8. DOES OPTIMAL CAPITAL STRUCTURE EXIST IN CHINESE MILITARY ENTERPRISES? EVIDENCE FROM INDUSTRIAL HETEROGENEITY

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Abstract

This paper aims to discuss the relationship between capital structure and firm performance in different Chinese industries. Depending on panel threshold regression method, different optimal capital structure levels are examined in the air force and naval equipment industries. Firm size, profitability, tangible assets and state-owned shares can explain this phenomenon effectively. Besides, there is no threshold effect for land force equipment industry, which may be due to the military reforms in People's Liberation Army, industry situation and uncertainties in the surroundings. Overall, this study focuses on Chinese different state-owned defence industry, providing a new perspective suggesting that capital structure theory developed from a Western economic perspective can be applied to present-day China. For the future research perspective, the Chinese private defence industry is a new field which is worthy of discussing.

Keywords: capital structure; enterprise performance; military industries; panel unit root; panel threshold regression model

JEL Classification: C33, G32, L25

1. Introduction

Being cognizant of the weakness in its military industry and unstable surrounding environment (Su *et al*., 2022a; Su *et al*., 2022b), China has implemented a series of significant reforms to improve the military system. Relying on several files of "Opinions on the integrated development of economic construction and national defence construction" and "Strategic outline of civil integration development", China's defence industry has achieved significant development. In 2020, China's defence expenditure reached 244,934

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million U.S. dollars, which means the global second largest spender. In first half of 2021, the total business income of enterprises in the defence industry reached 253.4 billion CNY, with 23.33% growth rate. Their main business covers almost all kinds of military forces, and own the whole industrial chain from raw materials to assembly. Under the background of civil-military integration (CMI) strategy, the long-term self-closeness and barrier of defence enterprises has been broken up. In particular, the social or private capital is allowed to participate in enterprise operation, which provides multiple financing ways, including internal financing, debt financing, equity financing and asset securitization. This paper is motivated by the context of Chinese defence firms as a special industry that is related to the national policies, with a strong planning characteristic. More importantly, many Chinese defence companies can easily generate hierarchy, bureaucracy and risk-aversion, which form the institutional, legal and technology barriers for the private capital to enter. Therefore, it is significant to focus on analysing the relationship between capital structure and enterprise performance for the defence industries in China.

The purpose of this paper is to investigate whether the optimal capital structure exists in Chinese different defence industries, and to discuss the potential influencing factors. In order to address the objective, the Chinese defence industry is classified into Land Force equipment industry (LFEI), Air Force equipment industry (AFEI) and Naval Force equipment industry (NFEI) based on the following features. First, there are significant differences in the capital structure. For example, according to our analysis, during the sample period, the industrial average capital structure, measured by total debt to equity, in LFEI, AFEI and NFEI are 0.911, 1.159 and 1.331 respectively. Second, asset securitization rates are various in different defence industries. For example, AFEI plans to reach the aim of 70% in 2020, which is the highest among these three industries. Third, the level of CMI is higher for AFEI and NFEI, which means they appeal more to non-state capital into their industries. Last, AFEI possesses the largest number of listed enterprises, followed by NFEI and LFEI. Therefore, it is important to investigate whether these differences influence capital structure and financing ways.

A number of papers attempt to explain the relationship between capital structure and firm performance from different standpoints. On the one hand, many empirical studies show a positive relation between these two variables (Sener *et al*., 2020; Fan, 2019; Detthamrong *et al*., 2017). Conversely, most empirical studies show a negative relationship between these key variables (Barbiero *et al*., 2020; Botta, 2020; Le and Phan, 2017; Vo and Ellis, 2017). Most of the earlier studies focus on the capitalist system, while the inclusion of background planned economy and specificity of defence companies as factors in the nexus between capital structure and firm performance always remained ignored. Meanwhile, compared with capitalist system, the development of the Chinese defence industry is closely related to the national and military policies, showing strong planning features. This study will enrich the literature and find out the result of the nexus between capital structure and firm performances employing data for different Chinese defence industries, considering the communist external environment background. Compared with the capitalist system, government policy, industry situation, reforms of mixed ownership system and uncertainties in the surroundings in communism have an impact on the empirical results.

The paper proceeds as follows. Section 2 shows the literature reviews. Section 3 presents the optimal capital structure model. Section 4 shows the methodology. Section 5 discusses data and sample. Empirical results are demonstrated in Section 6. Section 7 drives the discussion and the conclusion is presented in Section 8.

2. Literature Review

2.1. The Statement of the Problem

The Chinese defence industry faces many challenges from home and abroad, such as incomplete military reforms, which produce significant impact on funding activities and capital structure affecting firms' performance. China faces external unstable surroundings, it shares borders with 15 other countries in Asia, and several of them claim territorial dispute. PLA's military modernization program has already had significant implication for the U.S. interests in the Western Pacific (Cabestan, 2020). Second, China has a unique character regarding its military industry. Due to long-term self-closeness, Chinese defence industry has formed the institutional, legal and technology barriers for private capital to enter the industry (Guo and Zhao 2017). China still faces many major obstacles, such as widespread corruption, lack of competition and entrenched monopolies, delays and cost overruns, quality control problems, bureaucratic fragmentation, an outdated acquisition system, and restricted access to foreign technology and expertise (Chase and Garafola, 2016; Wang *et al*., 2018). Third, military reforms, such as CMI, have not progressed successfully as expected. Several obstacles, including limited information-sharing, poor coordination between the military and civilian research communities, and poorly developed CMI policies, would frustrate Chinese military reforms (Ng *et al*., 2018; Char, 2020).

The presented development of the Chinese defence industry is not only a consequence of domestic force modernization, but also an external demand for defence industry production. On the one hand, Chinese defence industry has gone through several significant rounds of reforms, which would make China better adapted to modern war (Pollpeter, 2016; Ullah et al., 2020). In line with the databases from Stockholm International Peace Research Institute (SIPRI), four Chinese arms-producing companies rank among the SIPRI top 25 in 2019, and total sales of Aviation Industry Corporation of China (AVIC) reach 66846 million dollars, the highest value in past years. On the one hand the defence enterprises receive increasing orders from government military procurement, which boosts research and development, and facilitates new production practices. On the other hand, the increase in the value of arms transactions stimulates the development of Chinese defence industry. Chinese defence enterprises have become mature and have commercialized gradually, and the spin-off-related benefits of commercial business operation have been particular important in some defence sectors (Char and Bitzinger, 2016; Zhang et al., 2020). According to SIPRI, there was an overall upward trend in global arms trading volume during 2007-2019, and the top five arms exporters in the world are the United States, Russia, France, Germany, and China. Compared to 2007, Chinese total exports of conventional arms have increased by 189%, revealing the huge breakthrough in arms exports. In conventional arms export market, Pakistan is the Chinese main buyer, and its purchases account for 55% of total conventional arms exports (SIPRI, 2021).

The Chinese defence industry has made gradual progress in improving the efficiency of its operations and the technological sophistication of its products. Recent organizational and policy reforms, including mixed ownership reform and asset securitization, have created incentives for managers to improve production capabilities and enterprise performance (Bitzinger, 2015). Besides, China allows civil defence enterprises into procurement process, private capital participate in state-owned defence enterprises to some extent, which means limited competition is introduced (Jing and Benner, 2016). Considering the CMI strategy, it has become a basic problem to accelerate the integration between defence industry and

non-state capital (Ng et al., 2018). Furthermore, different stages of development are found in LFEI, AFEI and NFEI, and subsequently produce great influence on their corresponding defence listed firms (Char and Bitzinger, 2016; Yoshihara and Holmes, 2017; Wang et al., 2018).

2.2. Capital Structure and Firm Performance

Prior studies explored the link between firm performance and capital structure, but the results are mixed. Most literatures indicate there is a positive relationship between them. Huang and Song (2006) express that higher debt leverage tends to have fast sales growth rate for Chinese listed firms. Detthamrong *et al*. (2017) demonstrate that an obviously positive nexus exists between asset liability ratio and firm performance. Fan (2019) shows that Japanese enterprises with more debt would present better performance on long-term. Sener *et al*. (2020) indicate that there is positive relationship between debt financing and firm performance in the countries with better credit market regulations and more efficient legal systems. However, some studies put forward an opposite conclusion. Chakraborty (2010) proves that profitability, size and uniqueness of Indian listed firms are negatively linked to debt leverage. Salim and Yadav (2012) establish that firm performances, such as return on asset (ROA) are negative link to debt leverage. Pirzada *et al*. (2015) find that firms with higher debt leverage would have heavier interest burdens, which eroded their profits. Vo and Ellis (2017) and Le and Phan (2017) argue that the cost of debt financing would exceed its benefits, which would bring negative influence on firm performance. Botta (2020) suggests that over-levelled enterprises are considered as riskier and therefore lose market power in favour of more solid competitors. Barbiero *et al*. (2020) confirm that excessive levels of debt are associated with a reduction in investment efficiency, and further influence enterprise performance in low growth opportunities. Other studies indicate that no nexus between capital structure and firm performance exists. Modigliani and Miller (1958) put forward “MM” theory that was regarded as the foundation, which covers that capital structure would not produce influence on firm value. Ebaid (2009) reveals that capital structure choice is irrelevant with Egyptian firm performance such as ROA and gross profit margin. Lim *et al*. (2018) find that the lower cost of debt does not always translate into improved enterprise performance. Mardones and Cuneo (2019) find that there is no robust evidence to prove the leverage would influence firm performance in Latin American companies.

However, there remains several research limitations in the published papers. First, existing theoretical and empirical research studies assume that there is linear and single positive, negative or no relationship between capital structure and firm performances (Detthamrong *et al*., 2017; Fan, 2019; Sener *et al*., 2020). This assumption ignores trade-off among different financing ways and is inconsistent with realities, which may generate the false results. The gap in this field is filled by Panel Threshold Regression Method (PTRM), driving more accurate conclusion. Second, according to the Table 1, most of the earlier studies focus on the capitalist system, while the inclusion of background planned economy and specificity of defence companies as factors in the nexus between capital structure and firm performance always remains ignored (Vo and Ellis, 2017; Le and Phan, 2017; Barbiero *et al*., 2020; Botta, 2020). However, compared with capitalist system, government policy, industry situation, reforms of mixed ownership system and uncertainties in the surroundings in communism have an impact on the empirical results. Meanwhile, compared with capitalist system, the development of the Chinese defence industry is closely related to the national and military polices, showing strong planning features. Last, industry heterogeneity is rarely noted in the most of the existing literature. Due to significant differences between land force,

air force and naval equipment industries in China (Char and Bitzinger, 2016; Yoshihara and Holmes, 2017; Wang et al., 2018), this study will enrich the literature and find out the result of the nexus between capital structure and firm performances for different Chinese defence industries. The external environment background of communism is considered in this paper.

Table 1. Comparison among cited studies with economic system and economic situation

Source	year	Country/region	Economic system	Economic situation (Unit: USD)	The relationship between capital structure and firm performance
Huang and Song	2006	China	communism	14.28 trillion	positive
Ebaid	2009	Egypt	capitalism	303.081 billion	no nexus
Chakraborty	2010	Indian	capitalism	2.871 trillion	negative
Gill *et al*.	2011	the U.S.	capitalism	21.433 trillion	positive
Salim and Yadav	2012	Malaysia	capitalism	364.681 billion	negative
Pirzada *et al*.	2015	Malaysia	capitalism	364.681 billion	negative
Detthamrong *et al*.	2017	Thailand	capitalism	544.264 billion	positive
Vo and Ellis	2017	Vietnam	communism	261.921 billion	negative
Le and Phan	2017	Vietnam	communism	261.921 billion	negative
Lim *et al*.	2018	China	communism	14.28 trillion	no nexus
Fan	2019	Japan	capitalism	5.065 trillion	positive
Mardones and Cuneo	2019	Latin American	capitalism	5.787 trillion	no nexus
Botta	2020	Europe	capitalism	15.634 trillion	negative
Barbiero *et al*.	2020	Europe	capitalism	15.634 trillion	negative

Note: Economic situation is described by the Gross Domestic Product (GDP) of each country in 2019, which dates from Word Bank.

3. The Optimal Capital Structure Model

According to the optimal capital structure model (Ardalan, 2017), debt and equity finance have a double nature. That is to say, too much or too little debt and asset finance have negative impact on firm performance, which is measured by ROA. This can be illustrated by starting with:

$$R_A = R_R + \left(R_R - R_D\right)\left(D/E\right) \quad (1)$$

where R_A, R_D and R_R represent return rate of asset holders, debt holders and real assets investment. D and E indicate debt and equity levels respectively. R_R is the rate of return on the investment in the real assets of the firm. R_A is the rate of return to the equity holders of the firm. Thus, R_D is a function of D/E, which is shown by $f\left(D/E\right)$, and $f^{'} = R_D^{'} > 0$, $f^{''} = R_D^{''} > 0$. We derivate right side of Equality (1) with respective

to D/E is equal to zero, and get $R_R - R_D - R_D^{'}(D/E) = 0$ to obtain the point when R_A reaches maximum at:

$$D/E = \left(R_R - R_D\right) / R_D^{'} \quad (2)$$

where $R_R - R_D$ is positive because firms would borrow only when the cost of debt is lower than the returns of real assets investment. $R_D^{'}$ is also positive. Hence, the right side of Equation (2) is positive, which defines a proper D/E , i.e., capital structure.

Then, we find that second derivative of Equation (1) is negative, which means D/E has an optimal level.

$$-R_D^{''}\left(D/E\right) - R_D^{'} - R_D^{'} = -\left[R_D^{''}\left(D/E\right) + 2R_D^{'}\right] < 0 \quad (3)$$

The Equation (3) is negative, which indicates that R_D would achieve maximum value, but it subsequently falls with more debt financing in the capital structure. Due to return of rate presenting Inverted-U form, it means capital structure exists at optimal level.

4. Methodology

Previous studies have different methods to discuss the link between capital structure and enterprise performance, but the results are confusing. Some methods, including structural equation model (Berger and Patti, 2006), quantile regression (Margaritis and Psillaki, 2010), Random Effects Regression (Vatăvu, 2015), Partial Least Squares (Ramli *et al*., 2019), are employed to investigate and find that there is a positive link between capital structure and enterprise performance. However, panel regression model (Ebaid, 2009) and Pooled Ordinary Least Squares (Le and Phan, 2017) hold the opposite conclusions, namely that debt financing would exceed its benefits, which would bring negative influence on enterprise performance. The major limitation of the above studies is that they assume the link is constantly either positive or negative. However, in reality, being affected by internal and external factors, the linear relationship may not be reliable (Yeh *et al*., 2010). In order to fill the research gap and obtain convincing results, we employ the panel threshold regression model (PTRM) to re-examine the link and provide evidence for optimal capital structure in LFEI, AFEI and NFEI.

The empirical approach is based on Hansen (1999) estimation and inference theory for non-dynamic panel data models. The PTRM is as follows:

$$y_{it} = \mu_i + \beta_1^{'} x_{it} \Omega\left(x_{it} \le \gamma\right) + \beta_2^{'} x_{it} \Omega\left(x_{it} > \gamma\right) + \varepsilon_{it} \quad (4)$$

where the indicator function is shown by $\Omega(\cdot)$, the optimal threshold value is demonstrated by γ , threshold variable is x_{it} . Time dimensions and cross-section are represented by the subscripts t and i respectively. ε_{it} is assumed independent and identically distributed with a finite variance σ^2 and zero mean.

Depend on whether the threshold variable x_{it} is larger or smaller than the threshold value γ, the observations are divided into two regimes. In both regimes, it is assumed that the individual effects μ_i are same. Therefore, differing regression slopes β_1 and β_2 can distinguish the two regimes. Equation (1) can also be written in following form:

$$y_{it} = \mu_i + \beta' x_{it}(\gamma) + \varepsilon_{it} \tag{5}$$

where $x_{it}(\gamma) = \begin{pmatrix} x_{it}\Omega(\tau_{it} \le \gamma) \\ x_{it}\Omega(\tau_{it} > \gamma) \end{pmatrix}$ and $\beta = (\beta_1' \beta_2')'$.

Empirically, the threshold regression model can be specified as follows:

$$ROA_{it} = \mu_i + \beta_1' CS_{it}\Omega(CS_{it} \le \gamma) + \beta_2' x_{it}\Omega(CS_{it} > \gamma) + \alpha_1 TA_{it} + \alpha_2 TE_{it} + \alpha_3 IE_{it} + \varepsilon_{it} \tag{6}$$

where enterprise index is denoted by $i = 1, \ldots, N$, the time index is $t = 1, \ldots, T$, μ_i is the enterprise specific effects and ε_{it} is the error term with finite variance σ^2 and zero mean. τ_{it} is represented by capital structure. Total assets (TA), total employment (TE) and institutional effect (IE) are regarded as explanatory regime-dependent variable, and $x_{it} = (TA_{it} TE_{it} IE_{it})'$. The dependent variable ROA_{it} indicates returns on assets for each enterprise i at time t.

5. Data and Sample

5.1. Sample Selection

The sample in this paper includes 87 defence enterprises listed on the Chinese stock market between 2007-2020. China put forward the CMI strategy in 2007, which accelerated the integration between defence industry and non-state capital. The final sample includes 3524 firm-quarter observations after excluding firm-quarters fall into the following kinds: companies undergoing bankruptcy or in severe financial distress, and firms with missing observations on the variables in the regression model. All of data are collected from the China Stock Market and Accounting (CSMAR) database and are winsorized at 1% and 99% to mitigate reporting errors. In terms of their industry, these firms can be classified into three different industries, including LFEI, AFEI and NFEI.

5.2. Data Description

Table 2 reports summary statistics of variables, including ROA, CS, TA, TE, IE, BS, EA and OS for LFEI, AFEI and NFEI, respectively. We find that the mean of capital structure for the above three industries are 0.701, 0.783 and 1.562, NFEI has the highest financial leverage, which indicates that Naval Force equipment enterprises are more dependent

on debt rather than equity financing, and it holds the first place in other three control variables such as TA, TE and IE. Meanwhile, LFEI has the highest BS, EA and OS, which indicates that Land Force equipment enterprises have large scale of business and long history of development. The Jarque-Bera test results indicate that the data series do not follow normal distribution. Skewness tests demonstrate that the variables follow positive skew that means the tail on the right side of the distribution is longer or fatter.

Meanwhile, the sample interval (2007-2019) covers the 11th to 13th Five-Year Plan, which includes Chinese authorities relevant defence industry reform policies during planned economy period. As one may see from Table 3, since 2007, the Chinese government has focused on advancing the shareholding reform of defence industrial enterprises, facilitating industry profits and ROA to rise up. During the 13th Five-Year Plan period, equity incentives and employee stock ownership plans are implemented in state-owned defence firms, which makes institutions remain upbeat on Chinese defence firms and high IE.

Table 2. Descriptive Statistics of the Variables

		Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
LFEI	ROA	0.015	0.008	0.028	1.257	6.789	213.954***
	CS	0.894	0.701	0.546	0.752	2.399	27.583***
	TA	26.907	24.085	25.329	2.903	14.773	1809.334***
	TE	2405.333	2035	1802.181	2.482	10.798	897.286***
	IE	0.349	0.306	0.229	0.282	1.826	17.821***
	BS	13.782	12.376	11.293	0.173	2.394	20.331***
	EA	21.342	19.652	20.921	1.823	2.902	17.293***
	OS	49.284	50.258	48.283	1.283	3.482	273.983***
AFEI	ROA	0.018	0.014	0.029	1.004	19.647	6243.623***
	CS	1.231	0.983	5.656	3.073	251.807	1375.644***
	TA	92.655	63.531	101.992	2.278	8.749	1195.182***
	TE	8018.058	6525	8680.315	2.077	7.649	863.327***
	IE	0.385	0.364	0.255	0.092	1.829	31.191***
	BS	10.073	11.732	12.674	0.293	3.832	22.392***
	EA	18.232	19.379	11.328	0.322	4.394	20.938***
	OS	45.232	46.525	32.632	0.482	3.829	22.302***
NFEI	ROA	0.012	0.009	0.019	0.622	9.137	215.645***
	CS	1.763	1.562	0.924	0.625	2.424	10.408***
	TA	508.224	108.145	728.073	1.304	2.964	37.404***
	TE	16013.421	7092	184.327	1.156	2.955	29.396***
	IE	0.526	0.551	0.139	1.071	5.251	53.089***
	BS	15.283	13.463	11.287	1.924	3.203	22.783***
	EA	20.272	21.267	19.678	0.892	2.934	30.827***
	OS	42.873	43.468	23.253	0.324	2.873	28.657***

*Note: *** indicate significance at 1% level*.

Table 3. Average of indicators for each five-year-plan in the period of 2007-2019

		The 11th Five-Year Plan (2007-2010)	The 12th Five-Year Plan (2011-2015)	The 13th Five-Year Plan (2016-2019)
LFEI	ROA	0.012	0.015	0.018
	CS	0.893	0.891	0.892
	TA	24.872	25.021	27.223
	TE	2342.2342	2402.3492	2593.9234
	IE	0.302	0.319	0.352
AFEI	ROA	0.013	0.017	0.019
	CS	1.293	1.027	1.243
	TA	90.293	91.304	93.276
	TE	7912.873	8023.829	8129.321
	IE	0.323	0.327	0.374
NFEI	ROA	0.009	0.013	0.014
	CS	1.672	1.778	1.682
	TA	498.242	518.382	529.315
	TE	14923.223	15672.392	16729.392
	IE	0.487	0.508	0.537

Even though essential reforms have carried out by China, but its military industry has distinctive characteristics. First, state-owned shares are in a dominant position. Therefore, these enterprises can easily generate hierarchy, bureaucracy and risk-aversion. Second, due to long-term self-closeness, Chinese military industry has formed the institutional, legal and technology barriers for private capital to enter (Guo and Zhao, 2017). Third, previous military reforms did not achieve the aim of enhancing competition among corresponding enterprises.

6. Empirical Results

6.1. Basic Regression Results

This paper employs PTRM to examine the threshold effect between capital structure and enterprise performance for LFEI, AFEI, and NFEI. Meanwhile, the possible asymmetric nonlinear relationship is entirely examined. Before using this approach, we need to make sure that all variables in different industries do not have unit root, to avoid spurious regressions problem and inaccurate parameters estimation. Both tests of LLC (Levin et al., 2002) and IPS (Im et al., 2003) are turn to account in order to investigate the unit root hypothesis of all variables. Table 4 indicates that ROA, capital structure, total assets, total employment and institutional effect reject the null hypothesis, and there is no doubt that all variables are stationary, i.e. $I(0)$. By analysing, we find that there are optimal capital structure levels in AFEI and NFEI, but not in LFEI. Table 5 shows that the threshold values are 1.968 and 2.011, and the corresponding p-values are 0.038 and 0.072. Meanwhile, Table 6 indicates that the estimated coefficients β_1 of capital structure are positive when they are below the threshold value, which means that both capital structure and ROA follow the same trend. However, when capital structure exceeds the threshold value, the coefficient

β_2 becomes negative. Hence, the threshold value is regarded as a turning point, which can distinguish different influences from capital structure.

Table 4. Panel unit root tests

		LLC test		IPS test	
		***t*-statistic**	***p*-value**	***t*-statistic**	***p*-value**
LFEI	ROA	-6.615***	0.000	-6.847***	0.000
	CS	-6.701***	0.000	-9.958***	0.000
	TA	-8.491***	0.000	-7.767***	0.000
	TE	-3.305***	0.001	-7.251***	0.000
	IE	-1.408*	0.079	-1.314*	0.081
AFEI	ROA	-12.068***	0.000	-13.015***	0.000
	CS	-2.781***	0.003	-3.056***	0.001
	TA	-13.661***	0.000	-13.674***	0.000
	TE	-12.833***	0.000	-12.328***	0.000
	IE	-3.693***	0.000	-2.101**	0.018
NFEI	ROA	-2.122**	0.017	-2.298**	0.011
	CS	-3.978***	0.000	-4.515***	0.000
	TA	-5.646***	0.000	-4.785***	0.000
	TE	-7.247***	0.000	-6.792***	0.000
	IE	-2.079**	0.019	-5.163***	0.000

*Note: *, ** and *** indicate significance at 10%, 5% and 1% level.*

Table 5. Tests for threshold effects between Capital Structure and ROA

	Single Threshold Effect Test		Double Threshold Effect Test		
	Threshold value	***F*-statistics**	**Threshold value**		***F*-statistics**
LFEI	0.715	5.487	0.417	0.715	4.135
AFEI	1.968	7.771**	0.464	1.968	5.875
NFEI	2.011	9.852***	0.982	2.011	4.811

*Note: p-value and F-statistics are obtained through repeating the bootstrap procedures 10,000 times for above two tests. ** and *** indicates significance at the 5% and 1% levels.*

Table 6. Estimated coefficients of Capital Structure for different military industries

	Coefficients	Estimated Value	OLS_{se}	t_{OLS}	$White_{se}$	t_{white}
LFE	β_1	2.199	1.462	1.504	1.431	1.537
	β_2	0.356	0.599	0.594	0.532	0.669
AFEI	β_1	0.074	0.028	2.643***	0.013	5.692***
	β_2	-0.091	0.046	-1.978*	0.039	-2.333**
NFEI	β_1	1.799	0.668	2.693***	0.632	2.847***
	β_2	-0.236	0.131	-1.802*	0.121	-1.951*

*Note: OLS_{se} ($White_{se}$) refers to homogeneous (heterogeneous) standard deviations. β_1 (β_2) shows that the coefficient estimates are smaller (larger) than the threshold value. *, ** and *** indicate significance at the 10%, 5% and 1% levels.*

6.2. Robustness Test

New control variables are added in this paper, rediscussing the threshold effect of capital structure on enterprise performance. Table 7 shows detailed description of these control

variables, including board size (BS_{it}), enterprise age (EA_{it}) and ownership structure (OS_{it}). Besides, ROA_{it-1} is also employed to endogenous problem. Table 8 indicates that these variables are subsequently added into estimating formula, which constructs the following panel threshold Models from (1) to (4).

Model (1):

$$ROA_{it} = \beta_1 CS_{it}\Omega(CS_{it} \le \gamma) + \beta_2 CS_{it}\Omega(CS_{it} > \gamma) + \alpha_1 TA_{it} + \alpha_2 TE_{it} + \alpha_3 IE_{it} + \alpha_4 BS_{it} + \varepsilon_{it}$$

Model (2):

$$ROA_{it} = \beta_1 CS_{it}\Omega(CS_{it} \le \gamma) + \beta_2 CS_{it}\Omega(CS_{it} > \gamma) + \alpha_1 TA_{it} + \alpha_2 TE_{it} + \alpha_3 IE_{it} + \alpha_4 BS_{it} + \alpha_5 EA_{it} + \varepsilon_{it}$$

Model (3):

$$ROA_{it} = \beta_1 CS_{it}\Omega(CS_{it} \le \gamma) + \beta_2 CS_{it}\Omega(CS_{it} > \gamma) + \alpha_1 TA_{it} + \alpha_2 TE_{it} + \alpha_3 IE_{it} + \alpha_4 BS_{it} + \alpha_5 EA_{it}$$
$$+\alpha_6 OS_{it} + \varepsilon_{it}$$

Model (4):

$$ROA_{it} = \beta_1 CS_{it}\Omega(CS_{it} \le \gamma) + \beta_2 CS_{it}\Omega(CS_{it} > \gamma) + \alpha_1 TA_{it} + \alpha_2 TE_{it} + \alpha_3 IE_{it} + \alpha_4 BS_{it} + \alpha_5 EA_{it}$$
$$+\alpha_6 OS_{it} + \alpha_7 ROA_{it-1} + \varepsilon_{it}$$

Table 7. The variables used in the study

Variables	Variable description	References
ROA	The ratio of earnings before interest and taxes to total assets	Yeh *et al*. (2010)
CS	The ratio of total debt to equity	Lu and Beamich (2004); Miglo (2007)
TA	Total assets	Shin *et al*. (2017)
TE	Total employment	Wang *et al*. (2003)
IE	The percentage shareholding by institutions	Chang *et al*. (2014); Lin and Fu (2017)
BS	A number of board directors, including a chairperson and independent directors	Chancharat *et al*. (2012); Bhagat and Bolton (2008)
EA	The natural logarithm of the number of years since the enterprise was listed	Coad *et al*. (2013)
OS	The proportion of common stock held by the top ten shareholders	Detthamrong *et al*. (2017); Margaritis and Psillaki (2010)

Table 8. The robustness test for adding different control variables

	Dependent variable	Threshold variable	Control variables
Model (1)	ROA_{it}	CS_{it}	$TA_{it},\ TE_{it},\ IE_{it},\ BS_{it}$
Model (2)	ROA_{it}	CS_{it}	$TA_{it},\ TE_{it},\ IE_{it},\ BS_{it},\ EA_{it}$
Model (3)	ROA_{it}	CS_{it}	$TA_{it},\ TE_{it},\ IE_{it},\ BS_{it},\ EA_{it},\ OS_{it}$
Model (4)	ROA_{it}	CS_{it}	$TA_{it},\ TE_{it},\ IE_{it},\ BS_{it},\ EA_{it},\ OS_{it},\ ROA_{it-1}$

Table 9 indicates the existence of threshold effect in different models of AFEI and NFEI, but not in LFEI, which is consistent with Table 5. Meanwhile, according to Table 10, for AFEI and NFEI, the estimated coefficients β_1 of capital structure are positive when they are below the threshold value, which means that both capital structure and ROA folow the same trend. However, when capital structure excesses threshold value, the coefficient β_2 becomes negative. Hence, it can be argued that the optimal capital exists for enterprise.

Table 9. Tests for the threshold effects between capital structure and enterprise performance

		Single-threshold effect test		Double-threshold effect test		
		Threshold value	*F*-statistics	Threshold value		*F*-statistics
LFEI	Model (1)	0.717	6.228	0.519	0.717	5.887
	Model (2)	0.711	6.792	0.517	0.711	6.396
	Model (3)	0.699	9.697	0.517	0.699	5.691
	Model (4)	0.701	5.734	0.493	0.715	4.158
AFEI	Model (1)	1.961	13.879*	0.575	1.961	4.801
	Model (2)	1.944	16.338**	0.555	1.944	5.531
	Model (3)	1.991	20.815***	0.611	1.991	4.884
	Model (4)	1.966	16.749**	0.569	1.966	4.112
NFEI	Model (1)	2.111	16.987**	1.237	2.111	3.715
	Model (2)	2.013	21.808***	1.113	2.013	4.161
	Model (3)	2.011	13.712*	1.231	2.011	4.827
	Model (4)	2.003	15.279**	1.101	2.003	5.672

*Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels.*

Table 10. Estimated Coefficients of Models

		Coefficients	Estimated value	OLS_{se}	t_{OLS}	$White_{se}$	t_{white}
LFEI	Model (1)	β_1	3.619	1.635	2.213**	1.591	2.275**
		β_2	0.681	0.661	1.031	0.572	1.191
	Model (2)	β_1	3.905	1.631	2.394**	1.556	2.509**
		β_2	0.662	0.656	1.009	0.577	1.147
	Model (3)	β_1	-6.236	1.995	-3.126***	2.623	-2.377**
		β_2	-0.801	0.522	-1.534	0.412	-1.944
	Model (4)	β_1	-2.488	1.421	-1.751	1.411	-1.763
		β_2	-0.028	0.529	-0.053	0.453	-0.062

		Coefficients	Estimated value	OLS_{se}	t_{OLS}	$White_{se}$	t_{white}
AFEI	Model (1)	β_1	5.748	2.818	2.039*	2.708	2.123*
		β_2	-1.556	0.503	-3.093***	0.343	-4.536***
	Model (2)	β_1	5.946	2.717	2.188*	2.112	2.815***
		β_2	-1.554	0.503	-3.089***	0.343	-4.531***
	Model (3)	β_1	5.111	2.713	1.884*	2.117	2.414**
		β_2	-1.468	0.505	-2.907***	0.351	-4.182***
	Model (4)	β_1	4.995	2.519	1.983*	2.799	2.047*
		β_2	-1.312	0.508	-2.583***	0.352	-3.727***
NFEI	Model (1)	β_1	0.865	0.425	2.035*	0.377	2.294**
		β_2	-0.758	0.351	-2.159**	0.325	-2.332**
	Model (2)	β_1	0.793	0.411	1.929**	0.396	2.003*
		β_2	-0.784	0.365	-2.148**	0.364	-2.154**
	Model (3)	β_1	1.078	0.554	1.945*	0.522	2.065*
		β_2	-1.048	0.392	-2.673***	0.378	-2.772***
	Model (4)	β_1	1.105	0.458	2.413**	0.401	2.755***
		β_2	-1.018	0.495	-2.057*	0.444	-2.293**

Note: β_1 and β_2 indicate the coefficient estimated values that are smaller and larger than the threshold value. ***, ** and * indicate significance at the 1%, 5% and 10% levels.

6.3. Empirical Results in Threshold Effects

In terms of Tables 5 and 9, it is noticed that threshold value in NFEI is higher than that in AFEI and the potential reasons can be summarized as follows. The first one is enterprise size. Due to large enterprises that are usually diversified, this brings a relatively lower bankruptcy risk (Titman and Wessels, 1988). Therefore, larger enterprises are usually considered to depend more on debt financing (Hang *et al*., 2018). From Table 2, we discover that the mean and median values are 508.224 and 108.145 in NFEI, which are higher than AFEI (92.655 and 63.531). Figure 1 also indicates that NFEI has the largest employment. That means enterprises in NFEI are larger, and indicates that these enterprises rely more on debt financing. The second one is profitability. A higher profitability would bring a stable cash flow stream, which would relieve financial stress and get more tax deduction (Cole, 2013). Figure 2 illustrates that the net profit margin on sales rate in NFEI is highest from 2007 to 2014, which contributes to the higher debt financing in this industry. The third is tangible assets. It is usually regarded as guaranty to borrow debts. When enterprises have more tangible assets, they obtain debt financing more easily (Chakraborty, 2010). Figure 3 points out that tangible assets in NFEI are larger than those in AFEI, hence, this factor plays a key role in financing decisions. The last one is state-owned shares. Shares that held by state are in dominated situation in most of these enterprises. Because of this inappropriate ownership structure, the supervisory board function with difficulty, which makes internal control problem a serious one (Guo and Zhao, 2017). Relying on this, the regulation and restraint are not effective, and these enterprises would avoid risks and prefer equity financing. Figure 4 highlights that the state-owned shares percentage for NFEI and AFEI are 56.1% and 61.5%, which is consistent with previous studies (*i.e*. Guo and Zhao, 2017) and it can be considered as major factor results in difference in capital structure.

Figure 1. Average employment for LFEI, AFEI and NFEI

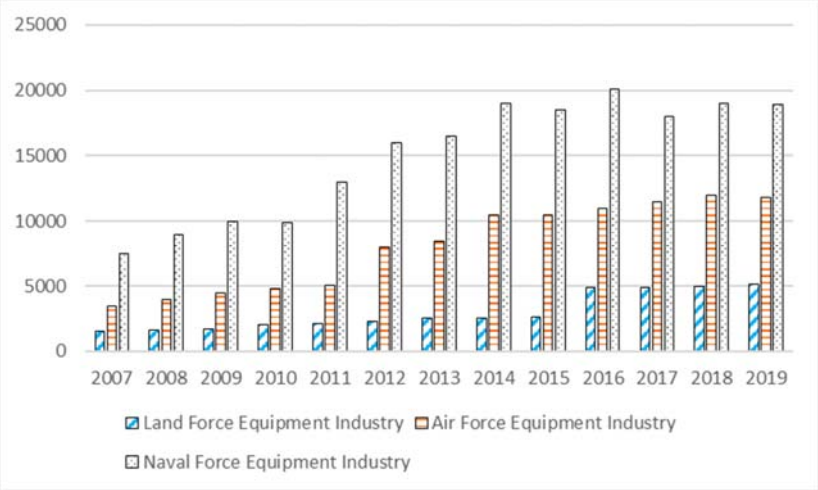


Figure 2. Net profit margin on sales rate for LFEI, AFEI and NFEI

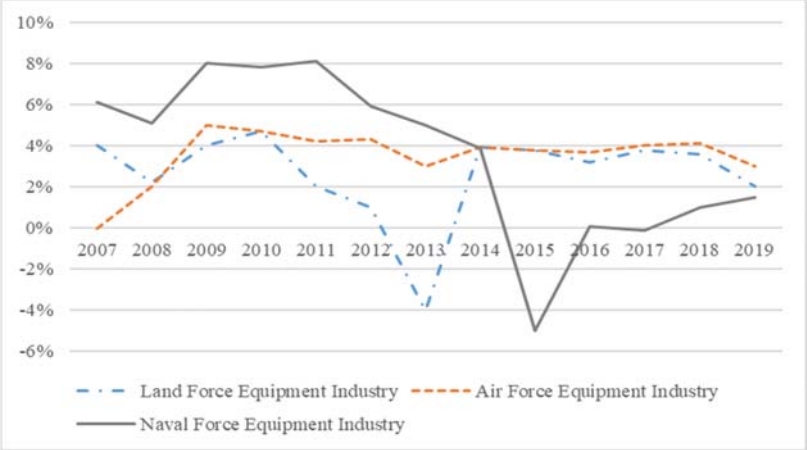


Figure 3. Average tangible assets for LFEI, AFEI and NFEI

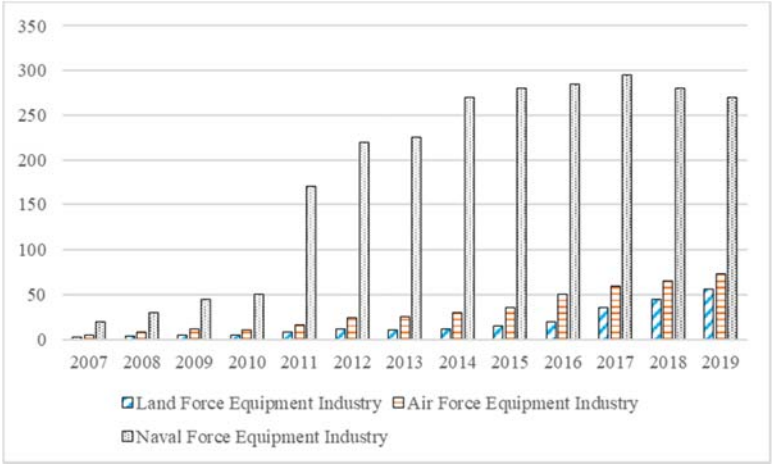
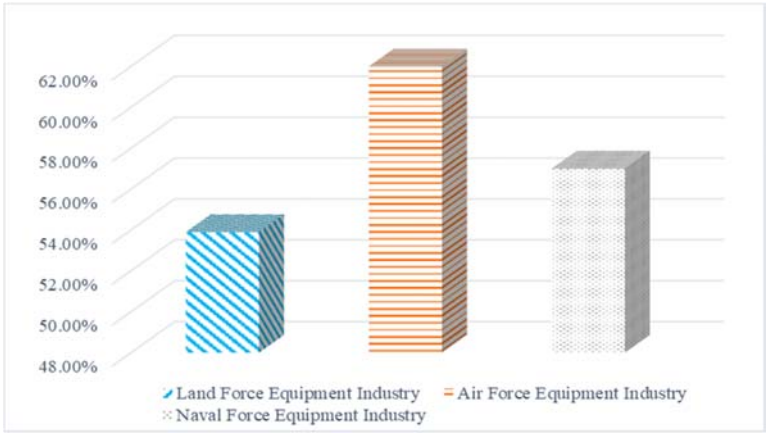


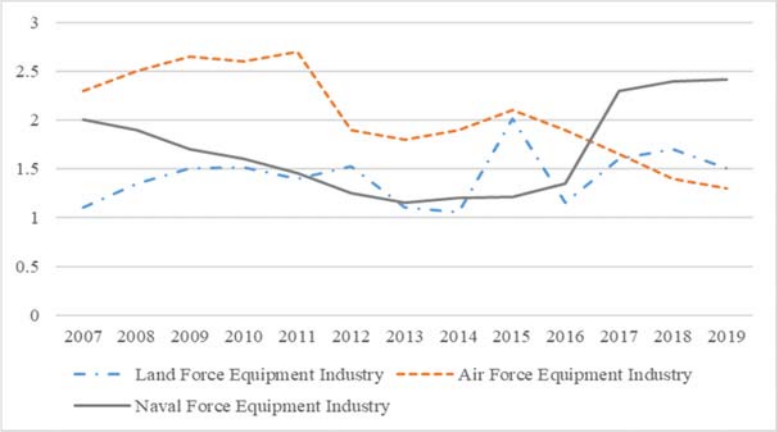
Figure 4. State-owned shares for LFEI, AFEI and NFEI in 2019



The equity financing is relatively important in LFEI, which can be contributed into the following reasons. The first one is mixed ownership reforms. In 2017, China South Industries Group issued "Guiding Opinions about Developing Mixed Ownership Economy", which focused on accelerating equity structure adjustment and strengthening capital operation. The second one is lower industry development level. China South Industries Group and China North Industries Group, controlling the most listed enterprises in LFEI, have lower asset securitization rate as compared to other military groups. Benefiting from the fact that these two major military groups are under development in the military industry group sequence, it will be the general trend for high-quality military assets to be listed through asset restructuring. At the same time, Land Force is now transformed from regional defence to all-field combat, which needs more quantity and higher quality weapons and equipment

and provides opportunities for this industry. The third one is high bankruptcy risk. Debt has a negative impact on the enforceability of relational contracts because too much debt increases the enterprise's reneging temptation. We find that enterprises in LFEI have low liquidity ratio (current assets are divided by current liabilities), as shown in Figure 5. The LFEI owns the lowest liquidity ratio in most years of the sample, which means enterprises in this industry have high bankruptcy risk, and hence, they prefer equity financing. The final is low debt capacity. In case of moral hazard, the debt capacity mainly depends on own capital, which means enterprises would obtain more debt financing when their own capital is higher. We find that the average growth rate of net assets is 15.851%, 20.192% and 31.901% for LFEI, AFEI and NFEI, respectively. It indicates that LFEI has weaker debt capacity compared with the other two industries, and prefer equity financing.

Figure 5. Liquidity ratio in LFEI, AFEI and NFEI



As shown in Table 5 and Table 9, there exists no optimal capital structure in LFEI. In addition, Table 10 further points that the parameter of β for LFEI in models 3 and 4 is negative. The phenomenon of no optimal structure and negative coefficients can be summarized in the following aspects. First, when meeting positive policy changes, enterprises could easily obtain funds from banks, which would influence their capital structure (Lee et al., 2017). China has begun to implement new round of military reforms. According to this, some enterprises, such as Inner Mongolia First Machinery Group Co., Ltd., are chosen as the reform units to carry out asset securitization, equity incentive, and appeal to non-state capital. Second, industry-situation does matter for enterprises in making financing decisions (Islam and Khandaker, 2015). Ministry of National Defence of the People's Republic of China (MNDPR) put forward strategic requirements of mobile operation and Omni-directional attack and defence system, LFEI has intensified reform, innovation and construction. Finally, most of Land Force equipment enterprises are subordinate to the China North Industries Group Co., Ltd (CNIG) and China South Industries Group Co., Ltd (CSIG). Hence, the reform is undergoing, which produces an inevitable impact on defence enterprises' capital structure. Meanwhile, China faces great uncertainties in the surroundings. Geopolitical risks are considered to have influence on equity returns in emerging and conventional stock markets (Caldara and Iacoviello, 2016; Bouri et al. 2018; Hu et al., 2022; Wang et al., 2022a; Wang

et al., 2022b). Consequently, it is often regarded as one of the determinants of financing decisions, that issue equities or bonds, which would further influence capital structure. Accordingly, being influenced by policy uncertainty, industry-situation, military reforms and geopolitical risks, the enterprises in Land Force equipment industry do not have optimal capital structure.

7. Discussion

This study tries to unravel the optimal capital structure model in different defence industries, including LFEI, AFEI and NFEI. Firstly, the empirical results indicate that the optimal capital structure is suitable for AFEI and NFEI, and the level of capital structure is higher in NFEI, these results are broadly consistent with the optimal capital structure theory. It is noticed that threshold effect does not exist in LFEI, which could be interpreted as a consequence of the enterprise size, profitability, tangible assets and state-owned shares. Combined with certain backgrounds, this phenomenon can contribute to military reforms in PLA, industry situation, reforms of mixed ownership system and uncertainties from surroundings. Secondly, industry heterogeneity is further considered. To differ from previous studies (Su *et al*., 2019), we divide defence industry into land, air and naval force industries. In terms of our analysis, there are huge differences, including assets, employment, profitability, state-owned shares and other factors, among these industries. Depending on the industry segmentation, we avoid heterogeneous problem, and obtain meaningful conclusions. Thirdly, this paper offers practical policies in terms of novel empirical results. Unique to Chinese defence enterprises, government should restrain from intervening in the issuance process. A better allocation of capital can only be achieved when enterprises are free to choose their financing strategies. Fourthly, according to the theory of optimal capital structure, enterprises should deepen their management reforms to reduce information asymmetry, balance the possible interest conflicts between debt and equity holders, and select prudent financing policies to maximize their enterprise performance. Finally, the link between capital structure and enterprise performance is newly investigated by advanced PTRM, which takes time factors into consideration, increases testing power and solves biased parameter estimation problem. This method enables us to determine the threshold effect and to identify the two regimes demarcating, where there are positive and negative capital structure rewards.

8. Conclusion

Compared with prior studies, we bring the following contributions. First, this paper reviews the reforms of Chinese defence industry and points out that the focus has transferred from nation to enterprises. Second, previous studies always assume that the link between enterprise performance and capital structure is linear. Hence, the panel threshold regression method is employed to investigate whether capital structure produces asymmetric effect on defence enterprise performance. Third, based on differences among LFEI, AFEI and NFEI, we find that optimal capital structure exists in AFEI and NFEI, but not in LFEI. Meanwhile, it is noticed that the optimal capital structures are different, which is explained by enterprise size, profitability, tangible assets and state-ownership. Besides, there is no threshold effect for LFEI, which can be contributed in military reforms in PLA, industry situation and uncertainties in the surroundings. Finally, the policy implications are provided. Debt financing should be allocated in appropriate proportion of capital structure, and aware of company bankruptcy risks. Reforms regarding mixed ownership and scientific research institutes, and

process of high-quality assets injecting into listed defence enterprises should be accelerated for LFEI.

The policy implications emphasized by our empirical results are shown as follows. For the AFEI and NFEI, due to existing optimal capital structures, enterprises can reasonably adjust their debt or equity to the target proportion to obtain better performance. At the same time, the percent of debt financing exceeds equity for AFEI and NFEI, respectively, indicating that these two industries prefer debt financing. Due to government protection, defence enterprises find it easier to borrow money from state banks. Hence, these enterprises should note the risks brought by high debt financing, such as bankruptcy. For the LFEI, because of uncertain policies, industry situations, mixed ownership reforms and other factors, there is no optimal capital structure. Hence, market-oriented enterprises should be built by accelerating asset securitization, injecting high-quality assets and incorporating social capital. Although the Chinese government has started to implement share split reforms, it still maintains ownership control and exerts great influence on capital structure. In recent years, the Chinese defence industry has faced intensive policies, such as CMI, and state-owned enterprises encounter government willingness and change their channels of financing. Hence, the capital structure will inevitably adjust with diversified sources of funding to maximize enterprise performance.

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