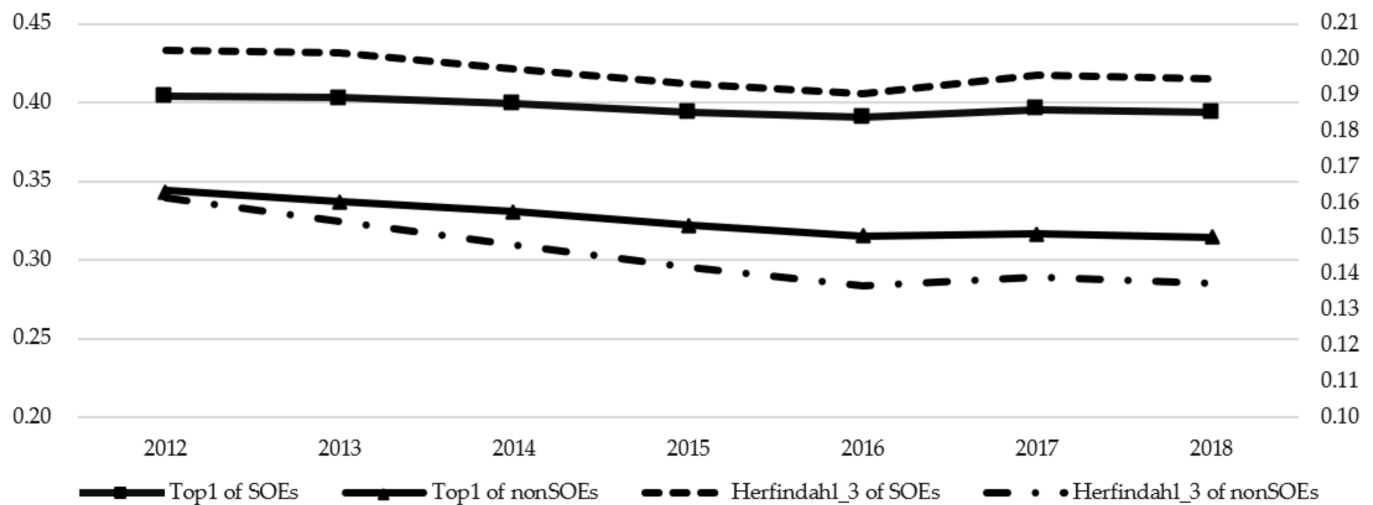


Figure 1. Ownership Structure of SOEs and non-SOEs (China, 2012–2018).

Secondly, according to econometric theory, the residual in Model (1) represents the long-term bank loan a firm obtains that cannot be explained by common economic factors. Therefore, it can be regarded as a measure of a firm's overborrowing. Considering the nature of overborrowing, only when the residual is greater than zero does firm overborrowing exist. Otherwise there is no overborrowing and Overloan is converted to zero correspondingly. Thirdly, the causal steps approach [105] is adopted to verify the mediating effect of overborrowing.

In the context of the current administrative-economic governance of state-owned commercial banks, firms may easily obtain access to a higher level of overborrowing owing to connections arising from being controlled by the same governmental stockholder, thus shrinking their innovation expenditure. If these four conditions described by Baron and Kenny (1986) are met, we can conclude that a mediation effect occurs. Additionally, we use the Sobel (1982) test to test the indirect effects of overborrowing on firm R&D intensity [106]. The Sobel test of significance assumes that the indirect effect of the independent variable is normally distributed, an assumption that may make this a conservative test [107]. The indirect effect is signified to be significant when the Sobel test Z value is significant ( $>1.96$  or  $<-1.96$ ) [108].

Hypothesis 1 suggests overborrowing mediates the relationship between state ownership and firm R&D expenditure. For the specification of the mediation link, we follow Baron and Kenny's (1986) procedure and find that all four steps are fulfilled (Table 3). A mediation effect exists if the coefficient of the direct path between the independent variable (state ownership) and the dependent variable (firm R&D intensity) is reduced when the indirect path via the mediator (overborrowing) is introduced in the model. In Step 4, the coefficient of state ownership is reduced and still significantly negative at the 1% level, suggesting a partial mediation role of overborrowing on the firm R&D intensity. The indirect effect ( $\eta_1 * \sigma_2$ ) the mediating variable overborrowing assumes approximately accounts for 5.12% of the inherent innovation efficiency loss. It means overborrowing essentially weakens the innovation capability of Chinese SOEs and would eventually defer their sustainable innovation. The results of the Sobel test in Table 3 also provide significant evidence of the existence of an indirect effect (as the Sobel Z values are significant:  $Z < -1.96$ ) for the above model.

**Table 3.** The causal steps approach of overborrowing’s mediating effect.

Variable	Step 1 R&D_ratio	Step 2 Overloan	Step 3 R&D_ratio	Step 4 R&D_ratio
State	−0.620 *** (0.098)	0.009 *** (0.002)		−0.489 *** (0.109)
Governsci	23.921 *** (3.567)		20.248 *** (4.039)	20.291 *** (4.030)
Stock_incentive	1.492 *** (0.244)		2.806 *** (0.371)	2.417 *** (0.390)
Independent	1.058 (0.765)		1.234 (0.874)	1.131 (0.871)
Assign	0.281 *** (0.098)		0.401 *** (0.122)	0.335 *** (0.123)
Herfindahl_3	−1.550 *** (0.304)		−1.358 *** (0.353)	−1.243 *** (0.350)
Politic		0.003 (0.002)		
Occupy		0.060 (0.039)		
Market		−0.004 *** (0.001)		
Financeback		0.010 *** (0.003)		
Overloan			−3.637 *** (0.644)	−3.528 *** (0.642)
Constant	−3.163 *** (0.208)	0.030 *** (0.011)	−2.828 *** (0.238)	−2.748 *** (0.243)
Year	yes	yes	yes	yes
Ind	yes	yes	yes	yes
Obs.	7638	5658	5628	5619
R-squared	0.452	0.219	0.481	0.483
Sobel Test	Coef.	Std Err	Z	$p >  Z $
Sobel	−0.3000	0.0368	−8.153	<0.001

Notes: Standard errors are in parentheses. \*\*\*  $p < 0.01$ .

#### 4.3. Political Connections Moderating Mechanism

The specific empirical proxy for the political connection level is the administrative order of politically connected managers in the firm. By referring to past studies on firm political connections and based on Chinese administrative-economic governance characteristics [60,109], the chairman or CEO in listed companies is usually nominated by the larger shareholders and thus has relatively bigger decision-making power on the board, making their position suitable for testing the speculation of firm political connections. The information related to this variable was collected from the CSMAR database. The administrative order divides into eighteen categories according to the administrative level classification standard of CSMAR (See Appendix B).

The political connections mechanism test is carried out in the form of group regression. First, the samples are encoded into two groups according to the administrative level of the firm’s political connection. If a firm’s chairman or general manager has a political connection at or above the provincial level, it is classified as a “high” administrative level firm; otherwise, it is classified as a “low” level one. Then, the above causal steps approach regression is repeated for each group, respectively. From the regression results in Table 4, overborrowing only passes the mediating effect test in the low political connection level group. In other words, while the firm is at a lower political level, which corresponds to much stronger promotion incentives and weaker administrative supervision, the local government is more inclined to intervene in the firm’s access to bank loans through its impact on local commercial banks.

**Table 4.** Group test of moderating mechanisms.

Variable	Group Regressions Results of Political Connection Mechanism								Group Regressions Results of R&D Experience Mechanism									
	Low R&D_ratio	High R&D_ratio	Low Overloan	High Overloan	Low R&D_ratio	High R&D_ratio	Low R&D_ratio	High R&D_ratio	Without R&D_ratio	With R&D_ratio	Without Overloan	With Overloan	Without R&D_ratio	With R&D_ratio	Without R&D_ratio	With R&D_ratio		
State	−0.636 *** (0.101)	−0.381 (0.729)	0.009 *** (0.002)	0.008 (0.008)					−0.513 *** (0.113)	−0.171 (0.814)	−0.664 ** (0.301)	33.196 ** (14.817)	0.027 *** (0.010)	−0.558 (1.004)			−0.260 (0.371)	−129.612 (403.319)
Overloan					−3.589 *** (0.649)	−13.565 ** (6.342)	−3.475 *** (0.647)	−13.489 ** (6.223)							−3.650 *** (0.643)	224.234 ** (80.847)	−3.636 *** (0.643)	219.033 ** (84.098)
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Obs.	7461	177	5500	158	5473	155	5464	155	7589	59	5627	40	5588	40	5588	40	5588	40
R-squared	0.451	0.658	0.218	0.611	0.479	0.687	0.481	0.687	0.448	0.689	0.217	0.943	0.477	0.821	0.477	0.821	0.477	0.821

Notes: Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

To further test the equality of coefficients between two linear regressions across groups, the Chow Test [110] is performed. The Chow Test is to determine whether changes occurred between two regressions. More specifically, step 1 and step 2 are re-regressed with an inclusion of the interaction of independent variable State and moderating variable Dummy\_pc (Dummy\_pc equals to one if a firm's chairman or general manager has a political connection at or above the provincial level; otherwise, it equals to zero). Step 3 is re-regressed with an inclusion of the interaction of mediating variable Overloan and moderating variable Dummy\_pc. Step 4 is re-regressed with an inclusion of the above two interactions. If the test determines that the coefficients of the interaction terms are significantly not equal to zero, this means there is significant evidence that a heterogeneous effect exists above and below that administrative break point. Observably, based on the interaction model, Table 5 Step 2 shows a significant effect of Dummy\_pc on the relationship between State and Overloan (the coefficient of interaction Dummy\_pc \* State is negative and statistically significant at the 1% level). Thus, SOEs with a higher level of political connections tend to restrain the overall level of overborrowing. In particular, Table 5 Step 3 shows a higher level of political connection inversely moderates the negative effect of overborrowing on R&D expenditure. In other words, a positive political connection's moderating role is mainly reflected in the path of state ownership (X) to firm overborrowing (M).

**Table 5.** Chow test of political connections' moderating role.

Variable	Step 1 R&D_ratio	Step 2 Overloan	Step 3 R&D_ratio	Step 4 R&D_ratio
State	−0.012 (0.140)	0.012 *** (0.002)		−0.032 (0.155)
Overloan			−2.731 ** (1.127)	−2.661 ** (1.134)
Dummy_pc	0.365 *** (0.083)	−0.017 *** (0.001)	0.049 (0.096)	0.065 (0.098)
Dummy_pc * State	−0.720 *** (0.182)	−0.006 ** (0.003)		−0.508 ** (0.203)
Dummy_pc * Overloan			−9.424 *** (1.750)	−9.557 *** (1.782)
Other variables	yes	yes	yes	yes
Year	yes	yes	yes	yes
Ind	yes	yes	yes	yes
Obs.	7638	5658	5628	5619
Adjusted R-squared	0.528	0.388	0.555	0.556
Chow Test <i>p</i> value	0.000	0.000	0.000	0.000

**Notes:** Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

#### 4.4. Top Managers' R&D Functional Experience Moderating Mechanism

The top managers lead the company and have a significant impact on the company's financing decisions. As proposed above, the functional experience associated with R&D is closely related to the innovation decision of managers. R&D functional experience will provide the directors and top managers with expertise knowledge, increase team heterogeneity, and reduce shortsightedness, thus promoting the firm's innovation [69,75]. Therefore, we use the proxy whether the firm's chairman or general manager has an R&D background to signify its internal innovation profile. Top managers' functional background derives from the management resumes disclosed in the firm's annual report.

Similarly to the political connection level mechanism, in the examination of hypothesis 3, the samples are firstly encoded into two groups according to the functional background of the chairman or general manager. If a firm's chairman or general manager has a background in R&D in the past, it is classified as a sample with an R&D background and marked as "with". Otherwise, it is classified as a sample without an R&D background and



marked as “without”. Secondly, the causal steps approach regression is repeated for each group, respectively. The results (Table 4) preliminarily show that overborrowing only has a mediating effect between state ownership and R&D expenditure in the group without R&D backgrounds. It suggests an R&D background helps mitigate the negative impact of SOEs’ overborrowing on R&D investment intensity. This finding reinforces our contention that top managers’ R&D functional experience plays an important governance role in reducing the innovation expenditure deficit in SOEs. However, the specific moderating path on which an R&D background acts needs to be further examined. Similarly, we further run the Chow test on the above causal regression. Step 1 and step 2 are re-regressed with an inclusion of the interaction of independent variable State and moderating variable Dummy\_rdback (Dummy\_rdback equals to one if a firm’s chairman or general manager has a background in R&D; otherwise, it equals to zero). Step 3 is re-regressed with an inclusion of the interaction of mediating variable Overloan and moderating variable Dummy\_rdback. Step 4 is re-regressed with an inclusion of both interactions. Table 6 Step 3 shows a significant effect of Dummy\_rdback on the relationship between Overloan and R&D\_ratio (the coefficient of interaction Dummy\_rdback \* Overloan is positive and statistically significant at the 1% level). This suggests that Dummy\_rdback moderates the relationship between overborrowing (M) and firm R&D expenditure (Y). In other words, managers with R&D functional experience engage less in moral hazards such as abandoning innovative opportunities beneficial to firms. Our results, therefore, confirm the role of director human capital in promoting innovation. This result suggests that Hypothesis 3 is empirically supported.

**Table 6.** Chow test of R&D experience moderating role.

Variable	Step 1 R&D_ratio	Step 2 Overloan	Step 3 R&D_ratio	Step 4 R&D_ratio
State	−0.312 ** (0.144)	0.030 *** (0.008)		−0.101 (0.643)
Overloan			−2.499 ** (1.138)	−2.425 ** (1.139)
Dummy_rdback	4.247 *** (0.158)	−0.007 * (0.003)	2.229 *** (0.139)	2.829 *** (0.345)
Dummy_rdback * State	8.492 *** (0.509)	−0.149 (0.099)		19.370 * (10.179)
Dummy_rdback * Overloan			8.183 *** (3.095)	8.522 *** (3.102)
Other variables	yes	yes	yes	yes
Year	yes	yes	yes	yes
Ind	yes	yes	yes	yes
Obs.	7638	5658	5628	5628
Adjusted R-squared	0.589	0.535	0.662	0.662
Chow Test <i>p</i> value	0.000	0.112	0.000	0.000

**Notes:** Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

#### 4.5. Robustness Tests

To further validate the results and test their consistency, several robustness checks were performed. Our robustness test mainly relates to three concerns. Firstly, one concern exists about the appropriateness of a proxy for R&D investment intensity. Referring to the method of Kao and Chen (2020) [111], we firstly substitute the R&D investment intensity with the proportion of R&D expenses in total assets (See Table 7). Secondly, another concern involves how existing extreme observations may influence the accuracy of our estimations. Therefore, all continuous variables are once again winsorized by 5% instead of 1% (See Table 8). Thirdly, the last concern relates to improper designation for the omitted dependent variable. Considering the incompleteness of data, some firms’ R&D investments maybe not be disclosed and are treated as omitted observations. For a large number of omitted observations, we cannot distinguish between zeros that represent a true zero

level of R&D activity and zeros that were created by the statistical authorities because no figures were recorded in the database. During the previous empirical process, these omitted observations are made to be zero. However, this designation may lead to an underestimation of coefficients. Therefore, we exclude these samples and carry out the regressions again (See Table 9). Overall the results were highly robust to these changes in specification.

**Table 7.** Variable Replacement test.

Variable	Step 1 R&D/Assets	Step 2 Overloan	Step 3 R&D/Assets	Step 4 R&D/Assets
State	−0.001 ** (0.001)	0.009 *** (0.002)		0.0002 (0.001)
Governsci	0.174 *** (0.016)		0.151 *** (0.018)	0.151 *** (0.018)
Stock_incentive	0.006 *** (0.001)		0.004 *** (0.001)	0.004 *** (0.001)
Independent	−0.007 * (0.004)		−0.001 (0.004)	−0.002 (0.004)
Assign	0.001 (0.000)		0.000 (0.001)	0.000 (0.001)
Herfindahl_3	−0.002 (0.002)		−0.003 (0.002)	−0.003 (0.002)
Politic		0.003 (0.002)		
Occupy		0.060 (0.039)		
Market		−0.004 *** (0.001)		
Financeback		0.010 *** (0.003)		
Overloan			−0.038 *** (0.004)	−0.039 *** (0.004)
Constant	−0.016 *** (0.001)	0.030 *** (0.011)	−0.013 *** (0.001)	−0.013 *** (0.001)
Year	yes	yes	yes	yes
Ind	yes	yes	yes	yes
Obs.	6252	5658	4444	4439
R-squared	0.344	0.219	0.367	0.368

**Notes:** Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Additionally, we address endogeneity issues in our analysis by applying an instrumental variable approach. Specifically, we analyze whether our mediator variable is exogenous in model (3). A recent contribution proposes that firm innovation inversely increases the firm information environment overall, subsequently stimulating firms' access to financing [112]. There may exist a problem of mutual cause and effect between firm overborrowing and the R&D investment intensity. In addition, the Hausman test [113] for endogeneity also shows that there exists endogeneity in overborrowing. To alleviate the endogeneity problem, we carry out the 2SLS regression test [114]. We take the mean of industrial overborrowing as the instrument variable of a firm's overborrowing. It is correlated with the firm's overborrowing, whereas it is unlikely to be affected by the firm's R&D investment intensity, thus meeting the basic requirements of correlation and exogeneity of instrument variables. The under-identification test (Anderson LM statistic is 903.83,  $p$  value is 0.00) also reflects that the instrument variable is correlated with the endogenous variable. The weak ID test statistics (Cragg–Donald Wald F is 1075.54) are far beyond the 10% Stock–Yogo weak critical values of 16.38, further rejecting that the instrument is weak. Our results in Table 10 show that the mediator—overborrowing—does cause firm's R&D intensity to drop down significantly.

**Table 8.** Winsorize Test (5%).

Variable	Step 1 R&D_ratio	Step 2 Overloan	Step 3 R&D_ratio	Step 4 R&D_ratio
State	−0.530 *** (0.075)	0.009 *** (0.002)		−0.408 *** (0.082)
Governsci	18.994 *** (2.612)		15.418 *** (2.931)	15.373 *** (2.922)
Stock_incentive	1.561 *** (0.184)		2.672 *** (0.263)	2.340 *** (0.275)
Independent	0.811 (0.698)		1.370 * (0.812)	1.203 (0.810)
Assign	0.266 *** (0.071)		0.348 *** (0.086)	0.293 *** (0.087)
Herfindahl_3	−0.904 *** (0.279)		−0.799 ** (0.316)	−0.666 ** (0.316)
Politic		0.003 (0.002)		
Occupy		0.086 * (0.050)		
Market		−0.003 *** (0.001)		
Financeback		0.009 *** (0.002)		
Overloan			−4.315 *** (0.625)	−4.183 *** (0.624)
Constant	−2.928 *** (0.191)	0.023 *** (0.008)	−2.664 *** (0.217)	−2.598 *** (0.220)
Year	yes	yes	yes	yes
Ind	yes	yes	yes	yes
Obs.	7638	5658	5628	5619
R-squared	0.527	0.226	0.558	0.560

**Notes:** Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Table 9.** Eliminating the default sample of R&D investment intensity.

Variable	Step 1 R&D_ratio	Step 2 Overloan	Step 3 R&D_ratio	Step 4 R&D_ratio
State	−0.722 *** (0.132)	0.015 *** (0.002)		−0.535 *** (0.151)
Governsci	23.708 *** (4.480)		22.581 *** (5.268)	22.369 *** (5.251)
Stock_incentive	1.041 *** (0.267)		2.303 *** (0.396)	1.899 *** (0.422)
Independent	1.808 * (0.944)		1.786 (1.122)	1.797 (1.120)
Assign	0.273 ** (0.113)		0.417 *** (0.146)	0.354 ** (0.146)
Herfindahl_3	−2.793 *** (0.412)		−2.798 *** (0.505)	−2.660 *** (0.500)
Politic		0.002 (0.002)		
Occupy		0.054 (0.044)		
Market		−0.002 * (0.001)		
Financeback		0.006 ** (0.003)		
Overloan			−3.763 *** (1.050)	−3.382 *** (1.053)
Constant	−3.633 *** (0.269)	0.039 *** (0.011)	−3.222 *** (0.304)	−3.167 *** (0.314)
Year	yes	yes	yes	yes
Ind	yes	yes	yes	yes
Obs.	6184	4416	4396	4391
R-squared	0.383	0.156	0.405	0.408

**Notes:** Standard errors are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Table 10. 2 SLS Regression Results.

Variables	2SLS-Stage1		2SLS-Stage2	
	Overloan		R&D_ratio	
	Step 3	Step 4	Step 3	Step 4
State		0.00312 *		−0.500 ***
Governsci	−0.299 *** (0.0528)	−0.296 *** (0.0528)	26.71 *** (5.177)	26.58 *** (5.105)
Stock_incentive	−0.0286 *** (0.00443)	−0.0258 *** (0.00469)	4.018 *** (0.456)	3.655 *** (0.464)
Independent	0.0359 *** (0.0133)	0.0365 *** (0.0133)	6.045 *** (1.284)	5.842 *** (1.267)
Assign	−0.00259 (0.00166)	−0.00196 (0.00169)	0.505 *** (0.161)	0.433 *** (0.161)
Herfindahl_3	0.00529 (0.00640)	0.00391 (0.00644)	−2.609 *** (0.621)	−2.434 *** (0.615)
IV2	0.965 *** (0.0280)	0.952 *** (0.0290)		
Overloan			−60.30 *** (2.796)	−58.00 *** (2.902)
Constant	−0.00423 *** (0.000741)	−0.00425 *** (0.000741)	−0.0377 (0.0719)	−0.0215 (0.0710)
Observations	5628	5619	5628	5619
R-squared	0.232	0.233		
IV F-stat			1192	1076
Durbin <i>p</i>			0.000	0.000
Under-identification test	Anderson LM statistic			903.83
	$\lambda^2(1)$ <i>p</i> value			0.00
Weak identification test	Cragg-Donald Wald F statistic			1075.55
	Stock-Yogo weak ID test critical value (10%)			16.38

Notes: Standard errors in parentheses. \*\*\*  $p < 0.01$ , \*  $p < 0.1$ .

## 5. Discussion

The relationship between bank credit and firm innovation has perplexed scholars for a long time. Shahzad et al. (2021) found evidence of an inverted U-shaped relationship between debt financing and corporate innovation, which implies that firms undertaking excessive debts over an optimum debt point may be detrimental to firm innovation [42]. In this study, we refine Shahzad et al. (2021)'s work by identifying and measuring the amount of SOEs overborrowing under China's administrative-economic governance mode. We provide an explanation for SOEs insufficient R&D expenditure, taking into account the corporate governance in transition economies.

More specifically, the indulgence effect of overborrowing urges top managers in SOEs to give up valuable R&D investment opportunities and choose a relatively "safe" policy, lowering R&D expenditure. According to our estimates, SOEs' indulgence effect reduces firm R&D investment intensity by about 3.18 percentage points. Despite the indulgence effect in SOEs, we find higher level political connections and R&D functional experience help mitigate the risk aversion of managers. As shown in the moderating analysis, the improvement in monitoring associated with a higher level of political connections can efficiently reduce the overall overborrowing and alleviate the adverse effects of overborrowing. In addition, managers with relevant R&D functional experience can also make up for the disadvantages of SOEs' overborrowing, highlighting that managers' specific intellectual capital might be a priority in the corporate governance reform of SOEs.

Our findings contribute to a growing empirical literature on a firm's corporate governance in the following ways. Firstly, they expand the understanding of the debt governance

role for innovation in transition economies. Existing studies draw inconsistent conclusions about debt's role in firms' innovation [42,115]. Focusing on the interplay of internal and external governance under administrative-economic governance, we reveal and examine the potential governance mechanism of overborrowing between a firm's state ownership and R&D expenditure. Our research further provides one possible explanation of a firm's innovation investment insufficiency. Secondly, it contributes to the present studies on government intervention and its economic consequences. In addition to the problem of overinvestment documented within the extant literature [116,117], our study demonstrates an excessive debt channel through which government intervention has a significantly negative impact on firm innovation.

Our research, therefore, has some practical implications for SOEs to improve innovation by increasing the proportion of technological managers or directors and giving them more power on technical strategy and discretion on R&D spending. For example, SOEs can set a technology committee at the board level. As a counterpart, local firms need to further improve internal monitoring on the politically connected directors to better reduce the agency costs. The promotion assessment for local SOEs' officials should be comprehensive and sustainability-oriented. In addition, during promoting the innovation of SOEs, the reform of external governance (such as the board diversity and ownership diversification of banks) is also indispensable. In other words, restricting ineffectual intervention in financial institutions can help optimize R&D resource allocation, thereby improving firm innovation capacity.

This study could be viewed as a preliminary step in a comprehensive evaluation of how overborrowing affects the innovation of SOEs. It is indeed a preliminary research because our methodology directly estimates the firm's overborrowing by the residual of the OLS regression model. Alternative strategies of estimating the overborrowing of firms, either by focusing on the counter-cyclical character of discretionary fiscal policy made by the government, or by directly calculating the firm's position changes in commercial banks, would be highly complementary to this approach. In addition, except for overborrowing between SOEs and non-SOEs, whether and to what extent the overborrowing among SOEs and other types of firms (Privately Owned Enterprises, Collectively Owned Enterprises and Foreign-Invested Enterprises) influences firms' innovation still needs careful investigation and examination, which will allow a more efficient use of the available innovation resources across different types of firms.

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## Appendix A

Table A1. Descriptive statistics of variables.

Variable	Total Sample			SOEs			Non-SOEs			t-Test Diff = Mean (SOEs)-Mean (Non-SOEs)
	N	Mean	St. Dev	N	Mean	St. Dev	N	Mean	St. Dev	
Loan	18,822	0.04	0.08	6511	0.07	0.10	12,311	0.03	0.06	34.31
Overloan	6907	0.05	0.06	2335	0.07	0.08	4572	0.04	0.05	18.98
State	18,822	0.35	0.48	-	-	-	-	-	-	-
Cash	18,822	0.18	0.13	6511	0.16	0.12	12,311	0.19	0.14	-15.71
Size	18,822	22.1	1.33	6511	22.81	1.43	12,311	21.75	1.11	56.36
Lev	18,822	0.42	0.27	6511	0.51	0.20	12,311	0.37	0.20	45.07
Liquid	18,822	0.22	0.17	6511	0.26	0.20	12,311	0.19	0.14	30.71
ZJ	18,822	0.04	0.06	6511	0.05	0.07	12,311	0.04	0.06	8.72
Roe	18,762	0.06	0.37	6481	0.05	0.24	12,281	0.07	0.42	-2.65
Growth	17,865	8.08	1007.21	6429	21.34	1678.81	11,436	0.63	18.66	1.32
Top1	18,822	0.35	0.15	6511	0.40	0.15	12,311	0.32	0.14	33.03
Herfindahl_3	18,822	0.16	0.12	6511	0.20	0.13	12,311	0.14	0.10	30.19
R&D_ratio	18,822	3.56	4.20	6511	1.99	3.02	12,311	4.39	4.49	-25.70
Governsci	15,553	0.03	0.01	-	-	-	-	-	-	-
Independent	18,820	0.38	0.05	6510	0.37	0.05	12,310	0.38	0.05	-7.11
Assign	18,609	0.28	0.45	6383	0.10	0.30	12,226	0.37	0.48	-41.51
Stock_incentive	18,822	0.11	0.18	6511	0.0038	0.02	12,311	0.17	0.20	-66.62
Politic	15,590	0.19	0.40	5553	0.16	0.36	10,037	0.21	0.41	-8.38
Layer *	4588	5.62	3.24	1372	5.90	3.21	3137	5.46	3.22	4.22
Occupy	18,822	0.02	0.02	6511	0.02	0.02	12,311	0.02	0.02	1.95
Market	15,553	5.80	0.84	5551	5.53	0.81	10,002	5.95	0.82	-30.88
Financeback	12,311	0.10	0.30	6511	0.08	0.27	12,311	0.10	0.30	-3.42

\* Here, we only count the companies whose chairman of the board or general manager has political connection and its administrative level can be identified.

Table A2. Yearly descriptive statistics of overborrowing.

Year	N	Mean	St. Dev	P1	P99
2012	780	0.0547	0.0718	0.0003	0.3373
2013	857	0.0547	0.0715	0.0006	0.3453
2014	936	0.0497	0.0657	0.0006	0.3011
2015	970	0.0481	0.0615	0.0005	0.2754
2016	1021	0.0475	0.0640	0.0004	0.3064
2017	1103	0.0463	0.0595	0.0006	0.2959
2018	1240	0.0441	0.0578	0.0004	0.2784

Table A3. Variance inflation factors of variables.

Model 1		Model 2		Model 3	
Variable	VIF	Variable	VIF	Variable	VIF
Cash <sub>it-1</sub>	1.49	State	1.44	State	1.61
Size <sub>it-1</sub>	1.71	Politic	1.04	Overloan	1.30
Lev <sub>it-1</sub>	1.83	Occupy	1.12	Governsci	1.17
Liquid <sub>it-1</sub>	1.82	Market	1.21	Stock_incentive	1.42
ZJ <sub>it-1</sub>	1.15	Financeback	1.05	Independent	1.05
Roe <sub>it-1</sub>	1.04			Assign	1.14
Growth <sub>it-1</sub>	1.01			Herfindahl_3	1.15
Top1 <sub>it-1</sub>	13.13				
Herfindahl_3 <sub>it-1</sub>	13.62				
Mean VIF	2.60	Mean VIF	2.56	Mean VIF	2.54

## Appendix B

According to the administrative level classification standard of CSMAR database, the political connections order of top managers is encoded into eighteen categories from top level to the lowest level. If the board chair or general manager currently or previously is a member of the government and the Chinese People's Political Consultative Conference (CPPCC), his or her political connection order is marked as follows: 01 indicates national leader, 02 indicates sub-national leader, 03 indicates provincial-ministerial level, 04 indicates sub-provincial level, 05 indicates bureau-director level, 06 indicates deputy-bureau-director level, 07 indicates division-head level, 08 indicates deputy-division-head level, 09 indicates section-head level, 10 indicates deputy-section-head level, 11 indicates inspector level, 12 indicates deputy-inspector level, 13 indicates investigator level, 14 indicates deputy-investigator level, 15 indicates section-chief level, 16 indicates deputy-section-chief level, 17 indicates staff member level, 18 indicates clerk level, and 98 means unable to identify the administrative level. In addition, if the board chair or general manager is a representative of the National People's Congress or the Party, 01 indicates the country level, 03 indicates the provincial level, 05 represents the municipal level, 07 indicates the county level, and 09 indicates the town level.

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