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## Article

# Military-Civil fusion and optimisation of urban industrial structure—an evidence from China

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# GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE Military-Civil fusion and optimisation of urban industrial structure—an evidence from China

Zhaobin Sun<sup>1</sup>, Xiwei Liu<sup>2</sup>, Ling Li<sup>1</sup> and Xiaoliang Yang<sup>3</sup>\*

**Abstract:** China's military-civil fusion (MCF) policy has attracted global attention. Since 2010, China has constructed over 30 MCF national demonstration bases (MCFNDBs) to optimise local industrial structure and promote local economic development. However, the evaluation of the actual economic effects of these MCFNDBs has not reached a consensus. We use panel data for 285 cities from 2006– 2017 to investigate the economic effect of MCFNDBs by difference-in-difference estimation. We find that constructing MCFNDBs are significantly beneficial to upgrading the urban industrial structure in less developed regions and provincial capital cities; however, it plays an insignificant role in the industrial structure rationalisation.

Subjects: Industrial Economics; Econometrics; Industry & Industrial Studies

Keywords: military-civil fusion; industrial structure optimisation; industrial upgrading; industrial rationalisation; difference-in-difference

JEL: C23; O14; R58

### 1. Introduction

In recent years, many developing countries, such as China, have actively promoted the optimisation of the urban industrial structure, which has brought new momentum to the economic development of all countries. Since the reform and opening-up in 1978, China's economy has made remarkable achievements that led to GDP growth of nearly 10% per year, and its contribution to the global economic growth has risen from 3.1% in 1978 to 27.5% in 2018. The industrial structure optimisation played a great role in this period.

Industrial structure is the result of the distribution of resources and final products across different industries (Kuznets, 1949). Kuznets (1957) studied the relationship between economic growth and the labour force ratio in various industries in 18 countries and found that as the economy develops, labour gradually shifts from agriculture to more productive industries. The transformation trend of the modern industrial structure presents an initial decrease in the first and second industries and an increase in the size of the tertiary industry. The transformation from low-end industry to high-end industry is the upgrading of the industrial structure, which is one dimension of the industrial structure optimisation (Gan et al., 2011). The rationalisation of the industrial structure (also known as the degree of interindustry agglomeration), the second dimension, reflects how well industries coordinate and the extent to which resources are effectively used (Chang & Lou, 2004). A prevailing measurement for the upgrading of urban industrial structure is the ratio of employment and output. Generally, the ratio of employment and output in agriculture decreases and the ratio in the service industry increases under increases in GDP per capita. However, the ratio of employment and output in an industry is hump-shaped in the level of economic development (Duarte & Restuccia, 2010; Jorgenson & Timmer, 2011).





In the early 1980s, in order to adapt to the government's goal of developing and modernising national defence, Deng Xiaoping proposed the basic policy of military-civil fusion (MCF) that "combining military industry and civilian industry, combining peacetime and wartime, giving priority to military products, and supporting military industry by civilian industry." The process of MCF, however, was delayed by the sudden change of the international situation in the 1990s. Until 2007, the 17th Congress of the Communist Party of China once again put forward the strategic principle of establishing and improving the MCF, and successively issued a number of laws and regulations to ensure the smooth implementation of MCF. In 2012, the 12th Five-Year Plan made MCF a national strategy, ushering in a new chapter of MCF in China.<sup>1</sup>

During this period, the Ministry of Industry and Information Technology of China carried out the cultivation and identification of military-civil fusion national demonstration bases (MCFNDBs) in batches. Since 2009, China has constructed a total of 36 MCFNDBs in 30 cities across 22 provinces within nine years. At the same time, many local governments issued a series of supporting policies and special fund management regulations for the development of MCF industry, and provided support to dual-use technology R&D and other MCF projects through subsidies, equity investment, loan discount and other ways. Although the degree of MCF in China still lags far behind that of most European countries and the US, it has shown a trend of rapid improvement in the past decade (Zhan & Zhao, 2017). This paper focuses on such a catch-up period, viz. the construction period of the MCFNDBs, and investigates the influence of the constructing MCFNDBs on the local industrial structure optimisation.

MCF includes military-to-civilian conversion and civilian participation in the military. The former is thought to be an investment process (Hartley & Bhaduri, 1993; Intriligator, 1996) that generates economic benefits (Thorsson, 1984; Wulf, 2005). To produce civilian products and services, military departments can use funds, technology, human resources, land, weapons and equipment (Brauer & Marlin, 1992). Although military science and technology could promote civilian development, obstacles to the military-to-civilian mechanism and the lack of coordination between the military sector and the civilian sector may lead to many problems. For example, the growth of China's military demand coincides with a reduction in the amount of national defence industrial labour; however, national defence production is still overstretched and productivity is very low (BrÖmmelhÖrster & Frankenstein, 1997). Under military production, performance is prioritised over cost-savings and costs are not controlled by the market but rather by large bureaucracies, which make management competence in the military production sector different from that in the civilian production sector (Azulay et al., 2002; Kelly & Watkins, 1995; Kulve & Smit, 2003). It is more profitable for military enterprises to lobby for politically closed defence markets than to convert military production lines into civilian production lines (Sapolsky & Gholz, 1999).

The participation of private enterprises in military production has long been encouraged by scholars. Gansler (1989) points out that the level and development speed of technology in many civilian fields has surpassed military technology (such as the electronic information technology), and the spillover of technology from the civilian sector to the military sector is beneficial. In addition, the deepening of social division of labour and the huge market scale make civilian production more efficient, and the participation of civilian enterprises in military production helps to improve the efficiency of the latter (Huang et al., 2017). The promotion of civilian-to-military helps attract a large amount of social capital to participate in national defence construction (Tang et al., 2019). However, some scholars have questioned the feasibility of civilian-to-military based on practical experiences. For example, both Russia and early Ukraine made detailed plans to promote civilian production in the defence industry, but ultimately failed due to inade-quate funds (Gonchar, 2000). The strategic goal of MCF is not only to enable civilian technology to benefit military products, but also to enable the MCF process to benefit the national economy. Such benefits are reflected in many aspects, like the improvement of enterprise productivity (Burk, 2002), the optimisation of resource allocation (Chu, 2016), and the optimisation of industrial

structure (Zhan & Zhao, 2016; Zhang, 2011). Therefore, both dimensions of the MCF will be considered in this paper.

Industrial policy has been widely used in most developing countries such as China. However, the effectiveness of industrial policies, especially the construction of development zones, has long been controversial (Busso et al., 2013). Similar industrial policy in developed countries is usually the enterprise zone program (EZP). For example, Ham et al. (2011) study the EZP in the US and Gobillon et al. (2012) evaluate the French EZP. In China, the construction of national development zones has significantly promoted the upgrading of industrial structure, although it has not promoted the rationalisation of industrial structure; that is, it has not promoted the optimisation of China's industrial structure (Yuan & Zhu, 2018). Moreover, time lags may occur in industrial policies which have uncertain impacts on both the effects of the MCF and the optimisation of the industrial structure. The overall results in the whole country indicate that the development of MCF is conducive to the upgrading of regional industrial structures, although it also hinders the process of upgrading the industrial structure to a certain extent. Regional results indicate that strong MCF areas can significantly improve the overall industrial structure of a region, although the adverse impact on the upgrading of industrial structure is greater. In contrast, weak MCF areas have no significant impact on the upgrading of the overall industrial structure (Xie & Zhao, 2016). China's output structure is evolving faster than both the employment structure and the economic development level. China is in a difficult transformation period from a late-middle industrialisation stage to a high-income development stage. China may have witnessed the "de-industrialisation trend" too early before the upgrading (Zhang et al., 2019). China's "The Belt and Road Initiative" has significantly promoted the rationalisation of the industrial structure; however, it has not led to upgrades of the urban structure along the route and has not obviously promoted the optimisation of China's overall industrial structure (Q. Wang & She, 2020).

This paper has two major contributions. First, compared with previous studies, this paper focuses on the impact of MCFNDBs on the industrial structure optimisation within the city where the base is located. The construction of MCFNDBs in China is a quasi-natural experiment that provides the conditions for applying the difference-in-difference (DID) approach. Second, this paper finds that although MCFNDBs are involved in the upgrading of urban industrial structure in some cities, they do not play a significant role in the rationalisation of urban industrial structure. This study has an important impact on the government's policy-making by showing that vigorously promoting the construction of MCFNDBs is not an optimal choice for achieving the optimisation of industrial structure.

The rest of this paper has the following structure: section 2 presents the institutional background. Section 3 describes the data setting, data source, and DID method. Section 4 provides the empirical findings and the results of an endogeneity diagnostic, a placebo test and a robustness test. Conclusions and policy implications are drawn in Section 5.

#### 2. Institution background

#### 2.1. Socialisation of Military Logistics Support

To solve many problems faced by military logistics support, such as backward technology, insufficient funds, bloated personnel, outdated facilities, extensive management, serious waste and low efficiency, the Central Military Commission issued guidelines called "Promoting the Socialisation of Military Logistics and Other Support During the 11th Five-Year Plan" in February 2007. The socialisation of military logistics support rapidly developed throughout the country, and the socialisation of military security was incorporated into the overall plan of national economic and social development and into the special plans and annual work plans of relevant departments of the State Council. Subsequently, many excellent private enterprises were contracted to provide military services, such as catering, medical treatment, barracks, military uniforms, fuel and other areas of logistics support, which caused the upgrading of industrial structure. In 2015, the size of the Chinese army was reduced by 0.3 million to 2 million. In addition to these reductions in the front-line combat force, most urban units consisting of cooks, civil servants, drivers, feeders, telephone workers and other staff were reduced, and their work was substituted by civilian services. The reform of military logistics socialisation provides a greater market space, such as military general product modules, non-main combat equipment maintenance services, military supplies, waste material destruction and recovery, general material storage, military online shopping malls, property, security, military transportation, catering, and facilities maintenance. As the vast majority of logistics support belongs to the tertiary industry, the implementation of socialisation of military logistics support has brought the city an impetus to upgrade the industrial structure.

### 2.2. Identification of MCFNDBs

To promote the development of MCF, since 2010, China's Ministry of Industry and Information Technology has actively carried out the cultivation and identification of MCFNDBs. The government has also promoted MCF towards industrial agglomeration and large-scale development. To date, China has identified MCFNDBs in 30 cities across 22 provinces (Figure 1 The details of all the MCFNDBs in 30 cities are shown in Appendix I).

#### 3. Data, main variables and methodology

### 3.1. Data description

We collected panel data across 291 cities from 2006 to 2017. To ensure that the observed cities were consistent, we then eliminated 6 cities, namely, Chaohu, Lhasa, Bijie, Tongren, Sansha, and Haidong, because of unavailable data and the late establishment of the cities. Therefore, the final dataset included 285 cities (The data on the level of MCF come from the official website of the Ministry of Industry and Information Technology of China. The MCF information comes from an annual report of the government's work, and the data on the economic characteristics of cities come from the 2007-2018 China Urban Statistics Yearbook and the Government's Statistical Bulletin on National Economic and Social Development.). This method is one of the quite few options available, given the extreme difficulty of obtaining data directly. In recent years, the method of analysing the word frequency in a text has been accepted by increasingly more scholars, and has been given a beautiful name—"Computer-Aided Text Analysis"



(McKenny et al., 2018). Studies using the occurrence frequency of certain words or phrases to estimate the observations of certain variables have been widely published in many prestigious journals. For example, Sontuoso and Bhatia (2021) measure individual strategic selection by the frequency of certain words used in a person's daily language. James and Rivera (2022) measure US corruption by the frequency that words such as "corrupt", "fraud", "bribe", etc. appear in newspapers. Although the government's annual work report may seem to cover all aspects of the country, it in fact summarises the progress of the past year's major issues and lays out vital tasks for the coming year. Given the limited space available, many general or non-focused work deployments are usually not specifically mentioned in the annual report. Appendix II lists some of the statements in the annual reports that strongly support MCF, giving a sense of how seriously the government takes it. On the contrary, in some years, there is no mention of MCF in the annual reports. Governments at all levels will not give priority to MCF projects when promoting various projects.

#### 3.2. Main variables

### 3.2.1. Dependent variables

The upgrading and rationalisation of urban industrial structure are two characteristics of the industrial structure optimisation. The former can be measured by the output ratio of the highend technology industry to the manufacturing industry (Fu et al., 2016). Following Gan et al. (2011) and Jiao (2015), we use the ratio of tertiary industry to secondary industry to measure industrial structure upgrades. In addition, the employment ratio of the tertiary and secondary industries is used as an alternative index to test the robustness of the urban industrial structure.

The degree of inter-industry aggregation reflects how well industries coordinate and the extent to which resources are effectively used. Drawing on the methods of Fu et al. (2016) and Gan et al. (2011), the rationalisation of the industrial structure is reflected by the Theil index. The calculation formula is as follows:

$$\operatorname{Rat} = \sum_{i=1}^{3} \left( \frac{Y_{i}}{Y} \right) \left| \operatorname{Ln} \left( \frac{Y_{i}/Y}{L_{i}/L} \right) \right|$$
(1)

where the dependent variable, Rat represents the rationalisation of the industrial structure.  $Y_i$  and  $L_i$  represent the output value of industry i and the number of employees in the city, respectively. When the economy is in equilibrium, the productivity level is identical across sectors, i.e.  $Y_i/L_i = Y/L$ ; thus, Rat = 0. Conversely, if the industrial structure deviates from the equilibrium, then the Theil index is non-zero, indicating that the industrial structure is unreasonable. Smaller values correspond to a more reasonable industrial structure.

#### 3.2.2. Independent variables

Degree of MCF. Our study uses two indicators to measure the degree of MCF: the level of MCF and the degree of attention to MCF. The level of MCF reflects the degree of urban military-civilian conversion or civilian participation in the military. It is measured by the proportion of the industrial output value of the MCFNDBs in the total industrial output value of the city where it is located. The degree of attention to MCF reflects the central government's concern about MCF, measured by the frequencies of "MCF" in the government work report released every year. MCF is mainly led and promoted by the central government. Therefore, the degree of attention to MCF determines the intensity and development of MCF.

Urban economic characteristics. This paper chooses urban economic characteristics as control variables to avoid potential deviations caused by omitted variables. According to Bai & Qian (2010), these urban characteristics include the following aspects.

Table 1. Summ	nary Statistics of	F Key Variables			
Variable	Sample size	Mean	SD	Min	Max
Dependent viable					
Upgrading	3420	0.8662	0.4734	0.0943	5.3401
Employment	3420	1.4550	1.0985	0.1823	21.2791
Rat	3420	0.2629	0.2128	0.00014	1.7205
Degree of MCF					
MCF level	3420	0.0136	0.0814	0	1
MCF frequency	3420	0.5833	0.6402	0	2
Urban economic o	characteristics				
Gdpp (RMB)	3420	4.4948	0.3187	3.4420	6.8077
Technology (%)	3420	19.63	4.53	1.58	45.56
Unemployment (%)	3420	5.69	03.24	0	55.99
Investment (%)	3420	83.89	77.10	0	145.933
Finance (%)	3420	274.55	189.57	64.88	183.985
Urban politics and	d geography charac	teristics			
Rank	3420	2.8877	0.3575	1	3
Area	3420	1.8702	0.8382	1	3

- (1) Urban per capita GDP depicts the level of urban economic development.
- (2) Development level of urban science and technology reflects the scientific and technological capabilities required for the transformation of industrial structure.
- (3) Urban unemployment rate reflects the government's legal environment, with a lower unemployment rate corresponding to a better legal environment.
- (4) Scale of urban investment reflects the total amount of urban fixed asset investment and is a 'troika' to promote economic development. In the current stage of China's economy, expanding and optimising investment play a key role in industrial transformation and the elimination of backward and excess capacity
- (5) Urban financial pressures reflect the liquidity of financial resources and can measure the local financial environment.

Urban politics and geography characteristics. The administrative level is a typical Chinese urban political feature, and it is captured by three dummy variables: municipality, provincial capital city and general level city. Regional economic development differences are a symbol of China's economic development imbalance, which is set as two dummy variables in developed and less developed regions, where the economic development of the central and western regions is relatively slow.

The descriptive statistics of the variables are shown in Table 1, and definitions of the variables are provided in Appendix III.

#### 3.3. Empirical strategy

The MCFNDBs identified by China provide a quasi-natural experiment for the use of the DID method. In this paper, 30 cities at or above the prefecture-level city where MCFNDBs are located are set as the treatment groups, and the grouping variable "treat" is assigned a value of 1 (As Xi'an and Chongqing are recognised twice, there are only 30 MCFNDBs). The remaining 255 prefecture-level cities are set as the control groups, and "treat" is assigned a value of 0. According to the

specific time of identification, the experimental staging variable "post" is set for the preexperiment and post-experiment. Because this is a gradual strategy, "post" is assigned a value of 0 before identification and 1 after identification. To more accurately evaluate the effect of MCFNDB on the optimisation of urban industrial structure, it is necessary to further set the interaction term "treat  $\times$  post" of two dummy variables: treatment groups and experimental stages. The coefficient of the interaction term can capture the average difference between a city that is identified as a MCFNDB and a city that is not identified as a MCFNDB. In this paper, the impact of MCFNDBs on the optimisation of urban industry structure is comprehensively tested in the regression model as follows:

$$Trans_{it} = \theta_0 + \theta_1 treat_i \times post_t + \theta_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$
(2)

where Transit represents the optimisation of the industrial structure of city i in year t and is usually depicted by the upgrading and rationalisation of the industrial structure;  $X_{it}$  is a set of control variables related to urban-level economic characteristics;  $\mu_i$  is the urban fixed effect, controlling for the influence of fixed factors on industrial structure optimisation; and  $\gamma_t$  is the time fixed effect, which excludes the time trend. Our parameter of interest is  $\theta_1$ . If  $\theta_1$  is significantly positive, it can be inferred that the effect of the MCFNDB on the optimisation of urban industry structure is effective.

### 4. Empirical results

In this section, we mainly examine the effect of MCFNDBs on the optimisation of the urban industrial structure. The baseline regression includes full-sample and subsample results, endogeneity problems are solved with the instrumental variable, parallel trends are tested before the DID method is used, and placebo and robust tests are performed. The placebo test identifies the significance of the pre-experimental variables and randomly selected treatment groups, and the robustness test is validated by substituting for the dependent variable and choosing dependent variables that are irrelevant to MCF policy.

In addition to maintaining exogenous policy experiments, the application of the DID model implies an important hypothesis that if there is no policy impact, then the time trend of the treatment and control groups should be parallel. Figure 2 shows that the parallel trend is basically fulfilled before 2012. There is a significant change after 2012, indicating that the identification of a MCFNDB has a lag of two years.

Figure 3 shows the results of a parallel trend test based on the partial effect of the annual dummy variable of the upgrading of the urban industrial structure, and it indicates that the policy experiment has a real effect in 2012.



Figure 2. Parallel Trend of MCFNDBs and Optimisation of Urban Industrial Structure.

#### 4.1. Baseline

Table 2 reports the results of the full sample and subsample estimations. The model controls for urban economic characteristics, urban fixed effects and time fixed effects. As shown in Panel A, the regression results indicate that the coefficients of the interaction term "treat  $\times$  post" of upgrading are significantly positive at the 10% level. The interaction term "treat  $\times$  post" of rationalisation is positive, although it is not significant at any level. Panel B shows that only the upgrading index of cities located in the less developed regions is significant at the 10% level and the upgrading and rationalised index of the cities in developed regions is insignificant. Panel C shows that only the provincial capital city's upgrading and rationalisation index is significant at the 10% level while the indices of the other cities are not significant. This implies that compared with the control groups, MCFNDBs effectively improve the upgrading level of the urban industrial structure but do not significantly improve the rationalisation level of the urban industrial structure.

In different regions, local governments have given a lot of policy support to MCFNDBs, such as tax incentives, industrial investment funds and bank loans. However, the impact of MCFNDBs on the local economy varies from place to place, especially the impact on the upgrading of industrial structure in less developed regions is more significant. The reasons for this are, first of all, to accelerate economic development, local governments in less developed regions have given greater support. For example, in 2018, Xi'an issued the "Special Policy for the Development of MCF Industry in Xi'an National Independent Innovation Demonstration Zone", with an annual expenditure of 200 million Yuan to support MCF enterprises; Mianyang in Sichuan province has devoted a lot of policy resources into the local science and technology city, and has therefore been listed as a national pilot city for revitalising science and technology through military-to-civilian conversion. Secondly, the economic development in less developed regions is slow, while the level of technology is relatively low. Military products usually involve three markets—military procurement, private enterprises to undertake military matching, and logistics support socialisation. However, most of the products in the first two markets have high technical content, which makes it difficult to carry out MCF. The technical content of military materials required for the "logistics support socialisation" is relatively low, and military-to-civilian commonality and complementarity are stronger. Therefore, urban logistics support enterprises in less developed regions are more likely to develop rapidly in the industrial chain, value chain, and service chain. Finally, most of the MCFNDBs are located in less developed regions (see, Figure 1), and the central government's policy of promoting MCF is also focused on these regions.



Figure 3. Partial effect based on the annual dummy variable.

Table 2. Optimisat	ion Effects of MCFNDBs					
Panel A. Whole sampl	e					
		Upgrading(1)			Rat(2)	
Treat×post		0.0904* (0.0545)			0.0052 (0.0224)	
Control		YES			YES	
Year FE		YES			YES	
City FE		YES			YES	
Constant		3.6864*** (0.8343)			0.7227*** (0.1441)	
R <sup>2</sup>		0.4031			0.1815	
Observations		3,420			3,420	
Panel B. By economic	zoning					
		Upgrading			Rat	
	Developed areas(1)	Less develo	oed areas(2)	Developed areas(	3) Less	developed areas(4)
Treat×post	0.1426 (0.1089)	0.0)	:00* 476)	-0.0070 (0.0203)		0.0114 (0.0332)
Control	YES	X	S	YES		ΥES
Year FE	ΥES	λ	S	YES		ΥES
City FE	YES	λ	S	YES		ΥES
Constant	3.9811*** (0.8158)	3.23	75*** 387)	0.7305*** (0.2547)		0.7184*** (0.1778)
R <sup>2</sup>	0.4411	0.4	230	0.1507		0.2124
Observations	1,452	1,9	68	1,452		1,968
Panel C. By administre	ative ranks					
		Upgrading			Rat	
	Municipality(1)	Capital(2)	Prefecture(3)	Municipality(4)	Capital(5)	Prefecture(6)
Treat×post	0.1943 (0.1759)	0.1312* (0.0723)	0.0126 (0.0382)	0.0676 (0.0364)	0.0458* (0.0244)	0.0100 (0.0284)
						(Continued)

l able 2. (continuea)						
Control	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
City FE	YES	YES	YES	YES	YES	YES
Constant	5.9574 (11.3870)	7.7561*** (1.7054)	3.4192*** (0.8223)	-0.5284 (1.2651)	-0.0354 (0.3389)	0.7545*** (0.1529)
R <sup>2</sup>	0.9162	0.6184	0.3878	0.7583	0.2056	0.1886
Observations	48	288	3,084	48	288	3,084
Note: Due to space limito the city fixed effect. The	ttions, the table does not li regression is mis-estimate	ist the regression results of using the robust stando	of urban economic charact ard. The value in parenthe	eristics as expressed in th ses is the standard error;	e "control". Year FE represents the time fixed the same conditions are applied below.	effect. City FE represents

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The main reason why the MCFNDB has no significant impact on the rationalisation of the urban industrial structure may be the use of Theil index to measure the rationalisation. The continuous upgrading of the urban industrial structure implies the three industries development is not balanced, that is, the tertiary industry develops faster than the secondary industry, the secondary industry develops faster than the primary industry, and thus rationalisation is not significant.

#### 4.2. Endogeneity diagnostic

The DID model is used to investigate the optimisation effect of the urban industrial structure, and the ideal situation should be that MCFNDBs are randomly identified. That is, the selection of the treatment groups should not be disturbed by other measurable or unmeasurable factors that affect the urban industrial structure optimisation, although the actual situation may not be consistent with this process. The identification of MCFNDBs might not be random. Moreover, the urban industrial structure optimisation may be better before the city has a MCFNDB. A dualcausality is observed that leads to the interference of policy endogeneity in the selection of treatment groups, which affects the accuracy of our estimation. Therefore, this paper refers to the quasi-natural experimental research of Tsoutsoura (2015) when selecting appropriate instrumental variables to solve the endogeneity problem of treatment group selection.

Since the endogenous variable in this paper is the grouping variable "treat", the dummy variable is a good instrumental variable to indicate if a city has garrisons or has a military advantage (traditional military city or significant military characteristics). In theory, whether or not a city has garrisons or military industry advantages can satisfy two conditions of effective instrumental variables (Acemoglu et al., 2001): From the current MCFNDB, it is not difficult to find that the vast majority of cities have a certain size garrison or have a certain military advantage, and the relevant conditions are satisfied; There is no other way to influence the optimisation of urban industrial structure except through the path of "urban garrison or military industry superiority →MCFNDB→optimisation of urban industrial structure". That is, whether a city has garrisons or military industry superiority is irrelevant to the stochastic disturbance term of Eq. (2), and the exogenous condition is satisfied.

It is noteworthy that the endogenous variable "treat" appears in the form of the interaction term in Eq. (2). Therefore, the endogenous variable in this paper is actually the interaction term "treat  $\times$  post"; therefore, the corresponding instrumental variable should be "IV  $\times$  post". The regression model of the first stage of the instrumental variable is thus

$$treat_{i} \times post_{t} = \beta_{1}IV_{i} \times post_{t} + \beta_{2}X_{it} + \mu_{i} + \gamma_{t} + \varepsilon_{it}$$
(3)

where IV is the two-value instrumental variable. A sample city that owns garrisons or has the advantage of military industry is given a value of 1; otherwise, the value is 0. Other definitions are the same as in Eq. (2).

Table 3 reports the estimation results based on the panel instrumental variable method. The first-stage regression results are listed (column 1). The coefficients of the interaction term "IV  $\times$  post" are significantly positive at the 1% level, and the F statistic is 14.71, which is significantly larger than the critical value of 10. These findings show that the instrumental variables satisfy the correlation conditions and are not weak. We further report the second-stage regression results (columns 2 and 3). When the regression for the upgrading and rationalisation of industrial structure is carried out, the interaction term "treat  $\times$  post" coefficients of upgrading that this paper focuses on are significantly positive at the 5% level (but rationalisation is insignificant), which shows that after further solving the endogeneity problem of treatment group selection, the identification of MCFNDBs can still promote upgrading rather than rationalisation for China's urban industrial structure, and the conclusions of this paper remain unchanged.

Table 3. IV Estimation	Results		
	First stage of regression	Second stage	of regression
	Treat×post(1)	Upgrading(2)	Rat(3)
IV×post	0.9368*** (0.0062)		
Treat×post		0.0776** (0.0319)	0.0083 (0.0145)
Control	YES	YES	YES
Year FE	YES	YES	YES
City FE	YES	YES	YES
ConstantR <sup>2</sup>	0.0440 (0.0427) 0.9360	3.6849*** (0.2069) 0.4031	0.7231*** (0.0942) 0.1815
Observations	3,420	3,420	3,420
First-stage F-statistics	12.82		

#### 4.3. Placebo test

In addition to the graphic analysis of the parallel trends, placebo tests were carried out, namely, the significance test of the interaction item "treat  $\times$  post" coefficient in the pre-experiment and after the random reselection of processing groups. Compared with Eq. (2), this model examined whether the difference between the treatment group and control group in each year from 2006–2008 prior to the identification of the MCFNDB was significant (Liang & Cheng, 2018):

$$Trans_{it} = \theta_{1}treat_{i} \times post_{t} + \sum_{t=placeboyear}^{t=2008} \theta_{t}Yr_{-}D_{t} \times treat_{i} + \theta_{2}X_{it} + \mu_{i} + \gamma_{t} + \epsilon_{it}$$
(4)

where  $Yr_D_t$  is a dummy variable for a year prior to the identification of the MCFNDB.

Panel A in Table 4 shows that the 2006–2008 coefficients in columns 2–4 and columns 6–8 are not significant at any level, indicating that the model satisfies a parallel trend. Panel B shows that after the random reselection of the treatment groups, neither the upgrading nor the rationalisation index of urban industrial structure is significant, which shows that the MCFNDB has promoted the upgrading rather than the rationalisation of the industrial structure in some cities (For convenience, we have set the year of the MCFDB as 2010).

#### 4.4. Robustness test

Panel A in Table 5 shows the quantification of the upgrade of urban industrial structure with the ratio of employment in the tertiary industry to that in the secondary industry. The estimated results show that the interaction term of the "post  $\times$  treat" coefficient of the whole sample is significantly positive at the 10% level. However, after economic zoning, the less developed regions are significant at the 1% level (not significant in developed regions). These findings show that the identification of MCFNDBs has significantly improved the upgrading of urban industrial structure only in less developed regions, indicating that the results are more stable. Panel B shows that when substituting dependent variables that are not related to the MCF policy, the interaction term "treat  $\times$  post" coefficient is not significant at any level, which indicates that the implementation of the MCF policy has no effect on variables unrelated to the MCF policy (In the DID model, we keep the same treatment groups and control groups as well as the true time of policy implementation).

Panel A. Parallel	trend regression							
		Upgr	ading			R	at	
	(1)	(2)	(3)	(†)	(5)	(9)	(2)	(8)
Treat×post	0.0904* (0.0545)	0.0904 (0.0550)	0.0890 (0.0558)	0.0890 (0.0558)	0.0052 (0.0224)	0.0054 (0.0226)	0.0051 (0.0230)	0.0051 (0.0230)
Treat×year 2011		-0.0010 (0.0288)	0.0023 (0.0311)	0.0023 (0.0311)		-0.0057 (0.0153)	-0.0050 (0.0175)	-0.0050 (0.0175)
Treat×year 2010			0.0315 (0.0316)	0.0315 (0.0316)			0.0066 (0.0247)	0.0066 (0.0247)
Treat×year 2009				0.0000(.)				0.0000(.)
Control	YES							
Year FE	YES							
City FE	YES	ΥES						
Constant R <sup>2</sup>	3.6864*** (0.8343) 0.4031	3.6864*** (0.8344) 0.4031	3.6851*** (0.8345) 0.4031	3.6851*** (0.8345) 0.4031	0.7227*** (0.1441) 0.1815	0.7228*** (0.1442) 0.1815	0.7225*** (0.1443) 0.1815	0.7225*** (0.1443) 0.1815
Observations	3,420	3, 420	3, 420	3, 420	3, 420	3, 420	3, 420	3, 420
Panel B. By randon	Ily reselected treatm	tent groups		-				
		Upgre	ading			R	at	
	Whole sample (1)	Developed areas (2)	Less de ar (	eveloped eas (3)	Whole Sample (4)	Developed areas (5)	Less de are ((	veloped eas 5)
Rantreat×post	-0.0250* (0.0129)	-0.0304 (0.0196)	).0- (0.0)	0159 0164)	0.0102 (0.0082)	-0.0020 (0.0088)	0.0)	157 123)
Control	YES	YES	>	'ES	YES	YES	A	S
year FE	YES	YES	×	'ES	YES	YES	Ъ	ES
city FE	YES	YES	Y	'ES	YES	YES	AF	ES
								(Continued)

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Table 4. Placebo Test

Note: "Rantreat" represents "randomly selected treatment groups".

Table 4. (Continued)

Table 5. Robustness Test				
Panel A. Substitution of depe	endent variable			
		Em	ıployment	
	Whole sample	Developed areas	P	ss developed areas
	(1)	(2)		(3)
Treat×post	0.1601** (0.0813)	0.0587 (0.1826)		0.2245*** (0.0842)
Control	YES	YES		YES
Year FE	YES	YES		YES
City FE	YES	YES		YES
Constant R <sup>2</sup>	4.1800*** (0.8245) 0.0845	5.1360*** (0.9357) 0.1709		3.6528*** (0.9788) 0.0800
Observations	3,420	1,452		1,968
Panel B. Choice of dependent	t variables that are unrelated	to the MCF policy		
	Gdpp(1)	Technology(2)	Unemployment(3)	Finance(4)
Treat×post	0.0077 (0.0182)	0.0074 (0.0058)	-0.0018 (0.0036)	0.1971 (0.1604)
Control	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
City FE	YES	YES	YES	YES
ConstantR <sup>2</sup>	4.2436*** (0.0191) 0.8582	0.3184*** (0.0396) 0.1642	0.1591*** (0.0276) 0.0793	8.7783*** (1.3515) 0.1485
Observations	3,420	3,420	3,420	3,420

#### 5. Conclusions

#### 5.1. Main findings

The optimisation of urban industrial structure can be measured by the upgrading and rationalisation of this structure. The optimisation of urban industrial structures is essentially the process of optimising the efficiency of urban resource allocation. Whether MCFNDBs can promote the optimisation of the urban industrial structure lies in whether the local government can integrate demonstration bases into an urban development plan and relies on base development to drive the optimisation of the urban industrial structure. We find that MCFNDBs can promote the upgrading of urban industrial structure in less developed regions or in provincial cities, although the rationalisation of the urban industrial structure is insignificant. The main reasons may be that the transmission mechanism of technology conversion from military to civilian is not smooth, the investment of a single subject is insufficient, the coordination of policies is insufficient, and an effective industrial chain has not yet been formed.

#### 5.2. Policy implications

To accelerate the optimisation of the urban industrial structure, municipalities should give full play to the spillover effect of military technology and pay attention to the characteristics of cities. For example, the Chengdu-Deyang-Mianyang region in Sichuan Province should take advantage of the fact that 20% of the licensed research and production units of weaponry and equipment in the whole country are located in this region, take aerodynamic and information security industries as a breakthrough point, and build military bases and vigorous economic growth poles. Ningde in Fujian Province, which is located at the forefront of the air defence identification area of the East China Sea, should take the construction and sharing of military port transportation infrastructure as a breakthrough point to promote the optimisation of urban industrial structure. Ningbo in Zhejiang Province, which was the first pilot demonstration city of "the Made in China 2025 Plan", has a good foundation for new materials, new energy, high-end equipment, nonferrous metals, automobile accessories, etc. Thus, this city should focus on attracting military research institutes and local cooperation and incubate the industrialisation transformation of military science and technology achievements. Xi'an in Shaanxi province should take the civil-military dual-purpose optical, mechanical and electrical technology industry and electronic components technology industry as a breakthrough point to implement the optimisation of the urban industrial structure.

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#### Notes

 Examples of relevant rules include, "The guiding Opinions on Promoting the Shareholding Reform of Military Enterprises" issued in 2007, "Guidelines on the Participation of the Non-Public Economy in the Construction of National Defense Science, Technology and Industry" issued in 2008, "Opinions on Further Promoting the Maintenance and Support Construction of Integrated Military-Civilian Equipment" issued in 2009, "Several Opinions of the Central Military Commission of the State Council on Establishing and Improving the Research and Production System of Military-civilian Integrated Weapons and Equipment" issued in 2010, and "Implementation Opinions on Encouraging and Guiding Private Capital to Enter Defense Science, Technology and Industry" issued in 2012.

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### Appendices

Appendix I. MCF	NDBs Identified in China		
Year	MCFNDB Location	Year	MCFNDB Location
2010	Xi'an District, Shaanxi Province	2012	Ningbo District, Zhejiang Province
	Xiaogan District, Hubei Province		Handan District, Hebei Province
	Guangyuan District, Sichuan Province	2013	Xiangtan District, Hunan Province
	Mianyang District, Sichuan Province		Hanzhong Industry Park, Shaanxi Province
	Zhuzhou District, Hunan Province		Bishan Industrial Park, Chongqing
	Baotou District, Inner Mongolia Municipality		Luoyang District, Henan Province
	Xiangyang District, Hubei Province		Tiding District, Liaoning Province
	Guiyang District, Guizhou Province	2014	Danyang District, Jiangsu Province
2012	Daxing District, Beijing		Zunyi District, Guizhou Province
	Jingdezhen District, Jiangxi Province	2015	Xi'an Weapon Industry Base, Shaanxi Province
	Kunming District, Yunnan Province	2016	Liangjiang New Area, Chongqing
	Wuhu District, Anhui Province		Zhanjiang District, Guangdong Province
	Pinjiang Industrial Park, Hunan Province		Guan Industry Zone, Hebei Province
	Lanzhou District, Gansu Province		Dalian Industrial Zone, Liaoning Province
	Minhang District, Shanghai		Ningde District, Fujian Province
	Harbin District, Heilongjiang Province		Changzhi Industrial Park, Shanxi Province

#### Appendix II. Statements in the Government's Annual Work Reports Related to MCF

The following is a list of some of the statements in the annual reports that strongly support MCF, giving a sense of how seriously the government takes it. On the contrary, in some years, there is no mention of MCF in the annual reports. Governments at all levels will not give priority to MCF projects when promoting various projects.

- "The government will launch a number of major science and technology projects involving, ..., and dual-use technology", announced in the 2006 annual report.
- "The government should improve military-civilian integration, the military-implied into-civil system of national defense research and weapons and equipment production, and ....", announced in the 2009 annual report.
- "The government will promote integrated military-civilian development and strengthen national defense research and the construction of weapons and equipment", announced in the 2011 annual report.

- "The government should adhere to the principle of military-civilian integration and military-implied into-civil, and follow the path of integrated military-civilian development with Chinese characteristics", announced in the 2012 annual report.
- "The government will deepen MCF", announced in the 2014 annual report.
- "The government should promote the in-depth development of MCF", announced in the 2015 annual report.
- "The government should promote the in-depth development of MCF in important areas", announced in the 2016 annual report.
- "The government will deepen reform of the defense-related science, technology and industry systems and deepen MCF", announced in the 2017 annual report.
- "The government should further implement the strategy of MCF and deepen reform of defense-related science, technology and industry", announced in the 2018 annual report.

Detailed government reports over the years are listed below: http://www.gov.cn/guowuyuan/ zfgzbg.htm.

Appendix III. Definitions of Key Variables	
Variables	Definition
Dependent variables	
Upgrading	Upgrading of urban industrial structure, ratio of output in urban tertiary industry to secondary industry
Employment	Ratio of employment in urban tertiary industry to employment in secondary industry
Rat	Rationalisation of the urban industrial structure, calculated by the Theil index
Degree of MCF	·
MCF level	Ratio of the MCFNDB's gross industrial output to the urban gross industrial output. Because the amount of data is very small, we use data standardisation
MCF frequency	Number of MCFs appears in the central government's work report each year
Urban economic characteristics	
Gdpp	Gross urban GDP/Gross population, CNY 10,000, and take the log value
Technology	Ratio of urban education and science and technology expenditure to financial expenditure
Unemployment	Ratio of urban registered unemployed population to employed population
Investment	Ratio of urban fixed asset investment to gross industrial output
Finance	Ratio of urban financial expenditure to financial revenue
Urban geographical and political characteristics	
Rank	Administrative level of the city. Municipality, Rank = 1; Provincial capital, Rank = 2; General level, Rank = 3
Area	Level of economic development. Developed region = 1; Less developed region>1 (central region, Area = 2; western region, Area = 3)



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