ATLANTIS PRESS

Advances in Economics, Business and Management Research, volume 110

5th International Conference on Economics, Management, Law and Education (EMLE 2019)

Civil–Military Integration and Technical Innovation of Private Listed Companies

Renfang Liu
School of Finance
Zhongnan University of Economics and Law
Wuhan, China 430073

Xianping Zhou
School of Finance
Zhongnan University of Economics and Law
Wuhan, China 430073

Guyue Xiang
School of Finance
Zhongnan University of Economics and Law
Wuhan, China 430073

***Abstract*—Civil-military integration policy has been raised to a national strategy. The Four Military Qualification Certificates are used to measure the level of civil-military integration. Using the data of listed firms from 2001 to 2018 based on difference-in-difference method, we find that civil-military integration significantly increases the R&D investment and substantially improves the innovation level of private enterprises, thereby promoting enterprises' technological innovation. Moreover, the R&D investment of enterprises is affected by the "civil-military integration" policies, and the promotion effect of substantial innovation of enterprises will appear "crowding out effect", but this effect will be diluted over time. Furthermore, policy suggestions and implications for civil-military integration are given.**

Keywords—civil–military integration; military industry qualification; technical innovation; difference-in-difference approach

I. INTRODUCTION

In March 2015, at the plenary meeting of the PLA delegation to the third session of the 12th National people's Congress (NPC), President Xi Jinping explicitly proposed for the first time that "the integration of the army and the people should be upgraded to a national strategy." On January 22, 2017, the political Bureau of the CPC Central Committee held a meeting and decided to set up the Central Committee for military and Civil Integration and Development, with President Xi Jinping as its director. The report of the 19th CPC National Congress also pointed out that in the new era, we should "pay more attention to military-civilian integration" and "form a pattern of in-depth development of military-civilian integration." The key to promoting the integration of the army and the people lies in innovation.

Schumpeter believes that economic growth is not caused by capital, labor and other factors of production, but by technological innovation. From the micro level, technological innovation is the internal driving force for the survival and development of enterprises. However, the essential characteristic of technological innovation is the coexistence of risk, uncertainty and high reward. If enterprises invest a lot of R&D funds, they may get rich returns, or they may "go to waste" because of the uncertainty of the market, resulting in a waste of resources. This impact is more obvious to private enterprises, therefore, Technological innovation is a "double-edged sword" for enterprises. However, compared with the uncertain market demand for civilian products, the demand for military products is certain, so private enterprises "joining the army" can reduce the risk of innovation caused by market uncertainty to a certain extent, which is beneficial to private enterprises to carry out technological innovation.

"Private enterprises participating in military industry" and "Military enterprises participating in civilian products" are important forms of "integration of the Military and the civilian". The development of military and civilian integration can not only improve the efficiency of resource allocation (Huang Chaofeng et al., 2017) [1], Moreover, it has played an important supporting and promoting role in the interaction between the army and the people in the scientific research and production of national defense science and technology and weapons and equipment, the close combination of the national defense industry and the civilian industry, and the scientific overall planning of national defense security and economic development (Dong Xiaohui, et al. 2012) [2]. Over the past 40 years of reform and opening up, China's private enterprises have accumulated a large number of advanced technologies and products through the introduction, absorption, transformation and independent research and development, and have become the main force in the construction of the national economy and the new force in the building of the national defense army. By the end of 2017, of the more than 27.26 million private enterprises across the country, nearly 10,000 private enterprises had entered the ranks of national defense military industry and military construction and support, and thousands of private enterprises had been deeply involved in weapons and equipment scientific research, production, maintenance and

technical services. By the end of December 2018, more than 1500 state-owned and private enterprises had obtained military industrial qualifications and participated in weapons and equipment construction. It can be seen that private enterprises have a strong ability to innovate, and private enterprises "joining the military" can promote technological innovation in military enterprises through knowledge exchange, technology transfer, and personnel mobility, so as to improve the level of technological innovation in the whole country. And then promote economic growth. Therefore, the study of "civilian joining the military" has a strong practical significance.

At present, the literature research on the micro level of "military-civilian integration" mainly focuses on the efficiency of military-civilian integration. Zhao Liming et al. (2015) [3] and Duan Jie et al. (2019) [4] think that the factor input efficiency is generally low in civil-military integration enterprises. As a result, the output efficiency is not ideal, and there are great differences in different regions. The samples selected by this kind of research are basically listed companies of the top ten military industrial groups, that is, "military to civilian" type enterprises, but less "civilian military" enterprises. The research on the enterprises of " civilian joining the military" is mainly about the problems and suggestions of " civilian joining the military", Domestic scholars generally believe that there are barriers such as unblocked information channels, many barriers to entry and exit, unfair treatment, high cost of joining the army, financing difficulties and so on (Shubenyao et al., 2007). Gao Junmei et al., 2008) [5-6]. As for the measurement of "military and civilian integration", most scholars measure it from the regional or national level as a whole. Ma Wuxing (2009) [7] and Li Hongkuan (2018) [8] designed the index system of military-civilian integration, assigned the index weight, and calculated the degree of military-civilian integration of the index system. Li Jian et al. (2012) [9] evaluated the degree of military-civilian integration from micro, meso and macro dimensions, but only limited to theoretical analysis. Ma Xifang et al. (2017) [10] evaluated the performance of regional civil-military integration. Due to the need to score, there are some subjective factors in the above study. For this reason, Meng Binbin et al. (2019) [11] adopted the analytical framework of macro-structure measurement, taking the output difference of factors in different departments as a breakthrough to measure the degree of civil-military integration from the macro-economy as a whole.

To sum up, the existing literature has the following limitations: (1) mainly based on narrative theoretical analysis, a small number of literature use quantitative analysis, but only through on-the-spot visits, questionnaires and other ways, there are few empirical studies; (2) when measuring the integration of military and civilian, there is a certain degree of subjectivity in the weighted calculation of index, and there is little literature on measuring the integration of military and civilian in micro enterprises at the regional and national level; (3) in the existing small number of empirical studies, we mainly take the top ten military industrial groups as the research object, from the perspective of "military to civilian", but there are few studies on "civilian joining the military".

This paper takes the listed companies of "civil participation in the military" with military industry-related qualifications as the research object, uses "military industry four certificates" to measure military-civilian integration, and adopts the multi-time double difference method to make an empirical analysis on the changes of technological innovation before and after enterprises acquire qualifications. Based on the analysis of the empirical results, this paper puts forward some policy suggestions to promote the integration of the military and the civilian.

The main innovation points of this paper are reflected in several aspects: (1) the process of "military to civilian" has been going on all the time. Taking the private enterprises that have obtained the relevant military industrial qualifications as samples, this paper discusses the influence of "civilian joining the military", which is a kind of military-civilian integration. The sample is novel. In line with DID settings, the data is "cleaner"; (2) from the point of view of the type and quantity of military industrial qualification, we can objectively measure the degree of military-civilian integration of micro-enterprises; (3) this paper uses multi-time point double difference for empirical analysis, which enriches the empirical research of military-civilian integration.

II. Theoretical Mechanism and Research Hypothesis

Technological innovation plays an important role in promoting economic and social development and progress, so it has been the focus of economists' research, but there are many views on the influencing factors of technological innovation, which has not been unified so far.

A. Technological Innovation and Demand Dull Theory

Whether technological innovation originates from technology promotion or demand pull is an issue that economists have debated for a long time. Schumpeter himself said with a technical push. Schmukler puts forward the theory of demand pull through the analysis of patent and investment sequence, and thinks that it is in the movement of innovation activities.

B. Technological Innovation and Monopoly Competition

American economists Kaman and Schwartz studied the process of technological innovation from the perspective of monopoly and held that there are three factors that determine technological innovation: (1) the degree of competition, which is a necessary condition for technological innovation. Because technological innovation can get more profits than competitors; (2) the size of enterprises, it affects the size of the market prospects opened up by technological innovation. The larger the scale of the enterprise, the larger the market opened up by technological innovation; (3) monopoly power, which affects the durability of technological innovation, the higher the degree of monopoly, the stronger the control of the market, the more difficult it is to be imitated in the short term, and the more durable the technological innovation is.

Therefore, the market structure most conducive to technological innovation is the so-called "moderate competition" market structure between monopoly and perfect competition (Ye Ming, 1990; Shaw, 1995) [13-14].

Other scholars hold the opposite attitude on the impact of enterprise size on technological innovation. Arrow (1962) [15] believes that small businesses are more innovative. Agrawal (1992) [16], Boone (2000) [17], Gao Liangmou and Li Yu (2009) [18] also believe that the expansion of enterprise scale makes enterprises slow and rigid in innovation incentive, decision-making and management. There is a "big business disease" that cannot be properly judged in the face of crises and opportunities.

C. Technological Innovation and Social Capital

After studying the role of social capital in promoting scientific and technological innovation, Fountain (1997) [19] points out that "one of the most key characteristics of social capital is the transitivity of trust, that is, if A trusts B and B trusts C, then A trusts C, too." Due to this characteristic of social capital, which improves the mutual trust between enterprises, enterprises improve the ability of technological innovation by establishing extensive social networks with external sources of knowledge and information (Zhang Fanghua, 2003) [20]. Through empirical analysis, Lin Zhouyu and Lin Hanchuan (2012) [21] also think that enterprises in areas with high degree of social capital development have a higher level of technological innovation.

The factors that affect the technological innovation of enterprises come from many aspects, including external factors, such as policy, market environment, etc., as well as internal factors, such as innovation motivation, risk resistance and innovation ability. The above three viewpoints are the external factors that affect the technological innovation, and the external factors may also affect the enterprise technological innovation through the internal factors. "military and civilian integration" is such a factor. First, "military-civilian integration" is a national policy and an external factor in itself. Compared with civilian products, the demand for military products is more clear and can reduce the risk of innovation caused by market uncertainty to a certain extent. "civilian join the military" enterprises have more motivation to carry out technological innovation, that is, demand-driven technological innovation; Second, "military-civilian integration" has broken the monopoly of the original military industry and introduced competition, so that the current market structure of the military industry is a so-called "moderate competition" market structure between monopoly and perfect competition. Thus it is beneficial to technological innovation; third, because of the particularity of the military industry and a higher threshold for entry, private enterprises "joining the military" itself represents a kind of national technical recognition, is a kind of invisible social capital, and is more likely to be favored by investors. It is also easier to get financial support, so that enterprises have more money to invest in R&D, which is conducive to technological innovation.

For this reason, this paper puts forward hypothesis 1, H1: military-civilian integration can promote the technological innovation of private listed companies.

Furthermore, according to the above point of view of technological innovation and monopoly competition, the larger the scale of the enterprise, the larger the market opened up by technological innovation, so the more conducive to technological innovation. At the same time, the most favorable market structure for technological innovation is the market structure between monopoly and perfect competition, and the higher the process of marketization, the fiercer the regional competition is. Therefore, this paper puts forward hypothesis 2 and hypothesis 3:

H2: compared with smaller enterprises, military-civilian integration can promote the technological innovation of large-scale private enterprises.

H3: compared with enterprises in areas with lower marketization process, military-civilian integration can promote the technological innovation of private enterprises in areas with higher marketization process.

III. RESEARCH AND DESIGN (MODELS, DATA AND VARIABLES)

A. Model Construction

As the military industry has set a threshold for market entry, enterprises need to obtain the "military industry four certificates" evaluated by third-party organizations in order to" join the military. "Military-civilian integration" is a policy born out of enterprise behavior for private enterprises, and it is a quasi-natural experiment. And the time for each enterprise to obtain qualification is different, and the time to participate in military products is also different, so it is suitable to use the multi-point double difference model to estimate. Referring to the method of Thorsten Beck et al. (2010)[22], this paper constructs a multi-time-point double difference fixed effect model, and deeply analyzes the influence of "military-civilian integration" policy on the technological innovation of private listed enterprises.

$$TechInno_{it} = \beta_0 + \beta_1 treat_{it} + \delta_0 time_{it} + \delta_1 did_{it} + \sum control_{jt} + \mu_j + \delta_t + \varepsilon_{it} \quad (1)$$

Among them, the explained variable $TechInno_{it}$ represents the technological innovation of company i in the t year, which is measured by enterprise R&D investment and patent application data; the explanatory variables include $treat_{it}$, $time_{it}$ and did_{it}. The variable $treat_{it}$ is used to reflect whether the concerned enterprise obtains the qualification or not. The value of 1 indicates that the enterprise has obtained the military qualification, and the value of 0 indicates that the enterprise has not obtained the military qualification. The variable $time_{it}$ is used to reflect the progress of obtaining qualification. The value is 1 from the first to the fifth year after obtaining the qualification, otherwise it is 0. Since the validity period of the weapons and equipment production license and confidential qualification is five years, the qualification of the equipment undertaking unit and the certification of the weapons and

equipment quality management system are valid for four years. And the confidential qualification is the premise of obtaining the weapon equipment production license and the equipment undertaking unit qualification. The research period of this paper is within five years after obtaining the qualification. Due to the different time of obtaining all kinds of qualifications, this paper is based on the time of obtaining the last kind of qualification during the research sample period for the enterprise to obtain the qualification time. In order to test the effect of military-civilian fusion, we set up the intersection term did_{it}, which is the intersection term of $treat_{it}$ and $time_{it}$, and is also the core explanatory variable of this paper. The value of this multiplication item is that the two dumb variables "processing group" and "qualification time" are taken at the same time, and the value of this variable is 1, and the other case is 0, in order to measure the impact of obtaining military qualification on enterprise technological innovation. Therefore, the influence of "military-civilian integration" on enterprise technological innovation is the coefficient δ_t of did_{it} variable. If the coefficient is positive, it shows that military-civilian integration can promote enterprise technological innovation. $control_{jt}$ is the control variable, μ_j and δ_t are industry virtual variables and annual virtual variables, respectively.

B. Sample Selection and Data Sources

The largest shareholders of the listed companies of the top ten military industrial groups are basically state-owned legal persons, and the analysis of "military to civilian" can use the listed companies of the top ten military industrial groups as the object of analysis. This paper attempts to discuss the influence of "civilian joining the military", so the private listed companies are selected as the object of analysis. This paper takes the non-financial private listed companies of A shares from 2001 to 2018 as the research sample, in which the ST enterprises, the qualified enterprises in 2018 and beyond, and the enterprises with vacant index data are excluded. Finally, 8112 observed values were obtained. The relevant information of the "four certificates of military industry" of private enterprises is obtained through "crawling" and manual collation of Juchao net, Oriental Wealth Network, flush and other major financial websites, and the financial data come from CSMAR database. Financial data variables (except virtual variables) are processed with 1% Winsorize to overcome the impact of outliers. The qualified enterprises were taken as the treatment group (107) and the unqualified enterprises as the control group (1328).

C. Variable Selection

1) Technological innovation

At present, the literature at home and abroad mainly uses three methods to measure the index of technological innovation: the first is the input method, and most of them are R&D investment, which focuses on the R&D decision-making and R&D capability of enterprises. The second is the output method, which adopts more patents, focusing on the research innovation and efficiency. The third is the comprehensive index, such as the total factor productivity (TFP), TFP calculation needs to use the capital stock, but China's National Bureau of Statistics does not provide the capital stock data, resulting in different researchers come to a very different TFP. Some literatures use the number of patent licenses to measure, however, because patent licensing generally has a delay of 1-2 years, and subjective factors, and patent applications can avoid these problems.

According to the detailed rules for the implementation of China's Patent Law, the patents applied by enterprises can be divided into three categories: invention, utility model and design. Among them, the invention patent is a new technical scheme for the improvement of products, methods or processes. The examination and approval is strict, the effective time is long, and the technical content is the highest, which belongs to substantive innovation. In contrast, utility model and design patents are low-tech innovations in the structure and appearance of products, which can be regarded as strategic innovation. The main purpose of this paper is to investigate whether military-civilian integration is conducive to enterprises pay more attention to technological innovation, and then improve the level of technological innovation. Therefore, with reference to the literature of Tan et al. (2015) [23] and Zhang Xuan et al. (2019) [24], this paper uses R&D investment intensity RDint (R&D investment amount / operating income) to measure whether enterprises attach more importance to technological innovation. Using the sum of the number of patent applications to measure the total innovation level of the enterprise (Pat), measures the substantive innovation level (Pat1) by the number of invention patent applications. The level of strategic innovation (Pat2) is measured by the sum of the number of patent applications for utility models and designs.

2) Military and civilian integration

Due to the particularity of the military industry, enterprises involved in the military have a strict threshold for entry, in which obtaining military qualification is a necessary condition. There are four kinds of military industrial qualifications, namely, secrecy qualification of weapons and equipment scientific research and production units(SQW), certification of weapons and equipment quality management system(WEQ), qualification of equipment undertaking units(QEU), and license of scientific research and production of weapons and equipment(SRW) (hereinafter referred to as "four certificates of military industry"). The first two qualifications are the prerequisites for obtaining the latter two qualifications. The scientific research and production activities of weapons and equipment refer to the scientific research and production activities of the overall, systematic and special supporting products of weapons and equipment. According to the importance of weapons and equipment and their special supporting products, the license of scientific research and production of weapons and equipment can be divided into category I license and category II license. According to the company's own situation and the degree of confidentiality of the production products, the confidentiality qualification can be divided into first, second and third level, and the first level is the highest. The type and quantity of military industrial qualification obtained by enterprises determine the scope and degree of military involvement of enterprises. Therefore, this paper uses whether to have

military industrial qualification to measure whether the enterprise is a military and civilian integration enterprise, some is 1, otherwise it is 0, that is, the above did_{it} variable is used to measure.

3) Control variables

With reference to Adams et al. (2005) [25], Beiner et al. (2006 [26], Cheng (2008) [27] and Li Lin et al. (2009) [28], this paper uses the logarithm of the total assets of the company to measure the size of the company (Size), Using the total liabilities / total assets of the company to measure the capital structure (Lev), uses the rate of return on equity to measure corporate performance (Roe), uses the largest shareholder shareholding ratio (Top1) to measure equity concentration. At the same time, it controls both the industry virtual variable and the annual virtual variable.

D. Descriptive Statistics

"Table I" reports the descriptive statistics for the main variables in this article. It can be seen from the table that the median of RDint, Pat, Pat1 and Pat2 is less than the average, especially the RDint variable, and the standard deviation is also large, indicating that there is a great difference in the intensity of R&D investment and the number of patent applications among enterprises. And most enterprises have less R&D investment and patent applications. The mean and median of other data have little difference, and are basically normal distribution.

TABLE I. DESCRIPTIVE STATISTICS OF MAJOR VARIABLES

Var	Sample	Mean	Std	Min	Med	Max
RDint	8112	5.000	4.492	0.070	3.775	26.420
Pat	5341	2.545	1.141	0.000	2.485	8.864
Pat1	5342	1.688	1.119	0.000	1.609	8.149
Pat2	5342	1.843	1.340	0.000	1.792	8.302
did	8112	0.028	0.166	0.000	0.000	1.000
Roe	8112	0.075	0.075	-0.245	0.072	0.296
Size	8112	21.549	0.958	19.652	21.458	24.294
Lev	8112	0.336	0.182	0.035	0.317	0.775
Top1	8112	33.092	13.531	8.930	31.370	69.220

IV. ANALYSIS OF EMPIRICAL RESULTS

A. Analysis of Regression Results

1) Full sample analysis

"Table II" reports the regression results of multi-time DID fixed effect model of "military-civilian integration" on R&D input and innovation output of enterprises. The results show that the did coefficient is significantly positive in the regression of R&D input intensity index RDint and substantive innovation level index, which indicates that "military-civilian integration" significantly strengthens the intensity of R&D investment and significantly improves the level of substantive innovation. In this paper, hypothesis 1 is proved. In terms of the intensity of R&D investment, enterprises "joining the army" will increase R&D investment by 2.034 times as much as before "joining the military." This may be explained as follows: first, "civilian participation" enterprises regard "military-civilian integration" as a strategic goal of enterprises. In the early stage, a lot of resources will be invested, including obtaining military qualifications, increasing R&D investment, strengthening staff training, etc., in order to obtain more generous returns in the future. Second, to participate in "military-civilian integration" can enjoy state-related funding and financial subsidies, enterprises have more funds to invest in R&D; Third, the "military industry four certificates" on behalf of the national technical recognition, can form social capital, more easily favored by investors, making it easier for enterprises to obtain external financial support; Fourth, "military and civilian integration" forces enterprises to increase investment in R&D, enhance the level of technological innovation, enhance core competitiveness, so as to obtain long-term cooperation opportunities. Judging from the innovation results, the "joining the military" of enterprises will increase the output of substantive innovation by 26.6%. The average level of substantial innovation output of private listed companies in China is about 1.688, which translates into a total of about 4.41 patents. This means that if private enterprises "join the military", the average number of invention patent applications of private listed companies in China will increase by 1.17, and the innovation output will increase greatly.

TABLE II. MILITARY-CIVILIAN INTEGRATION AND ENTERPRISE TECHNOLOGICAL INNOVATION: TOTAL SAMPLE REGRESSION

	RDint	Pat	Pat1	Pat2
did	2.0337***	0.1286	0.2658***	-0.0210
	(4.9970)	(1.4898)	(2.8833)	(-0.2335)
control	yes	yes	yes	yes
year	yes	yes	yes	yes
industry	yes	yes	yes	yes
N	8112	5341	5342	5342
r^2	0.4070	0.2112	0.1680	0.3267
r^2_a	0.4009	0.2002	0.1565	0.3174

[a.] Note: the data in the table are the regression coefficients of their respective variables, and the t values in parentheses are the significant levels of 1%, 5% and 10%, respectively.

2) Analysis according to the types of military qualifications

Furthermore, in order to investigate the impact of the degree of military-civilian integration on enterprise technological innovation, this paper carries on the grouping regression according to the type of qualification obtained.

TABLE III. MILITARY-CIVILIAN INTEGRATION AND ENTERPRISE R&D INVESTMENT: GROUPING TESTING ACCORDING TO THE TYPES OF QUALIFICATIONS OBTAINED

	SRW		QEU		WEQ		SQW	
	Yes	No	Yes	No	Yes	No	Yes	No
did	1.7650**	0.4746	2.3132***	-0.0766	1.2500**	-0.2423	1.3813**	-1.4551*
	(2.5722)	(0.4363)	(2.8087)	(-0.1072)	(2.0653)	(-0.1972)	(2.2938)	(-1.7135)
control	yes	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes	yes
industry	yes	yes	yes	yes	yes	yes	yes	yes
N	455	284	392	347	701	38	672	67
r^2	0.4342	0.4352	0.3786	0.5187	0.3703	0.9466	0.4086	0.7870
r^2_a	0.3840	0.3581	0.3213	0.4593	0.3290	0.9060	0.3731	0.6805

[a.] Note: the data in the table are the regression coefficients of their respective variables, and the t values in parentheses are the significant levels of 1%, 5% and 10%, respectively.

"Table III" reports the regression results of grouping according to the types of qualifications obtained by enterprises, and the dependent variable is the R&D investment intensity index RDint. From the did coefficient, all the qualified column coefficients are positive, in the range of 1.25-2.32, and significant at the level of 5%, indicating that the qualification is positively correlated with the company's technological innovation. Moreover, the did coefficient of enterprises with weapons and equipment scientific research and production licenses and equipment undertaking units is obviously larger than that of enterprises with weapons and equipment quality management system certification and weapons and equipment production units' secrecy qualification, indicating that the deeper the integration between the army and the people, The more money you spend on research and development. It is proved that the integration of military and civilian can significantly improve the technological innovation of enterprises. "Table IV" reports the regression results of grouping according to the types of qualifications acquired by enterprises, with the dependent variable being substantive innovation (Pat1), an indicator of innovation output. From the did coefficient, all the qualified column coefficients are positive, all in the range of 0.13-0.26, the fluctuation range is small, and there are three significant columns in the four columns, indicating that there is a positive correlation between the qualification and the substantive innovation level of the company. Once again, it is proved that the integration of military and civilian can significantly enhance the technological innovation of enterprises.

TABLE IV. MILITARY-CIVILIAN INTEGRATION AND SUBSTANTIVE INNOVATION OUTPUT OF ENTERPRISES: GROUPING TESTING ACCORDING TO THE TYPES OF QUALIFICATIONS OBTAINED

	SRW		**QEU**		**WEQ**		**SQW**	
	Yes	No	Yes	No	Yes	No	Yes	No
did	0.2578**	0.2555	0.1392	0.2492	0.2161*	0.3592	0.2384**	0.5389
	(2.0559)	(0.9744)	(1.0680)	(1.0548)	(1.7347)	(1.1291)	(2.0450)	(1.0897)
control	yes	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes	yes
industry	yes	yes	yes	yes	yes	yes	yes	yes
N	373	237	323	287	574	36	548	62
r^2	0.3066	0.2359	0.2381	0.2683	0.2234	0.7703	0.2066	0.6641
r^2_a	0.2368	0.1204	0.1598	0.1629	0.1651	0.5768	0.1507	0.4878

"Table IV" reports the regression results of grouping according to the types of qualifications acquired by enterprises, with the dependent variable being substantive innovation (Pat1), an indicator of innovation output. From the did coefficient, all the qualified column coefficients are positive, all in the range of 0.13-0.26, the fluctuation range is small, and there are three significant columns in the four columns, indicating that there is a positive correlation between the qualification and the substantive innovation level of the company. Once again, it is proved that the integration of military and civilian can significantly enhance the technological innovation of enterprises.

3) Quantitative analysis according to military qualification

At the same time, in order to investigate the impact of the degree of military-civilian integration on enterprise technological innovation, this paper also carries on the grouping regression according to the number of qualifications obtained.

TABLE V. MILITARY-CIVILIAN INTEGRATION AND ENTERPRISE R&D INVESTMENT: GROUPING TEST BASED ON THE NUMBER OF QUALIFICATIONS OBTAINED

	One	Two	Three	Four
did	-1.1985	0.8127	1.0708	2.5094***
	(-1.5338)	(1.3054)	(1.1376)	(2.9670)
control	yes	yes	yes	yes
year	yes	yes	yes	yes
industry	yes	yes	yes	yes
N	96	70	280	293
r^2	0.8108	0.7203	0.5356	0.4154
r^2_a	0.7432	0.5979	0.4796	0.3460

a. Note: the data in the table are the regression coefficients of their respective variables, and the t values in parentheses are the significant levels of 1%, 5% and 10%, respectively.

"Table V" reports the regression results of grouping according to the number of qualifications acquired by enterprises, and the dependent variable is the R&D investment intensity index RDint. From the did coefficient of each column, except for the first column, the other column coefficients are positive, indicating that military-civilian integration is positively related to corporate technological innovation, and the significant level of enterprises with four certificates of military industry is 1%. And on the whole, the more the number of qualifications, the more R&D investment, which indicate that the more qualifications enterprises have, the deeper the degree of military involvement, the more conducive to technological innovation.

TABLE VI. MILITARY-CIVILIAN INTEGRATION AND SUBSTANTIVE INNOVATION OUTPUT OF ENTERPRISES: GROUPING TEST BASED ON THE NUMBER OF QUALIFICATIONS ACQUIRED

	One	Two	Three	Four
did	0.6344*	0.5340	0.4667*	0.0402
	(1.6872)	(1.4054)	(1.7915)	(0.3016)
control	yes	yes	yes	yes
year	yes	yes	yes	yes
industry	yes	yes	yes	yes
N	89	64	205	252
r^2	0.6761	0.7743	0.2269	0.3655
r^2_a	0.5547	0.6614	0.1090	0.2826

a. Note: the data in the table are the regression coefficients of their respective variables, and the t values in parentheses are the significant levels of 1%, 5% and 10%, respectively.

"Table VI" reports the regression results of grouping according to the number of qualifications acquired by enterprises, with the dependent variable being substantial Innovation (Pat1), an indicator of innovation output. From the point of view of the did coefficient, no matter how many qualifications the company has, the coefficient is positive, and there are two rows of coefficients are significant. However, the coefficient does not increase with the increase of qualifications. In other words, although the deeper the integration of military and civilian companies, the more R&D investment, but not the more innovative output. The possible explanation is that most of the R&D investment shows that we attach importance to technological innovation and have sufficient strength to support it, but the efficiency of R&D is not necessarily high; It may also be that companies with deeper military and civilian integration involve more complex and challenging technologies, long R&D cycles, and it is difficult to achieve results in a short period of time.

B. Parallelism Test

The parallelism test must be carried out in the policy evaluation by using the double difference method. In this paper, the parallelism test was carried out with reference to the method of Thorsten Becket al. (2010) [9]. The model is as follows:

$$TechInno_{it} = \beta_0 + \beta_1 D^{-8}{}_{it} + \beta_2 D^{-7}{}_{it} + \cdots + \beta_{13} D^{5}{}_{it} + \mu_j + \delta_t + \varepsilon_{it} \quad (2)$$

Results as shown in "Fig. 1", that is, the dynamic impact of military-civilian integration on the company's technological innovation, the time span is 13 years, that is, 8 years before qualification acquisition and 5 years after qualification acquisition. "Fig. 1" show that before the acquisition of military qualification, the company's technological innovation has not changed significantly, indicating that the development trend of the treatment group and the control group in the sample is the same; After obtaining the military industrial qualification, the company's R&D investment intensity and substantive innovation level have been significantly improved.

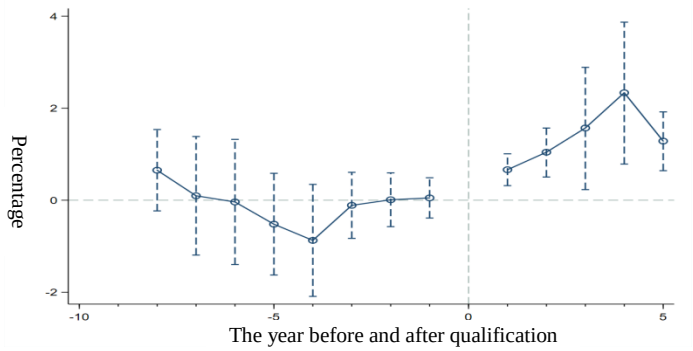

Fig. 1. Dynamic Impact of Military-Civilian Integration on R&D Investment Intensity.

C. Robustness Test

1) RDint1 (R&D investment/total), RDhum (R&D personnel ratio) as dependent variable

In order to test the robustness of the results, RDint1 and RDhum are used as dependent variables. After replacing the dependent variables, the impact of military-civilian integration on corporate technological innovation is still significant which shows that the conclusion of this paper is more robust.

2) Postponement of patents for inventions

Because it takes a certain amount of time from R&D investment to patent application, this paper delays the time of invention patent application by one year and two years. The impact of military-civilian integration on the substantive innovation output of the company is still significant, which is consistent with the previous conclusion.

3) Exclusion of some industry samples

As the vast majority of "civilian participation" enterprises belong to industry, in order to further verify the impact of military-civilian integration on enterprise technological innovation, this paper further removes some samples. Only five kinds of enterprises, such as manufacturing industry, construction industry, transportation industry, electric power thermal production and non-ferrous metal mining, were retained as the control group. The coefficient of military-civilian integration to technological innovation is positive at a significant level of 1%, indicating that the results are still significant after excluding samples of non-industrial industries. This is completely consistent with the previous conclusion.

V. Analysis of Influence Mechanism

Through the above analysis, the preliminary conclusions are as follows: military-civilian integration significantly improves the intensity of R&D investment and substantive innovation level of private enterprises, so as to promote technological innovation of enterprises. However, the deeper the integration of military and civilian is, the more R&D investment is, but not the more substantial innovation output. For this reason, this paper further analyzes whether military-civilian integration affects the level of substantive innovation by affecting R&D investment, thus affecting the company's technological innovation. The R&D investment intensity index $RDint_{it}$ and its cross term with did_{it} are used as independent variables, and the substantive innovation level index $pat1_{it}$ is used as dependent variable. For more information, see model (3).

$$pat1_{it} = \beta_0 + \beta_1 RDint_{it} + \delta_0 did_{it} + \delta_1 RDint_{it} * did_{it} + \sum control_{jt} + \mu_j + \delta_t + \varepsilon_{it} \quad (3)$$

TABLE VII. Regression Results Based on Intermediate Effect Test

	Pat1	**Pat1**	**Pat1**	**Pat**	**Pat1**	**Pat2**
RDint	0.0607***	0.0602***	0.0676***	0.0411***	0.0676***	0.0016
	(12.7835)	(12.6331)	(13.7429)	(8.5581)	(13.7429)	(0.3114)
did		0.1099	0.6017***	0.5173***	0.6017***	0.4706***
		(1.1428)	(4.3842)	(4.0169)	(4.3842)	(3.4758)
RDint*did			-0.0564***	-0.0556***	-0.0564***	-0.0564***
			(-4.4990)	(-5.0727)	(-4.4990)	(-5.5114)
control	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes
industry	yes	yes	yes	yes	yes	yes
N	5342	5342	5342	5341	5342	5342
r^2	0.1966	0.1968	0.2010	0.2210	0.2010	0.3285
r^2_a	0.1854	0.1855	0.1896	0.2099	0.1896	0.3189

a. Note: the data in the table are the regression coefficients of their respective variables, and the t values in parentheses are the significant levels of 1%, 5% and 10%, respectively.

"Table VII" reports the regression results. The coefficient of RDint in the first column is significantly positive, indicating that R&D input can significantly improve the substantive innovation output of enterprises. In the second column, when RDint and did are added to the model at the same time, the coefficient of RDint is still significant, but the

coefficient of did is not significant, indicating that military-civilian integration acts on the substantive innovation output of enterprises through the variable of R&D input intensity, thus affecting the technological innovation of enterprises. However, in the third column, when we introduce the interaction between RDint and did, we find that the coefficient of RDint*did is significantly negative, indicating that after participating in military-civilian integration, R&D investment has a "crowding-out effect" on the promotion of substantive innovation. The possible reason for this is that the technology involved in the military is more demanding, more difficult, more input and longer cycle than the civilian technology, so the output efficiency will be lower than the civilian technology. Therefore, although the private enterprises have invested more R&D expenses after they "joined the military." On the other hand, the output of substantive innovation has been reduced, resulting in a "crowding-out effect".

TABLE VIII. REGRESSION RESULTS BASED ON INTERMEDIARY EFFECT TEST (LAG NUMBER)

	Pat1	Pat1	Pat1
RDint	0.0676***		
	(13.7429)		
L.RDint		0.0642***	
		(11.746)	
L2.RDint			0.0555***
			(8.9382)
did	0.6017***	0.4877***	0.4028***
	(4.3842)	(3.5578)	(2.8155)
RDint*did	-0.0564***		
	(-4.4990)		
RDint*did_1		-0.0487***	
		(-4.1102)	
RDint*did_2			-0.0372***
			(-3.0296)
control	yes	yes	yes
year	yes	yes	yes
industry	yes	yes	yes
N	5342	4392	3383
r^2	0.2010	0.1911	0.1792
r^2_a	0.1896	0.1778	0.1631

Note: the data in the table are the regression coefficients of their respective variables, and the t values in parentheses are the significant levels of 1%, 5% and 10%, respectively.

In order to verify this possible explanation, this paper further carries on the R&D input intensity index to lag one period and two periods respectively to carry on the regression, the regression result is shown in "Table VIII". From the columns of "Table VIII", no matter whether the R&D investment adopts the current period or the lag period, the coefficient is significantly positive, and although the interaction coefficient between did and R&D investment intensity in each period is also significantly negative, with the increase of the number of lag periods, The absolute value of the coefficient is getting smaller and smaller, that is, with the extension of time, the "crowding out effect" of this kind of R&D investment on the substantive innovation of enterprises will become weaker and weaker. This proves our explanation.

VI. HETEROGENEITY ANALYSIS

A. Market Environment

Due to the imbalance of market development, the resources and policies enjoyed by enterprises in different market environments are quite different. In order to verify the influence of marketization process on technological innovation of military-civilian integration, this paper divides the total sample into two groups according to the average value of marketization degree, and the degree of marketization is high if it is greater than or equal to the average value. If it is less than the average, the degree of marketization is low. It reports the estimated results. On the whole, regardless of the degree of marketization, military-civilian integration has significantly improved the technological innovation of enterprises; Whether it is R&D investment or substantive innovation output, the enterprises in the areas with lower degree of marketization are higher than those in the areas with higher degree of marketization. This is contrary to hypothesis 3 in this paper. The possible reason for this is that areas with a lower degree of marketization are more likely to obtain financial support and funding from the government, so that more money can be invested in R&D. At the same time, the technology of enterprises in the region is relatively backward, and the technical difficulty of R&D is relatively low. It's easier to produce results.

B. Enterprise Size

Enterprises of different sizes have different degrees of technological innovation affected by internal and external factors. Due to the particularity of the military industry, military products have high technical requirements and need to invest a lot of R&D costs, while relatively large enterprises, small and medium-sized enterprises are facing financing difficulties and are in a disadvantageous position in all kinds of market competition. In order to verify the impact of enterprise size on military and civilian integration technology innovation, this paper divides the total sample into large and small and medium-sized enterprises according to the average enterprise size.

It reports the estimated results of enterprises of different sizes. From the index of R&D investment intensity, compared with large enterprises, military-civilian integration can significantly enhance the R&D investment intensity of small and medium-sized enterprises, so as to enhance technological innovation; From the perspective of substantive innovation production, compared with small and medium-sized enterprises, military-civilian integration can significantly enhance the innovation output of large enterprises, so as to enhance technological innovation. Although this is inconsistent with the previous assumptions, it is more realistic: because of the different types and ease of R&D technology and the different R&D cycle, the R&D input and output are not necessarily proportional to each other. Compared with large enterprises, the utilization of funds by small and medium-sized enterprises is more concentrated. In order to enhance their core competitiveness, small and medium-sized enterprises concentrate their main funds on research and development and concentrate their

efforts on a certain technology. Therefore, the number of invention patents is relatively small; Because of the more types of business involved in large enterprises, the products are more abundant, and the number of invention patents is also relatively large.

VII. CONCLUSION

With the in-depth development of civil-military integration, the research related to civil-military integration will receive continuous attention. This paper uses the samples of A-share listed companies from 2001 to 2018 to measure the integration of military and civilian from the point of view of the type and quantity of "four certificates of military industry" owned by private enterprises. The multi-time point double difference method is used to study the impact of military-civilian integration on the technological innovation of listed companies. The results show that the integration of military and civilian significantly improves the intensity of R&D investment and the level of substantive innovation of private enterprises, so as to promote technological innovation of enterprises. After a series of stability tests, this conclusion is still valid. Further research shows that enterprises act on the substantive innovation output of enterprises through the variable of R&D input intensity, which affects the technological innovation of enterprises. The intensity of R&D investment of enterprises will be affected by the policy of "military and civilian integration", and there will be a "crowding-out effect" to enhance the substantive innovation of enterprises, but this effect will dilute with the passage of time. Compared with the enterprises in the areas with higher degree of marketization, the positive promoting effect of "military-civilian integration" on the technological innovation of enterprises in the areas with lower degree of marketization is stronger. Military-civilian integration can significantly enhance the R&D investment of small and medium-sized enterprises, and significantly enhance the innovation output of large enterprises.

The study of this paper has an enlightening effect on both the government and private enterprises. The policy implications include: first, to increase the policy and financial support for "civilian participation" enterprises, especially small and medium-sized enterprises and enterprises in less market-oriented areas, so as to attract more private enterprises to "join the military" and promote the in-depth development of military-civilian integration; The second is to further improve the financial support to private enterprises, especially "civilian join the military" enterprises, to help enterprises to obtain more funds to invest in R&D, so as to promote technological innovation; Third, private enterprises should actively participate in military-civilian integration, which can effectively promote technological innovation and enhance market competitiveness.

REFERENCES

[1] Huang Chaofeng, Ju Xiaosheng, Ji Jianqiang, et al. How can the integration of the army and the people enrich the country and strengthen the army?-the integration of the army and the people, the evolution of the division of labor and the increasing returns [J]. Economic Research, 2017, (8): 187-201.

[2] Dong Xiaohui, Zeng Li, Huang Chaofeng. A study on the present situation and Countermeasures of the Development of military-civilian Integration Industrial Cluster — A case study of Hunan Province[J]. Scientific and technological Progress and Countermeasures, 2012, (11): 59-63.

[3] Zhao Liming, Sun Jianhui, Zhang Haibo. Analysis of collaborative innovation behavior of military and civilian integration technology[J]. Scientific and technological Progress and Countermeasures, 2015, (13): 111-117.

[4] Duan Jie, Bai Hailin, Jin Huining. An empirical study on the impact of Innovation on the efficiency of military and civilian Integration Enterprises — taking the listed companies of "Ten military Industrial groups" as an example[J]. Science and Technology Management Research, 2019, (2): 55-61.

[5] Shu Benyao, Su Yuan. SWOT Analysis and Strategy Choice of the Strategy of "people joining the Army" [J]. China's conversion from military to civilian, 2007, (4): 29-31.

[6] Gao Junmei, Tian Dashan, Li Xiaoning. Government policy and management of people joining the army[J]. China's conversion from military to civilian, 2008, (8): 25-31.

[7] Ma Wuxing. Research on military-civilian Integration of National Defense Mobilization[J]. Military Economic Research, 2009, (5): 28-30.

[8] Li Hongkuan, he Haiyan, Cai Jing, et al. A study on the Evaluation of the Development level of military-civilian Integration in China considering the relevance of Evaluation Indexes — based on DEMATEL-ANP Model and Grey Relational Analysis method[J]. Scientific and technological Progress and Countermeasures, 2018, (9): 113-122.

[9] Li Jian, Hu Junping, Song Wei. A study on the degree of integration of military and civilian in micro, meso and macro[J]. Military Economic Research, 2012, (4): 11-13.

[10] Ma Xifang, Guo Shizhen, Zhang Tianhui. Construction of regional civil-military integration performance evaluation system based on BSC[J]. Scientific and technological Progress and Countermeasures, 2017, (20): 113-120.

[11] Meng Binbin, Qi Gang, Zeng Li. Measurement of the degree of military-civilian integration in China: theory and demonstration[J]. Journal of Beijing Institute of Technology (Social Science Edition), 2019, (1): 128-135.

[12] Jia Liqun, Liu Xu, Wang Yingluo. Research Progress of Neo-Schumpeterian School on technological Innovation Theory[J]. China Science and Technology Forum, 1995, (5): 38-38.

[13] Ye Ming. The Origin and Development of technological Innovation Theory[J]. Soft Science, 1990, (3): 7-10.

[14] Xiao De. On the Theory of Western technological Innovation and its reference significance to China[J]. International Economic and Trade Exploration, 1995, (6): 10-14.

[15] Arrow, K. J. The Economic Implications of Learning by Doing[J]. Review of Economic Studies, 1962, 29 (3): 155-173.

[16] Agrawal, Anup Jaffe, Jeffrey F., Mandelker, Gershon N. The Post-merger Performance of Acquiring Firms: A Reexamination of an Anomaly [J] .Journal of Finance, 1992,47 (4): 1605-21.

[17] Boone, Audra L., J. Harold Mulherin. Comparing Acquisitions and Divestitures[J]. Journal of Corporate Finance,2000, 6 (2): 117-139.

[18] Gao Liangmou, Li Yu. Formation mechanism and dynamic expansion of the relationship between enterprise size and technological innovation[J]. Managing the World, 2009, (8): 113-123.

[19] Fountain, J. Social Capital, A Key Enable of Innovation in Science and Technology, Investing in Innovation: Towards aConsensus Strategy for Federal Technology Policy[M] .MIT Press,1998.

[20] Zhang Fanghua. Social Capital and technological Innovation of Enterprises — A New Vision of technological Innovation Theory Research[J]. Dialectics of Nature Newsletter, 2003, (6): 55-61110.

[21] Lin Zhouyu, Lin Hanchuan. The technological Innovation activity of Chinese Manufacturing Enterprises-the role of Social Capital[J].

Quantitative Economic and Technical Economic Research, 2012, (10): 37-51.

[22] Thorsten Beck, Ross Levine, Alexey Levkov. Big Bad Banks? The Winners and Losers from Bank Deregulation in the United states[J] .Journal of Finance, 2010, 65 (5): 1637-1667.

[23] Tan, Y.,Tian, X., Zhang, X., Zhao, H. The Real Effects of Privatization: Evidence from China's Split Share Structure Reform. Kelley School of Business Research Paper, 2015.

[24] Zhang Xuan, Zhang Jibao, Yan Xiwen, et al. "Business Reform and increase" and Enterprise Innovation — from the Perspective of Enterprise tax burden[J]. Financial Research, 2019, (3): 63-78.

[25] Adams, R., H. Almeida and D. Powerful CEOs and Their Impact on Corporate Performance[J].Review of Financial Studies, 2005,8:1403-1432.

[26] Beiner, S., W. Drobetz, M.M. Schmid, H. Zimmermann. An Integrated Framework of Corporate Governance and Firm Valuation[J]. European Financial Management, 2006,12(2):249-283.

[27] Cheng S. J. Board Size and the Variability of Corporate Performance[J]. Journal of Financial Economics, 2008,87:157-176.

[28] Li Lin, Liu Fengwei, Lu Wenbin. Research on the Governance effect of Equity checks and balances based on Corporate performance volatility [J]. Managing the World, 2009, (5): 145-151.