



Effects of top managers' military experience on technological innovation in the transition economies of China



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ABSTRACT

Due to the economies has emphasized the speed of economic growth and brings some ever-increasing challenges in the transition economics, China has turned the focus toward the sustainable quality of economic development. Especially, the effect of top managers' military experience on enterprises' innovation-led sustainable development is an important, yet unaddressed issue. Military experience of the top managers can prompt or hinder the firms' innovation-led sustainable development as shown in the literature. Based on propensity score matching method, this study uses Wind database and Shenzhen Guotaian Educational Technology Company Limited (CSMAR) database of Chinese enterprises from 2007 to 2017 to show that top managers' military experience affects risk behaviors for corporate investment. The negative effect between top managers' military experience and technological innovation investment appears to be reduced in private firms and weakened for equity incentive. All these findings are against common sense that the military experiences may boost the more risk-loving attitude. This study implies that enterprises should carefully select senior management teams to enhance investments in technological innovation.

1. Introduction

With gradual supply-side structural reforms in the transition economies of China, the elimination of backward production capacity and improvement of supply quality have become core tasks in the future development of enterprises. Innovation-led sustainable development plays a crucial role in allowing enterprises to change their traditional modes of development while maintaining their core competitiveness. Many scholars have focused on identifying how to promote the improvement of firms' sustainable innovation levels. Prior studies have documented the impact of corporate governance on sustainable innovation. Under the hierarchical organization of modern enterprises, enterprises' sustainable innovation investment is greatly influenced by the wills of top managers (Hambrick and Mason, 1984; Carpenter et al., 2004). The top managers' attitude on the innovation may result in the distinctive characteristics of the investment performance of enterprises (Kyu et al., 2017; Chen and Hsiang-Lan, 2014). Unfortunately, there are very a few research to provide direct evidence of the effect of top managers' military experience on innovation-led sustainable development.

China has a large number of veterans. According to the Ministry of Human Resources and Social Security, 28,800 veterans, 49.6% of the total, entered enterprises in 2016 and 35,000 veterans, 43.8% of the total, entered enterprises in 2017.¹ The leaders of many well-known Chinese companies, such as Huawei's CEO Ren Zhengfei and WanDa's Wang Jianlin, are veterans. They lead enterprises to innovate and achieve sustainable development. What we want to examine is whether other more veterans are committed to innovation after they become executives. The upper echelon theory holds that the heterogeneity of cognitive preference and value orientation leads to great differences in top managers' problem understanding and behavioral choices. The personal characteristics of top managers have an important impact on the resource allocation and strategic management of enterprises (Hambrick et al., 2015; Xi et al., 2013). Nonetheless, the ways in which top managers' military experience affects technological innovation investment under the different corporate governance is questionable towards innovation-led sustainable development, due to the lack of sufficient researches.

Drawing from the perspectives of innovation-led sustainable development and the upper echelon theory, this study examines whether

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¹ See <http://www.mohrss.gov.cn/SYrlzyhshbzb/zwgk/szrs/tjgb/>.

top managers' military experience hinders enterprises' technological innovation investment and attempts to identify the differences in the R&D investment decisions of top managers with military experience, when facing different corporate governance. It takes 2634 A-share main board listed companies and 15,268 firm-year samples during 2007–2017 as our research objects and empirically investigates how top managers' military experience influences technological innovation investment. It further examines the moderating effect of ownership type and equity incentive on the relationship between top managers' military experience and technological innovation investment.

Empirical findings of this study expand the literature on the factors that influence firms' innovation-led sustainable development from at least three aspects. First, we conduct a thorough empirical investigation of the effect of top managers' military experience on technological innovation with the propensity score matching method (PSM). Thus, we want to check whether top managers' military experience actually hinders technological innovation, resulting in the enhanced breadth and depth of the upper echelon theory in the field. Second, we want to examine whether the private enterprises constrain the negative effect between top managers' military experience and technological innovation investment. In this way, this study opens new possibilities for researchers to develop a better understanding of the boundary conditions of theories. Third, our research may propose some important practical implications as they indicate the role of the military backgrounds of top managers in the decision-making process of enterprise innovation—a factor that should be considered when attempting to improve the level of innovation-led sustainable development. In summary, our findings may trigger theoretical discussions among at least three aspects, including the perspective of top managers, firms' ownership type and innovation-led sustainable development. Therefore, it opens a new possibility for researchers to obtain a better understanding of the upper echelon theory.

In addition, This paper is structured as follows. [Section 2](#) reviews the literature on the relationship between top managers' experience and firm technological innovation investment, and presents three hypotheses. [Section 3](#) describes the data and the methods used. [Section 4](#) reports and discusses the estimation results. Finally, [Section 5](#) draws the main conclusions and provides some policy implications.

2. Literature review and hypothesis

2.1. Top managers' military experience and firm technological innovation investment

Technological innovation is an important output of the technology industry and is regarded by evolutionary economics researchers as an important indicator of innovation-led sustainable development ([Reichardt et al., 2016](#)). The outstanding contribution of technological innovation in knowledge, technology, and value creation has become a key factor in determining whether a company can grow healthily and sustainably ([Zhang and Tang, 2017](#)). A recent incident involving China Telecom's ZTE Corporation has exposed China's problems in independent innovation in the field of telecommunications. ZTE is the fifth largest manufacturer of communication equipment in the world and the second largest in China. Its business covers wireless network, optical transmission, broadband access, data communication, cloud computing collection terminal and other fields, but its main business areas rely heavily on foreign chips such as the United States. In 2010, driven by commercial interests, ZTE violated U.S. sanctions restricting the sale of U.S. technology to Iran. It has been punished by the rules and laws of commercial transactions. ZTE does not represent the overall situation of Chinese enterprises, but it is a mirror for Chinese enterprises. This incident has also sounded an alarm for Chinese enterprises. The situation that China's core technology is restricted by others has not been fundamentally changed. Chinese enterprises must grasp the key technology firmly in their hands as soon as possible. To

overcome such limitations, Chinese enterprises are striving to improve their innovation level. To this end, the academic community should also work on identifying the key factors that promote the innovation-led sustainable development capabilities.

According to statistics, 8.4% of CEOs in the U.S. S&P 500 have a military resume.² In recent years, Walmart and General Electric have recruited veterans who have returned from Iraq and Afghanistan to serve as top managers ([O'Keefe, 2010](#)). [Elder et al. \(1986\)](#) find that individuals are generally influenced by their military background, the effects of which vary with individual differences such as the duration of military participation and family background ([Elder and Glen, 1986](#)). Some scholars have pointed out that individuals typically become more adventurous and more adaptable to extreme environments and accidents after serving in the army ([Wansink et al., 2008](#); [Elder and Clipp, 1989](#)). [Killgore et al. \(2008\)](#) also propose that top managers with military backgrounds are often more confident, courageous, proactive, and adventurous ([Killgore et al., 2008](#)). However, [Malmendier et al. \(2011\)](#) assert that this risk-taking trait may cause top managers to overestimate their decision-making abilities and negatively impact the company's development in the face of major corporate decisions ([Malmendier et al., 2011](#)). How do top managers with military backgrounds make business decisions, and how do their military backgrounds affect the company? While some scholars believe that individuals' military experience is conducive to the cultivation of outstanding qualities such as loyalty, integrity, and leadership ([Franke, 2001](#); [Wansink et al., 2008](#)), Chinese history and reality indicate that military experience is more likely to induce in individuals conservative and cautious behavioral tendencies, which are not conducive to promoting enterprises' innovation-led sustainable activities ([Duffy, 2006](#)).

Top managers' military experience can temper their will, cultivate responsibility, and introduce in them highly individualized thinking patterns and preference characteristics, which ultimately affect their innovative behavior. On the one hand, soldiers are trained in identifying and clarifying targets and gathering foresight before taking actions. Top managers with military experience often have a high demand for predictable results of their decisions, and they are more likely to act cautiously in the face of risky strategic decisions ([Benmelech and Frydman, 2015](#)). In addition, 'advocating honor' is the core value of soldiers. Military personnel are guided throughout life by the idea that 'If I succeed one day, I will not let my honor down'. Top managers with military backgrounds also expect to gain high praise from their peers and society. However, innovation investment is high-risk. It is often uncertain whether innovation will be successful and whether new products can adapt to the market. Research and development failures not only affect corporate income, but also threaten the professional reputations and manpower resources of top managers. To avoid the operating risk caused by high uncertainty and protect their reputation from damage, top managers with military backgrounds usually take extreme care when making innovation decisions, which may lead to insufficient investment in innovation-led sustainable development. On the other hand, top managers with military backgrounds have less knowledge of financial accounting, marketing, and other relevant subjects than professional managers ([Benmelech and Frydman, 2015](#)). As innovative activities are highly specialized, top managers must have a high level of technical knowledge to provide the necessary support, and it is difficult to make complex innovation decisions merely on the basis of business experience. Military top managers with an inferior level of professional knowledge are more likely to be impeded by subjective thinking such as risk avoidance, and may act blindly in the process of innovation-led sustainable development decision-making. Based on the analysis above, the following hypothesis is presented:

² See <https://www.spglobal.com/en/who-we-are/our-people/our-leadership#sp-global-ratings>.

Hypothesis 1. *Under other invariable conditions, the military experience of top managers will have a negative impact on technological innovation investment. That is, companies with managers with military backgrounds are less inclined to engage in innovation-led sustainable development.*

2.2. Moderating effect of firm ownership type

Due to the Chinese government's interventions, enterprises with different ownership types greatly differ regarding their operating objectives and resource acquisition, among other aspects. Top managers' sustainable innovation decisions are not only limited to individual preferences, but also depend on the firm's specific ownership type. State-owned enterprises bear the policy burden of promoting economic development, maintaining stable employment, and improving social welfare. Diversification objectives enable state-owned enterprises to weigh their priorities between performance goals and social goals in their strategic decisions, which reduces their incentive to explore new markets and increase market share through innovation (Lin et al., 2010). At the same time, state-owned enterprises enjoy preferential policies such as tax reductions, tax exemptions, and tax refunds (Chen and Yang., 2019), and it is easier for them to receive financial subsidies when facing business difficulties, which can effectively prevent bankruptcy crises. Consequently, the existence of protective government policies and soft budget constraints³ places state-owned enterprises in a greenhouse environment with less market competition pressure and a lack of awareness of hardship. Some state-owned enterprises have even gained the corresponding monopoly advantage by virtue of government empowerment (Guo and Hui, 2014), weakening their motivation to actively innovate to cope with the pressures of market competition. In addition, due to the pressures of political promotion, state-owned top managers have stronger motivations to execute projects prudently from the beginning to end, and are more conservative and cautious in their strategic decision-making processes. In contrast, the private enterprises lack the support of government policies and economic resources, and they are in a more competitive market environment; as a result, innovation-led sustainable development is an important means for these enterprises to establish and maintain an advantage. Furthermore, in the private enterprises, top managers' incentives are mainly related to performance. Salary incentives can effectively promote R&D expenditures and increase corporate innovation activities (Francesca et al., 2019; Cheng, 2004). To achieve long-term development and obtain personal economic benefits, the top managers of the private enterprises will make strategic decisions on technology acquisition, integration (change) and development (Martin-Rojaset et al., 2019), and maintain their enterprises' competitive advantage through innovation. Therefore, the private ownership type effectively weakens the risk aversion preferences of top managers with military experience, strengthening their motivation to innovate. Based on the analysis above, the following hypothesis is proposed:

Hypothesis 2. *The relationship between top managers' military experience and enterprises' technological innovation investment is negatively regulated by the firm's ownership type. Compared with the private enterprises, military experience of top managers in state-owned enterprises has a more significant negative impact on enterprises' innovation-led sustainable development.*

2.3. Moderating effect of equity incentives

A firm's top management team has a mission to propose and implement strategies that are critical to business performance and sustainable development (Hambrick and D'Aven, 1992). Management

shareholding is generally considered to be the main incentive to prevent management from generating self-interested behavior, which not only provides managers with economic benefits, but also gives top managers decision-making power.

The current academic conclusions are inconsistent regarding the impact of equity incentives on top managers' R&D decisions. First, earlier research based on the agency theory indicates that equity incentives can reduce the conflicts of interest between shareholders and top managers and promote innovation-led sustainable development (Murphy and Jensen, 1990). That is, equity incentives have a significant positive impact on corporate R&D investment (Sun et al., 2016; Lin et al., 2011; Wu and Tu, 2007; Geletkanycz and Boyd, 2011; Bebchuk and Fried, 2003; Fu, 2012). Second, the relationship between equity incentive and R&D investment varies with different ways of equity incentive. Direct government subsidies favor firms in the short-term, but hinder them in their long-term innovation performance. Indirect tax credit, on the other hand, is favorable to a firm's short-term and long-term innovation performance (Zhang and Guan, 2018). Li (2014) found that current value of executives equity incentive negatively affects company's technological innovation intensity. In contrast, expected value of executive equity incentive has significant positive influence on company's technology innovation intensity. As executive equity cash increases, the influence of current value of equity incentive on company's technological innovation is weakened, as the impact of the expected value on technological innovation. Stock options are positively correlated with R&D investment, while stock holdings are negatively correlated with R&D inputs (Ryan and Wiggins, 2002). In general, working in non-high-tech enterprises, short-term incentives and long-term incentives for top managers are not related to R&D innovation. In high-tech enterprises, however, short-term incentives for top managers are not related to corporate R&D innovation, and long-term incentives for top managers are weakly related to R&D innovations (Balkin et al., 2000). Third, there was a non-linear relationship between top managers' shareholding and R&D investment (Cheng, 2004; Ghosh et al., 2010).

The agency theory holds that there is a difference in the objective function between top managers and shareholders, and strategic decisions must consider top managers' weighing of their own interests, which directly leads to principal-agent conflicts (Reger, 1997). As a 'golden handcuff' that binds the interests of top managers and shareholders, equity incentives effectively link top managers' compensation with the long-term performance of enterprises (Jensen and Meckling, 1976). Top managers with equity will benefit themselves by improving technological innovation investment, which is conducive to enterprises, innovation-led sustainable development (Smith, 1988). Equity incentives help top managers overcome their risk aversion tendencies and enhance risk tolerance. In addition, equity incentives enable top managers to obtain the right of sharing corporate interests and residual rights, which help them enhance their sense of ownership and pay more attention to the long-term interests of the enterprise. Therefore, equity incentives are interest coordination mechanisms that introduce enterprise values into top managers' personal interests. To some extent, this can alleviate the short-sighted behaviors of top managers with military backgrounds, improve their risk aversion tendencies, and promote investment in their enterprises' sustainable innovation. Therefore, this study proposes the following hypothesis:

Hypothesis 3. *The relationship between top managers' military experience and their enterprises' technological innovation investment is positively regulated by equity incentives. The higher the top managers' shareholding ratio, the weaker the negative influence of their military experience on innovation-led sustainable development.*

³ 'Soft budget constraint' refers to the economic phenomenon that Chinese state-owned enterprises can survive through government assistance when they encounter financial difficulties.

3. Research methods

3.1. Data

This study uses a dataset of Chinese A-share listed companies between 2007 and 2017 to empirically test the theoretical hypothesis, and screens the primary samples by: (1) excluding firms whose statements of public utilities, financial and insurance companies are not consistent with those of other listed companies; (2) excluding ST,⁴ *ST,⁵ delisted companies; and (3) excluding companies with abnormal data or a lack of financial data. After following the steps above, 15,268 observations were obtained from the data of 2,634 listed companies. The data used in this study is from Wind database and CSMAR (the Shenzhen Guotai Educational Technology Company Limited) database in China. The data about top managers' military experience was obtained from their resumes in the CSMAR database and search engines (e.g. <http://www.Baidu.com> and <http://www.cninfo.com.cn>). To eliminate the influence of extreme values, this study winsorized the variables at the 5% and 95% level, according to the literature.

3.2. Research methods and model specification

An important methodological problem in empirical research in social sciences is how to study 'self-selection' in causal inference with strict statistical methods (Morgan and Harding, 2006; Sobel, 1995). Considering that the gap of technological innovation investment may be the result of individual differences between enterprises, the lower technological innovation investment level of enterprises with top managers from military backgrounds is not necessarily the result of top managers' decisions. This study divides the sample enterprises into the treatment group or the control group according to whether they are managed by top managers with military backgrounds. To accurately compare the net effect of top managers' military experience, we apply the PSM method developed by Rosenbaum and Rubin (1983), which can strictly control for observed selection bias and address the endogeneity problem by using propensity scores (PS) to measure the extent of matching between the treatment and control groups. The specific steps are the following:

First, the PS is calculated. The PS value refers to the conditional probability of the enterprises managed by top managers with military backgrounds under certain characteristics, namely:

$$PS(X) = \Pr\{D = 1|X\} = E\{D|X\}, \quad (1)$$

Among them, D is a dummy variable set by the characteristics of top managers' military experience. If the enterprise is managed by top managers with a military background, $D = 1$; otherwise, $D = 0$. X is a characteristic variable that can affect the enterprises' hiring to the top manager who has military experience, that is, it is a matching variable. Drawing on Dehejia and Wahba's study (Dehejia and Wahba, 1998), we select the predicted value of the logit bivariate regression model to estimate the PS value:

$$PS(X_i) = \Pr\{D_i=1|X_i\} = \exp(\beta X_i)/(1 + \exp(\beta X_i)), \quad (2)$$

Among them, β is a regression coefficient of the logit model. Some matching variables may affect firms' innovation-led sustainable development, according to Wang and Huang (2006), Wen et al., (2015), Zhang et al. (2019), and other relevant studies (Hua-Hung et al., 2015;

⁴'ST' refers to the Shanghai and Shenzhen Stock Exchange's announcement that special treatment will be given to the stock transactions of listed companies with abnormal financial and other financial conditions. The abnormality mainly refers to two situations: one is that the net profits of listed companies in the two audited fiscal years are negative; the other is that the net assets per share audited in the last fiscal year are lower than the face value of stocks.

⁵'*ST' refers to the company has continued deficit for three consecutive years, and is given early warning of delisting by the stock exchange.

Zhang et al., 2019). The main matching variable X in this study is defined as follows. (1) Size of firm (Size): the size of a firm measured by the logarithm of total assets; (2) Performance level: measured according to the return on equity (ROE); (3) Efficiency level: measured according to the total assets turnover (Turnover); (4) Ownership type (State): whether the enterprise is state-owned will affect the top managers' decisions on technological innovation investment; this is measured according to whether the enterprise is state-owned or private; and (5) Industry characteristics (Industry): high-tech enterprises require more technological innovation investment. Industry characteristics also affect top managers' innovation motivations. In addition, following Bushee (1998), this study uses R&D to represent innovation-led sustainable development, which is the amount of R&D spending as a percentage of total sales. The main variables are defined in Table 1.

Second, the treatment and control groups are matched according to the PS value using nearest-neighbor matching, radius matching, and kernel matching. After matching, the control group excludes the enterprises that have significant differences in the matching variables with the treatment group, and only retains those that are comparable to the treatment group.

A balance test is then carried out, which examines whether the samples in the treatment and control groups can satisfy the common support hypothesis and parallel hypothesis. The common support hypothesis ensures that all the samples in the treatment group have matching control group samples using the PS value. The parallel hypothesis is that there is no significant difference between the treatment and control groups in the matching variables; that is, the difference in the technological innovation investment level between the two groups is entirely caused by the top managers' military experience.

Finally, the average treatment effect (ATT) is calculated and the net effect of the influence of the top managers' military experience on technological innovation investment is estimated. If the ATT is statistically significant, it shows that the top managers' military experience has a significant impact on the enterprises' research and development input.

$$ATT = E\{Y_{1i} - Y_{0i}|D_i = 1\}, \quad (3)$$

Among them, Y is R&D, which measures the level of research and development input in the enterprises, and Y_{1i} is the research and development input of the enterprises managed by the top manager who has a military background. Y_{0i} is the research and development input of the enterprises managed by a top manager who does not have a military background. $Y_{1i} - Y_{0i}$ is the treatment effect of top managers' military experience on the research and development input of the enterprises.

Model (4) is used to further test the effect of equity incentives in the relationship between military experience and enterprise R&D:

$$\begin{aligned} R\&D_{it} = & \beta_0 + \beta_1 Army_{it} + \beta_2 Army_{it} \times Share_{it} + \beta_3 Share_{it} + \beta_4 Size_{it} \\ & + \beta_5 ROE_{it} + \beta_6 Turnover_{it} + \beta_7 Cash_{it} + \beta_8 Indepen_{it} \\ & + \beta_9 Duality_{it} \\ & + \beta_{10} State_{it} + \beta_{11} Industry_{it} + \varepsilon_{it} \end{aligned} \quad (4)$$

4. Empirical analysis

4.1. Descriptive statistical analysis

Table 2 shows the descriptive statistics results of the matching variables in the treatment and control groups before PSM. As shown in Table 2, there are significant differences in the remaining features of the two groups except for the enterprise size (Size) and the independence of the board (Indepen). Among them, the average value of ROE in the treatment group is 0.0584, while that of the control group is 0.0660, and the mean difference is $-13.06,834\%$, which indicates that

Table 1
Variable definition and measurement.

Variable name	Variable explanation	Variable value
R&D	Research and Development Investment	The amount of R&D spending as a percentage of total sales
Army	Top managers with military experience	If at least one person in the top management has military experience, the value is 1; otherwise, 0
Size	Size of firm	Logarithm of total assets
ROE	Performance level	Profit from principal operations/Net assets at year end
Turnover	Efficiency level	The main business income/Total assets at year end
Cash	Cash flow	Net cash flow from operating activities/Total assets at year-beginning
Share	Top managers' shareholding ratio	Number of shares held by top managers/Total share capital
Indepen	Board independence	Number of independent directors/Number of board members
Duality	Both positions	If the CEO serves as chairman, the value is 1; otherwise, 0
State	Ownership type	If the firm is state-owned, the value is 1; otherwise, 0
Industry	Industry characteristics	If the firm is a high-tech enterprise, the value is 1; otherwise, 0

Table 2
Descriptive statistics of matching variable.

Name	N	Average value	Standard deviation	Minimum value	Maximum value	The median	Mean difference
Size	1200	21.9013	1.1785	19.1730	27.4349	21.7552	-0.3969%
	15,268	21.9882	1.2651	17.8061	28.5085	21.7936	
ROE	1200	0.0584	0.1888	-2.6890	0.8847	0.0741	-13.0683%
	15,268	0.0660	0.1535	-3.7787	2.0757	0.0707	
Turnover	1200	0.6035	0.5593	0.0162	7.6092	0.4798	-7.6094%
	15,268	0.6495	0.4842	0.0034	9.3098	0.5457	
Cash	1200	0.0562	0.2131	-0.5085	6.2409	0.0442	2.8458%
	15,268	0.0546	0.2053	-5.9660	8.6681	0.0478	
Share	1200	0.1547	0.2160	0.0000	0.7538	0.0089	7.5605%
	15,268	0.1430	0.2062	0.0000	0.8973	0.0053	
Indepen	1200	0.3739	0.0548	0.2857	0.6667	0.3333	0.2802%
	15,268	0.3729	0.0553	0.0909	0.8000	0.3333	
Duality	1200	0.2708	0.4446	0	1	0	1.0177%
	15,268	0.2681	0.4430	0	1	0	
State	1200	0.3500	0.4772	0	1	0	2.2793%
	15,268	0.3420	0.4744	0	1	0	
Industry	1200	0.3617	0.4807	0	1	0	8.5464%
	15,268	0.3308	0.4705	0	1	0	

Notes: The first row of data for each indicator is the descriptive statistics result of the sample enterprise which is in the treatment group, and the second row is the descriptive statistics result of the sample enterprise which is in the control group. In order to accurately comparing the differences in individual characteristics of the two groups of sample firms, descriptive statistics uses the data which is non-treated by the Winsorize.

the performance of enterprises with managers from military backgrounds is lower than that of enterprises without managers from military backgrounds. Interestingly, this contrasts conceptions that top managers' military background is beneficial to the performance of the enterprises in which they are employed. In terms of the shareholding ratio of top managers (Share), the average value in the treatment group is 0.1547, which is significantly higher than the average value of the control group at 0.1430. That is, the shareholding ratio of top managers with military backgrounds is significantly higher. Furthermore, from the ownership type (State) and industry characteristics (Industry), the proportion of state-owned enterprises and high-tech enterprises in which top managers with military backgrounds are located is significantly higher than that of non-military background top managers.

4.2. Influence of top managers' military experience on firms' technological innovation investment

4.2.1. Analysis of matching effect

Fig. 1 shows the kernel density distribution of the treatment and control group before and after nearest-neighbor matching. As shown in Fig. 1, there are some differences in the probability distribution of PS values before matching. The distribution center of the treatment group is rightward, which indicates that the two groups of samples have differing individual characteristics. If the difference in technological innovation investment between the two groups is directly compared, it will not be possible to effectively distinguish whether it is caused by individual characteristics or if it is the result of the top managers'

military experience. The control group's PS value distribution curve moved to the right after matching, and the kernel density curve between the two groups basically overlapped, meaning that the PS value distribution deviation between the treatment and control groups was corrected by the nearest-neighbor matching. The matching effect was good. Thus, the joint support hypothesis was verified.

Table 3 shows a comparison of the differences between the nearest neighbors of the matching variables. As shown in Table 3, the standardized deviation decreased significantly after matching, with the absolute value less than 5%, and the *t*-test results were not significant. This indicates that the difference between the matched treatment and control groups is not significant, verifying the parallelism hypothesis. Fig. 2 also shows that the matching effect is preferable. That is, the different levels of technological innovation investment between the two groups is entirely caused by the top managers' military experience.

4.2.2. The influence of top managers' military experience on firms' technological innovation investment

By comparing the significance level of the ATT, this study examines the influence of top managers' military experience on technological innovation investment. As shown in Table 4, the average R&D of the treatment group after matching is 0.0349, the mean value of the control group is 0.0382, ATT is -0.0033, and the significance test is passed at the 1% level. Thus, under the condition that the individual characteristics of the enterprises are consistent, top managers' military experience reduced the enterprises' R&D by 8.64%, and the R&D of enterprises managed by top managers with military backgrounds was

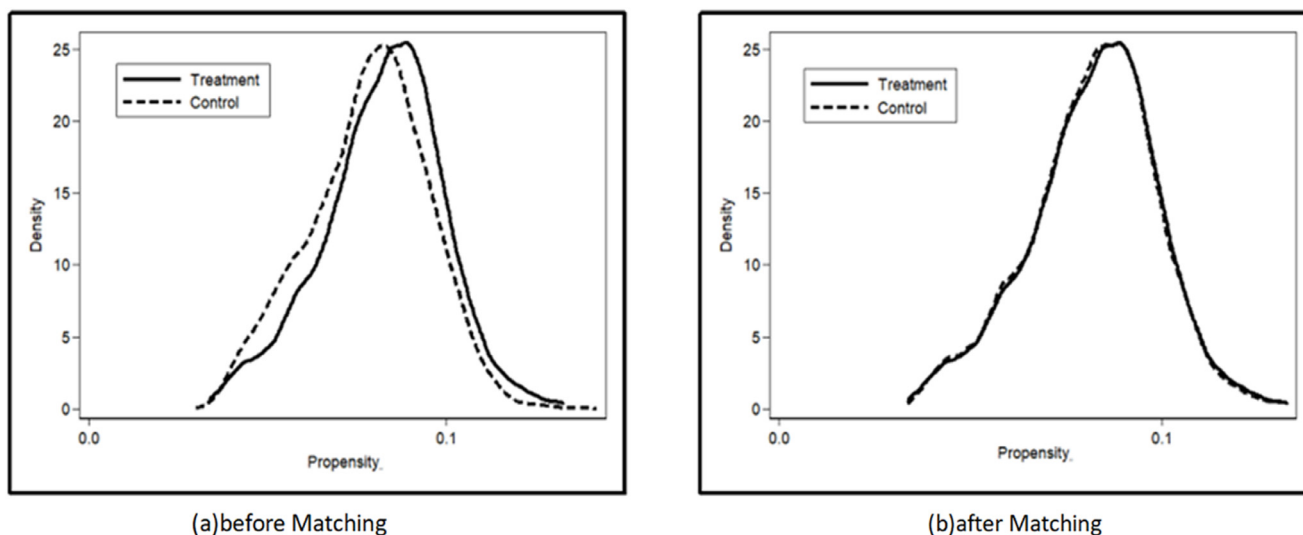


Fig. 1. Propensity scores kernel density distribution of treatment group and control group before and after matching.

significantly lower than that of enterprises without managers with military backgrounds. Meanwhile, ATT is -0.0033 with radius matching, which is significant at the 1% level. In the case of kernel matching, ATT is also significant at the 1% level, which indicates that top managers' military experience has a significant negative impact on technological innovation investment. The uniform style of military management imparts soldiers with clearly determined goals, emphasizes the predictability of their activities, and weakens their risk aversion preferences. As a result, soldiers tend not to make risky investments. However, innovation-led technological investment is high-risks; therefore, top managers' military backgrounds have a negative influence on firm's innovation-led sustainable development. Hypothesis 1 is thus supported.

4.3. Moderating effect of ownership type

To compare the differences in the influence of top managers' military experience on technological innovation investment with different ownership types, all enterprises are further divided into state-owned enterprises and private enterprises. As shown in Table 5, after the nearest-neighbor matching, the absolute value of the statement group's *T*-value of the state-owned enterprises corresponding to ATT in the

control group was 3.75, which is far greater than the absolute value of 0.37 for the private enterprises. The ATT values of the private enterprises under radius matching and kernel matching both failed to pass the significance test, which indicates that the negative influence of top managers' military experience on R&D investment is affected by the nature of ownership type. The negative influence of top managers' military experience on innovation-led sustainable development is more significant in the state-owned enterprises than in the private enterprises. Thus, a private right of firms motivates top managers to consistently innovate in technology, and may improve top managers' ability to take risks. Hypothesis 2 is verified.

4.4. Regulating effect of equity incentive

Table 6 lists the regression results of model (4), which illustrates the regulating effect of the equity incentive on top managers' military experience and technological innovation investment. As shown in Table 6, the cross-term coefficient between top managers' military experience and shareholding ratio is 0.0104, which is significant at the level of 1%. This shows that equity incentive can weaken the negative influence of top managers' military experience on technological innovation investment. The higher the proportion of top managers' shareholding, the less

Table 3
Comparison of matching variables before and after matching.

Variables	Before/ after matching	Mean		Std. Dev (%)	Std. Dev Decreased (%)	T test	
		Treatment Group	Control Group			T-values	P-values
Size	Before	21.8810	21.9650	-7.7		-2.48	0.013
	After	21.8810	21.8890	-0.7	90.5	-0.18	0.858
ROE	Before	0.0747	0.0739	0.9		0.31	0.754
	After	0.0747	0.0763	-2.0	-109.4	-0.48	0.629
Cash	Before	0.0496	0.0506	-1.4		-0.46	0.643
	After	0.0496	0.0508	-1.6	-18.6	-0.4	0.687
Turnover	Before	0.5612	0.6213	-19.0		-6.16	0.000
	After	0.5612	0.5676	-2.0	89.4	-0.52	0.606
Share	Before	0.1500	0.1386	5.7		1.92	0.055
	After	0.1500	0.1545	-2.2	60.7	-0.53	0.594
Indepen	Before	0.3739	0.3728	2.1		0.68	0.494
	After	0.3739	0.3744	-1.0	53.5	-0.24	0.814
Duality	Before	0.2708	0.2678	0.7		0.22	0.822
	After	0.2708	0.2588	2.7	-303.9	0.67	0.503
State	Before	0.3500	0.3413	1.8		0.61	0.544
	After	0.3500	0.3533	-0.7	61.5	-0.17	0.864
Industry	Before	0.3617	0.3281	7.1		2.37	0.018
	After	0.3617	0.3758	-3.0	57.8	-0.72	0.472

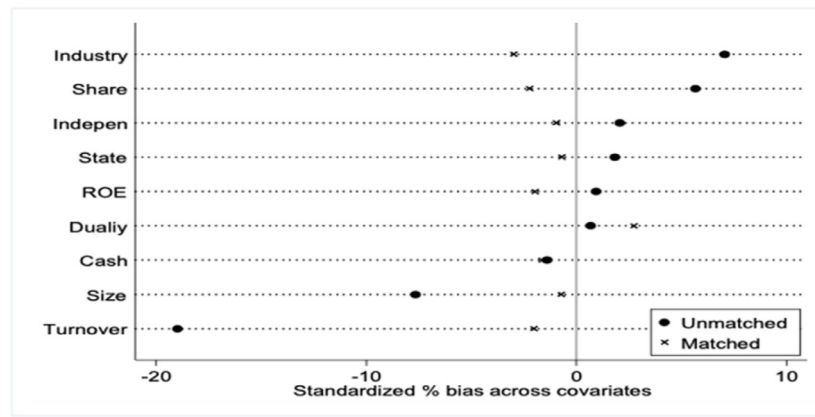


Fig. 2. Standardized deviation before and after matching variables.

obvious the negative impact of top managers' military experience on technological innovation investment. Hypothesis 3 is verified. This presents a solution for the principal-agent conflict by assimilating the objective function of top managers and shareholders. The equity incentive contract organically combines the top managers' compensation with the long-term performance of the enterprise, effectively binding the interests of top managers and shareholders, and fully encourages the top managers with equity to obtain the maximum profit by improving the R&D input that are conducive to the long-term development of the enterprises. Therefore, equity incentive can improve the risk aversion tendencies of top managers with military backgrounds and enhance their willingness to improve technological innovation investment. In addition, the relationship between R&D and ROE is not significant because it will take a long time for the performance of technological innovation to be acquired.

4.5. Robustness test

To verify the robustness of the results above, this study carried out the robustness test as follows: (1) Considering the subjectivity of the score estimation determined by the selected matching variables under the PSM method and deviation in the matching, based on the ideas of Abadie et al. (2004), the robustness test used the deviation correction matching method. The k-nearest neighbor matching technique with playback and juxtaposition was carried out using the Mahalanobis distance. At the same time, the deviation correction method was used to estimate the deviation, and the regression method was used to obtain the deviation correction matching estimator. The results of deviation correction and matching are shown in Table 7. The discrepancies of the technological innovation investment level between the treatment and control groups is entirely caused by the top manager's military experience; (2) The model 4 was tested by redefining technological innovation investment for the natural logarithm of R&D; and (3) Considering the endogeneity of equity incentive, top managers' military experience and the shareholding ratio was lagged behind for one period and the model 4 was conducted again. The results of (2) and (3) are shown in Table 8. The test results above are consistent with the main conclusions in this paper, indicating that the empirical conclusions of this study are relatively stable.

Table 4

The influence of top managers' military experience on enterprises' technological innovation investment.

Matching mode	Treatment group	Control group	ATT	Std Dev	T-values
Nearest neighbor matching ($n = 2$)	0.0349	0.0382	-0.0033***	0.0011	-2.90
Radius matching ($r = 0.001$)	0.0348	0.0381	-0.0033***	0.0009	-3.56
Kernel matching ($c = 0.01$)	0.0349	0.0380	-0.0032***	0.0009	-3.38

Notes: *** represent significance levels of 1%.

Table 5

The influence of top managers' military experience on R & D input under different ownership type.

Matching mode	SOEs	T-values	PEs	T-values
	ATT		ATT	
Nearest neighbor matching ($n = 2$)	-0.0064***	-3.75	-0.0005	-0.37
Radius matching ($r = 0.001$)	-0.0059***	-4.74	-0.0017	-1.43
Kernel matching ($c = 0.01$)	-0.0056***	-4.28	-0.0013	-1.12

Notes: *** represent significance levels of 1%. SOEs means the state-owned enterprises, and PEs means the private enterprises.

Table 6

Regulating effect of equity incentive on top managers' military experience and technological innovation investment.

Variables	Coefficient	T-value
Army	-0.0047***	-4.99
Army × Share	0.0104***	2.79
Share	0.0253***	19.65
Size	-0.0035***	-16.76
ROE	-0.0012	-0.4
Turnover	-0.0272***	-40.58
Cash	0.0127***	4.02
Indepen	0.0151***	4.02
Duality	0.0031***	6.27
State	-0.0034***	-6.53
Industry	0.0161***	35.84
_cons	0.1145***	24.04
N	15,268	
Adj-R ²	0.3014	
F-values	599.92	

Notes: *** represent significance levels of 1%.

5. Conclusion and policy implications

Using Chinese A-shares listed companies during 2007–2017 as samples, this study empirically tests the relationship between top managers' military experience and enterprise's technological innovation investment, as well as the moderating effect of firms' ownership type

Table 7
Deviation correction and matching estimation of influence of top managers' military experience on technological innovation investment.

Sample size	SATT	Heteroscedasticity robust standard error	Z value
All samples	-0.0031***	0.0008	-3.77
SOEs	-0.0074***	0.0012	-6.13
PEs	-0.0025**	0.0011	-2.34

Notes: ** and *** represent significance levels of 5% and 1% respectively. SOEs means the state-owned enterprises, and PEs means the private enterprises.

Table 8
Regulating effect of equity incentive on top managers' military experience and technological innovation investment (Robustness text).

Variables	(2) of robustness text Coefficient	(3) of robustness text coefficient
Army	-0.3306*** (-5.87)	-0.0039* (-1.82)
Army × Share	0.7352*** (3.42)	0.0152* (1.94)
Share	1.1191*** (15.38)	0.0149*** (5.65)
Size	-0.1760*** (-15.92)	-0.0056*** (-13.63)
ROE	0.9043 (11.29)	0.0077** (2.34)
Turnover	0.1848*** (7.13)	-0.0191*** (-19.24)
Cash	0.5352*** (9.42)	0.0043* (2.04)
Indepen	0.3916** (1.73)	0.0450*** (5.39)
Duality	0.1690*** (5.68)	0.0022* (2.05)
State	-0.3469*** (-11.23)	-0.0025** (-2.22)
Industry	0.6284*** (23.39)	0.0214*** (21.89)
_cons	-1.2090*** (-4.80)	0.1529*** (16.38)
N	12,770	11,580
Adj-R ²	0.1851	0.1342
F-values	263.41	164.14

Notes: ** and *** represent significance levels of 1% and 5% respectively. The value of T is in the parentheses.

and equity incentive on the relationship between the aforementioned factors. The findings are as follows: first, top managers' military experience has a significant negative impact on enterprises' technological innovation investment. Despite their courage, top managers with military backgrounds lack the ability to conducive to innovation, demonstrate conservative and risk aversion tendencies in the process of strategic decision-making and have a psychological aversion to sustainable innovation with uncertain future benefits. Second, the characteristics of state-owned and private firms affect top managers' decisions. Compared with the private enterprises, the military experience of top managers in the state-owned enterprises has a more significant negative impact on technological innovation investment, which can be attributed to objective reasons like political goals and soft debt constraints. Third, equity incentive can weaken the negative impact of military experience on enterprises' innovation-led sustainable development by alleviating the short-sighted behavior of top managers and overcoming their risk aversion tendencies. Long-term motivations of top managers drive the innovation-led sustainable development.

While our results must take into consideration the gaps in the data, the results suggest that enterprises should carefully select senior management teams to enhance investments in technological innovation. We now discuss three high-level implications for policy and sketch the need for further research.

First, military life has an impact on individuals' risk preferences. Although top managers with military backgrounds possess excellent qualities such as loyalty, integrity, courage, commitment, and a strong sense of responsibility, it has been shown above that cautious and conservative attitudes are not beneficial to the promotion of enterprise innovation. Risk-averse can originate from veterans' high requirements for predictable decision-making and characteristics of advocating honor. Therefore, top managers with military backgrounds should avoid arbitrariness and pool their wisdom together in the decision-making process of innovation-led sustainable development, constantly

improving their professional level and professional quality as enterprise managers. At the same time, when selecting and cultivating top management teams, enterprises should choose managers and make the best use of their talents by considering the supporting role of the top managers' knowledge and technology level on innovation decision-making as well as the impact of top managers' risk aversion behaviors on innovation-led sustainable development.

Second, the institutional shortcomings of state-owned enterprises should be removed to accelerate their transformation and modernization. Policy commitments and soft budget constraints make the technological innovation investment of state-owned enterprises more susceptible to restraints. The 'new normal' of China's economy presents great development opportunities with which the country embraces the new economic system as a rising power. In China, state-owned enterprises are the foundation and key factors of the national economy, and their competitive capabilities have a direct bearing on the development of the national economy and the comprehensive national strength. Therefore, state-owned enterprises should improve the standard assessment system, set clear management responsibilities, and improve the efficiency of enterprise management. We should establish a corporate governance mechanism that encourages innovation and allocate internal factors of production in a scientific and reasonable way. Next, new markets can be opened through innovation-led sustainable development and the crisis of overcapacity resolved. We should actively promote reform of mixed ownership and use private capital to invigorate technological innovation investment in state-owned enterprises.

Third, we should accelerate the implementation of an equity incentive system as well as create and perfect a long-term motivation system for top managers. Equity incentives act as a 'golden thread' that binds the interests of top managers and shareholders through an effective long-term mechanism. Equity incentives can alleviate the 'decision-making myopia' of top managers with military backgrounds and enhance their risk tolerance. Consequently, enterprises should build a scientific and effective equity incentive mechanism to improve the proportion of top managers' shares, thus alleviating the risk aversion tendencies of military top managers and promoting the sustainable innovation level of enterprises. In addition to stimulating enterprises' enthusiasm for innovation by formulating preferential policies and other measures, regulatory authorities should consider the impact of incentive mechanisms on enterprises' innovation-led sustainable development levels, accelerate the implementation of equity incentive systems, and standardize relevant documents on equity incentives to assist enterprises in improving internal governance mechanisms.

Our results are preliminary and future research might extend this work in several dimensions. One important theoretical question is how the implicit incentive works on the technological innovation of executives with military backgrounds. Executive compensation includes explicit compensation and implicit compensation. Explicit compensation mainly includes monetary compensation and equity incentive. Implicit compensation mainly refers to duty consumption. The phenomenon of rent-seeking, pessimistic income, excessively expense in-office, insider control is widespread existence in China. Duty consumption can be one way for the senior executives' embezzling of the corporate residual assets, which poses a difficult issue for the enterprise nowadays. We need to research further how to set up the monetary system of on the duty consumption and long term encouraging system to promote technology innovation of senior executives with military backgrounds.

Another question is what are the relationships among personal characteristics, executives compensation, compensation gap and technological innovation. Compensation gap directly affects the behavior of executives, which can effectively alleviate the principal-agent conflict, and urge executives to focus on the long-term interests of enterprises (Lee et al., 2008). Thus, compensation gap is the evaluation standard for executives to measure whether they are reasonably compensated. Can the compensation gap motivate executives with military

backgrounds to innovate? Is there any difference under different firm ownership type? Tying these results to directions may enable developing more precise policy advice on how directions in technological innovation are being and can be influenced by the decisions of top managers.

CRedit authorship contribution statement

Shujuan Guo: Conceptualization, Methodology, Writing - original draft, Supervision, Funding acquisition. **Botao Zan:** Formal analysis, Visualization, Investigation, Project administration. **Yuan Sun:** Formal analysis, Data curation, Validation, Writing - review & editing. **Meili Zhang:** Writing - review & editing.

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Supplementary materials

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