THE NONLINEAR RELATIONSHIP BETWEEN DEFENSE EXPENDITURE AND ECONOMIC GROWTH IN CHINA - AN EMPIRICAL ANALYSIS BASED ON MS-AR MODEL

ZHONGHOU GUO, **SIQI LIU**, **LIN JIN**
Military Economics Academy, 430035 Wuhan, China

Abstract: *This paper, which was inspired by Laurent Ferrara, chooses the time series for national defense expense accounts for the central fiscal expenditure ratio during 1953-2010 as the empirical data and uses MS-AR model to carry out regime switching test. The research shows that: the Classification Schedule obtained by using the model agrees with the actual case in China very well, which indicates that the time series for national defense expense accounts for the central fiscal expenditure ratio was indeed influenced by a potential variable-the National Strategy; Since 1989, China's national defense policy is defensive and the national defense construction is subject to economic construction, and the defense expenditure would not have substantial increase as long as there is no serious threat to national sovereignty and security.*

Keywords: *Defense Expenditure, Economic Growth, National Strategy, Markov-Switching AR Model, Non-linear relationship.*

1. PREFACE AND LITERATURE REVIEW

It has been proved by the past experience that: if a country hasn't allocated sufficient resources for national defense, then its defense couldn't guarantee the nation's security; if redundant resources have been allocated, then the defense would influence this country's economic progress.

Within the present framework of building a harmonious society, how to maintain a balance between national defense construction and economic development is an issue of great significance, which is closely related to the national security and the future economic and social development.

Researchers home and abroad have carried out extensive and in-depth researches on this issue. According to the present literatures, their researches provide significantly different results. For example, Benoit(1978) [1], Atesoglu and Mueller(1990) [2] think there is exterior positive correlation between defense expense and national economic growth. Yakovlev(2007) [3] and Pieroni(2008) [4] conclude that there is exterior negative correlation between defense expense and national economic growth.

Biswas, Ram(1986) [5] hold the point that there is no definite or obvious exterior correlation between defense expense and national economic growth. Gerhard and Ludger(2004) [6] think that: for a specific country, there must exist a threshold standard for defense expenditure. When defense expenditure is below the standard, the increase of it is beneficial to economic development; if defense expenditure surpasses the standard, the increase of it will hinder economic development. Wang Wanjun and Chen Xiaohe (2011) [7] adopted the time series data of China during 1952-2008 and used non-linear threshold regression model in their research. They found there is threshold effect between China's defense expense and economic growth. When the ratio of defense expense accounts for GDP is below 3.434%, the increase of the ratio has distinctive negative effect on economic growth when the ratio is bigger than 3.434%, the increase of the ratio will noticeably boom economic growth.

For a long period of time, economists always deemed that the relation between defense sector and economic sector was linear, therefore, linear evaluation methods, such as Least Double Multiplication or VAR Model, were frequently used in analysis.

However, Kinsella(1990) [8] pointed out that: there might essentially existed a certain non-linear relation between economic growth and relevant military variables. And this point of view was proved by the research results of Hooker, Knetter(1997) [9], Stroup, Heckelman (2001) [10] and Jesus, Gerhard (2004) [11].

From the angle of regime switching, this paper studies the co-relevance of defense expense and economic development by using non-linear method. We think that: it is impossible for a country to adopt unalterable strategies in coordinating defense construction and economic development. When the national and the international environment are undergoing dramatic changes, the national strategy might change correspondingly. To be more specific, during a certain period of time, this country might give priority to economic development rather than defense construction; while during another period of time, priority might be given to defense construction instead of economic development. The focus of the national strategy is shifting between defense construction and economic development, and this type of non-linear relation could be caught by using Markov-Switching Vector Auto-regression Modelwhich is abbreviated as MS-VAR. Markov-Switching Vector Auto-regression Model is deemed as one of the natural models representing the popularizing of non-linear-oriented traditional linear models. Laurent Ferrara(2003) [12] established VAR model by using four time series data: reciprocal of urban worker unemployment rate, production industrial index, employment advertisement index and construction expense index. Suppose economy cycle is a potential variable which is subordinated to the Three-regime Markov Chain Switching, then Markov-Switching Vector Auto-regression Model is established by combining VAR Model and Markov Regime switching model together. Smooth probability of three-regime switching is estimated by using MS(3)-VAR, thus researchers get the classification schedule of these three regimes. This schedule is quite similar to NBER' schedule of classifying economy cycle, which indicates that the chosen four macro time series are influenced by the switching of economy cycle.

This paper, which was inspired by Laurent Ferrara(2003) [12], chooses the time series for national defense expense accounts for the central fiscal expenditure ratio during 1953-2010 as the empirical data and uses MS-AR model to carry out regime switching test. The research shows that: during 1953-1967, the ratio of defense expense accounts for the central fiscal expenditure was small, and China gave priority to economic development rather than defense construction; while during 1968-1977, this ratio was high, and priority was given to defense construction instead of economic growth; and during 1978-2010, this ratio was small again, and priority was given to economic development instead of defense construction. The classification schedule acquired by using MS-AR Model agrees with the practical case of China quite well, which indicates that the time series for defense expense accounts for central fiscal expenditure ratio is indeed influenced by a certain potential variable, and this potential variable is national strategy. Meanwhile, from quantitative angle, the empirical result of this paper fully proves that the defense policy of China is defensive, and China's defense construction is subject to economic construction, and the defense expenditure would not have substantial increase as long as there is no serious threat to national sovereignty and security. Finally, in recent years, although China's defense expenditure has increased, the ratio of defense expense accounts for central fiscal expenditure is small. It testifies that recent increase of the defense expenditure is moderate and reasonable, and not excessive at all.

This paper has the following features:

(1) All of the present literatures demonstrate that defense expense growth of China in recent years is moderate and reasonable from qualitative perspective. While this paper uses calculation results to prove that defense expense growth is moderate and reasonable from quantitative perspective, which is more convincing.

(2) This paper illustrates the features of our country's defense policy with the calculation results from the model, which is a creative initiative.

The rest of this paper will include: part two is a narration of empirical model;

part three is about choosing variables and data description; part four is empirical analysis; part five is conclusion and policy signification.

2. INTRODUCTION TO EMPIRICAL MODEL

Markov-Switching Single Variable Auto-regression Model is a special case of Markov-Switching Vector Auto-regression Model. When the study object is composed of only one time series, MS-VAR model degenerates into MS-AR model. Despite the fact that MS-AR model is used from the beginning to the end of this paper, it is more scientific and general to introduce MS-VAR model which is relatively common as an empirical model.

According to traditional VAR model, the relationship between variables during sample period is invariable. However, in the real situation, the relationship between variables might change under the influence of multiple factors, such as exterior environment, the development of variables themselves, etc. And Markov-Switching Vector Auto-regression Model is widely adopted for it can better portray the non-linear dynamic relation of variables during sample period.

For K dimension VAR model which lags behind P order, there are two forms. One is the intercept type: y_0, y_1,…, y_{t-p} are fixed values,

$$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \quad t = 1,...,T,$$

$$u_t \sim i.i.d.N(0, \Sigma).$$

The other is the adjusted average type:

$$y_t - \mu = A_1(y_{t-1} - \mu) + \cdots + A_p(y_{t-p} - \mu) + u_t$$

, $u = \left(I_k - \sum_{j=1}^{p} A_j \right)^{-1} v$ is the Kx1 dimension average of y_t.

If time series is dominated by regime switching, then for observable time series vector y_t, its potential data generating process is depending on regime variable s_t.

In this study, it is supposed that $s_t = \{1,2\}$, and meets with state probability transferring matrix

$$P = \begin{pmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{pmatrix} \quad P_{11} + P_{12} = P_{21} + P_{22} = 1.$$

When the average of MS-VAR model is depending on s_t,MSM-VAR model is obtained; when the intercept item of MS-VAR model is depending on s_t, MSI-VAR model is obtained; when the auto-regression coefficients of MS-VAR model is depending on s_t, MSA-VAR model is obtained; when error item of MS-VAR model is heteroscedasticity, MSH-VAR model is obtained; if the average of MS-VAR model is depending on s_t, and at the same time error item is heteroscedasticity, MSMH-VAR model is obtained; if the intercept item of MS-VAR model is depending on s_t, and at the same time error item is heteroscedasticity, MSIH-VAR model is obtained. MSMH(2)-VAR(1) model, which has double regimes, lags behind Order 1, and whose average depends on s_t, and whose error item is heteroscedasticity, can be written in the following form:

$$y_t - \mu(s_t) = A_1(y_{t-1} - \mu(s_{t-1})) + u_t,$$

$$u_t \sim i.i.d.N(0, \Sigma(s_t)),$$

when $s_t = 1$,

$\mu(s_t) = \mu_1$;

when $s_t = 2$,

$\mu(s_t) = \mu_2$.

One-time change of the regime will immediately lead to a leap of process average, and the above formula could be changed into $y_t = v(s_t) + A_1 y_{t-1} + u_t$, $u_t \sim i.i.d.N(0, \Sigma(s_t))$,that is the MSMH(2)-VAR(1) model, which has double regimes, lags behind Order 1, and whose average depends on s_t, and whose error item is heteroscedasticity. With the change of average adjusted patterns and intercept form, different MS-VAR models have portrayed different dynamic adjusted patterns of the observable variables before and after regime switching.

MS-VAR model is the more generalized type of common VAR model. In the estimation result of MS-VAR, there is a LR linear test value. If this variable is significant, it indicates that adopting MS-VAR model in sample data is better than adopting common VAR model.If it is not significant, it indicates that common VAR model is better than MS-VAR model.

3. CHOICE OF VARIABLES AND DATA DESCRIPTION

3.1 Choice of variables and data description. If there is substantial change occurred to a country's defense strategy, the defense expenditure index could sensitively display this change. The defense expenditure accounts for central fiscal expense ratio is a universal index to measure defense expenditure burden.

In order to study whether the time series for defense expenditure accounts for central fiscal expense ratio is indeed influenced by national strategy, we choose the enforcement value of central fiscal expenditure and the enforcement value of defense expense during 1953-2010 as the empirical data. The source for the enforcement value of central fiscal expenditure is Statistic Yearbook of those years. Since Statistic Yearbook of 2012 has not been issued yet, the most recent data acquired is that of 2010. The enforcement value of defense expense is from the annual Defense Expense White Book of those years, and the enforcement value of 2010 defense expense is calculated from the relevant data contained in 2010 Defense Expense White Book.

Since the value of defense expense and the value of central fiscal expenditure are data of the same year, then the defense expense accounts for central fiscal expenditure ratio, which is acquired by dividing the annual defense expense with the annual central fiscal expenditure, has eliminated the influence of that year's inflation and could factually display the evolution of China's defense expense policy and national strategy.

3.2 Test of unit root. Before carrying out the empirical analysis, we first have unit root test on the time series for defense expense accounts for central fiscal expenditure ratio of various years by using ADF method. And the test result (which is listed in Table 1) indicates that the time series for defense expense accounts for central fiscal expenditure ratio is balanced.

Table 1.Unit root test on the time series for defense expense accounts for central fiscal expenditure ratio

Variables	I(c,t,d)	ADF statistics	Criticize of t(5% significance level)	There is unit root or not
Rate	(c,0,0)	-3.992825	-2.913549	I(0)

Note:c is the item with intercept,t means there is time tendency,d is lagging item.

4. EMPIRICAL ANALYSIS

In order to analyze the dynamic influence of national strategy change on the defense expense accounts for central fiscal expenditure ratio, we carry out single variable MS-AR model regime switching test on this ratio time series.

According to Krolzig(1997) [13], when the regime has switched, if the evolution path of average value is abrupt, it is advised to use MSM model series. If the national strategy is changing with the change of international and domestic environment, then we have reasons to believe that: when the national strategy changes, the evolution path of the defense expense accounts for central fiscal expenditure ratio is likely to change abruptly. Thus we use MSM model series as analyzing model.

4.1 Selecting MS-AR explanatory model. Krolzig(1997) [13] thinks that bottom-up Strategy should be followed rather than top-down Strategy in determining a process which is suitable for MS-AR model. Bottom-up Strategy starts with estimating MSM(M)-AR(P) or MSI(M)-AR(P) model which has less restrictions to find the most suitable explanatory model. Top-down Strategy starts with estimating MSMAH(M)-AR(P) or MSIAH(M)-AR(P) model which has more restrictions to find the most suitable explanatory model. If we follow top-down Strategy and first estimate MSMAH(M)-AR(P) or MSIAH(M)-AR(P) model, then we will run the risk of making likelihood function converge in local maxima. The reasons are as following: in estimating MS-AR model parameter, the principle followed in value calculation is finding a parameter which could maximize likelihood function in all. MSMAH(M)-AR(P) and MSIAH(M)-AR(P) model have distinctive and hyper-conventional statistical features which are quite different from that of MSM(M)-AR(P) and MSI(M)-AR(P) model. Moreover, these statistical features are hardly testable in theory. Therefore, it is especially important to choose initial value in estimating MSMAH(M)-AR(P) or MSIAH(M)-AR(P) model. Once computers have chosen inappropriate initial value, it will lead to likelihood function converge to local maxima.

Table 2. Determine P value in MSM(2)-AR(P)

Model type		Lagging order		
		Order 0	Order 1	Order 2
MSM(2)-AR	LogL	100.1357	119.2971	119.8961
	AIC	-3.2805	-3.9753	-4.0320
	HQ	-3.2114	-3.8918	-3.9339
	SC	-3.1029	-3.7603	-3.7788
	LR	20.6643 Chi(1) =[0.0000] ** Chi(3)=[0.0001] ** DAVIES=[0.0001] **	10.3480 Chi(1) =[0.0013] ** Chi(3)=[0.0158] * DAVIES=[0.0158] *	6.0931 Chi(1) =[0.0136] * Chi(3)=[0.1072] DAVIES=[0.1072]

Following bottom-up strategy, we first estimate MSM-AR model. Since theoretically, we deem there are two stages for national strategy: the stage in which economic development is subject to defense construction and the stage in which defense construction is subject to economic development. Therefore, we suppose M=2.

Next, we analyze lagging order P, and choose the optimal P value. The calculation result is listed in Table 2:

The LogL value of MSM(2)-AR(1) model is 119.2971,and the LogL value of MSM(2)-AR(2) model is 119.8961. R =2×(119.8961-119.2971)=1.198.

According to Krolzig(1997)it is known that R obeys $\chi^2(1)$, since $\chi^2_{0.9}(1)$=3.8415, under the condition that significance level is 5%, we do not accept the nullhypothesis, and we think P=1 is more suitable. When M=2, P=1, let's calculate other types of MSM(M)-AR(P) model, and the results are displayed in Table 3:

Table 3 .Choose suitable explanatory model

Model types		Lagging order	
		Order 0	Order 1
MSM(2)-AR	LogL	100.1357	119.2971
	AIC	-3.2805	-3.9753
	HQ	-3.2114	-3.8918
	SC	-3.1029	-3.7603
	LR	20.6643 Chi(1) =[0.0000] ** Chi(3)=[0.0001] ** DAVIES=[0.0001] **	10.3480 Chi(1) =[0.0013] ** Chi(3)=[0.0158] * DAVIES=[0.0158] *
MSMA(2)-AR	LogL	100.1357	98.8254
	AIC	-3.2805	-3.2219
	HQ	-3.2114	-3.1244
	SC	-3.1029	-2.9710
	LR	20.6643 Chi(1) =[0.0000] ** Chi(3)=[0.0001] ** DAVIES=[0.0001] **	-30.5954 Chi(2) =[1.0000] Chi(4)=[1.0000] DAVIES=[.NaN]
MSMH(2)-AR	LogL	101.5480	119.5010
	AIC	-3.2948	-3.9474
	HQ	-3.2117	-3.8499
	SC	-3.0816	-3.6965
	LR	23.4889 Chi(2) =[0.0000] ** Chi(4)=[0.0001] ** DAVIES=[0.0002] **	10.7559 Chi(2) =[0.0046] ** Chi(4)=[0.0294] * DAVIES=[0.0543]

MSMAH(2)-AR	LogL	101.5480	98.8254
	AIC	-3.2948	-3.1869
	HQ	-3.2117	-3.0754
	SC	-3.0816	-2.9001
	LR	23.4889 Chi(2) =[0.0000] ** Chi(4)=[0.0001] ** DAVIES=[0.0002] **	-30.5954 Chi(3) =[1.0000] Chi(5)=[1.0000] DAVIES=[.NaN]

Following the principle of maximizing LogL and minimizing AIC rule, HQ rule, SC rule, we make a choice between MSM(2)-AR(1) and MSMH(2)-AR(1). The LogL of MSM(2)-AR(1) is 119.2971, the LogL of MSMH(2)-AR(1)is 119.5010. R =2×(119.5010-119.2971)=0.4078.

According to Krolzig(1997) [4], it is known that R obeys $\chi^2(1)$. Since $\chi^2_{0.9}(1)$=3.8415, under the condition that significance level is 5%, we do not accept the null hypothesis, and think that MSM(2)-AR(1) is more suitable.

The LR test result of MSM(2)-AR(1) model shows that: LR linear test value is 119.2971, when the degree of freedom is 1 and 3, the significance level is 5% and 10% respectively, which indicates that non-linear model is better than linear model.

4.2 Smooth probability graph and regime switching period of MS-AR model.

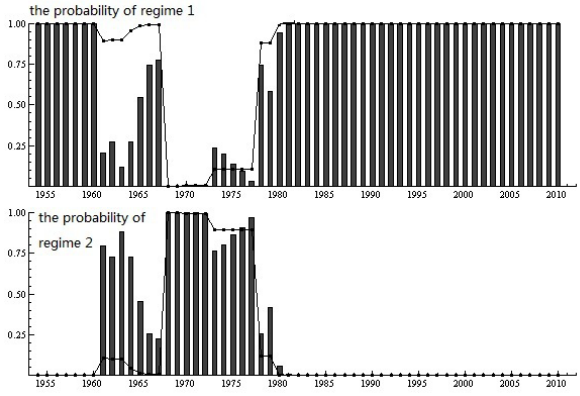

Fig. 1 Smooth probability graph and regime switching period classification

It could be observed from Fig. 1 that 1953-1967, 1978-2010 belongs to regime 1, and 1968-1977 belongs to regime 2.

4.3 Estimated coefficients of MS-AR model. Table 4 displays the estimation coefficients of defense expense accounts for central fiscal expenditure ratio MS-AR model. Data from this table demonstrates that: the average value of defense expense accounts for central fiscal expenditure ratio in regime 1 and regime 2 are both significant on the level of 1%, besides, in regime 1, it is 0.2839, and in regime 2, it is 0.3781. We could deem that regime 1 reflects the period when defense expense ratio is low, and regime 2 reflects the period when defense expense ratio is high.

Table 4.MS-AR model estimation coefficients

	ratio for defense expense accounts for central fiscal expenditure
Average value (period) of regime 1	0.2839***
Average value (period) of regime 2	0.3781***
ratio for defense expense accounts for central fiscal expenditure lags one order	0.494238***
standard deviation	0.025068

note: **means significance level is 5%,
***means significance level is 1%

During 1953-1967 (regime 1), the defense expense accounts for central fiscal expenditure ratio was low, which is a period when priority was given to economic development rather than defense construction. The reasons are as following: during 1953-1956, China has fulfilled Three Major Alterations; in 1956, the 8th assembly of Chinese Communist Party made the resolution that “the major conflict within the nation is the conflict between people’s demand on the rapid development of economy as well as culture and the real situation that present economy and culture couldn’t meet the demand of people”. This assembly also brought forward the task of building a socialist country comprehensively; Mao Zedong, in his essay On Ten Major Types of Relationship, put forward the basic guiding idea that military should give way to economy, and enhancing defense power by boosting economy; in 1957, the Central Military Commission passed Resolution on Reducing the Size of Army, Improving its Quality, and decided to reduce the population of army to 2.4 million in 1958, which was the smallest since the People’s Republic of China was founded;

During 1958-1962, China implemented its second Five-year Plan in economic construction; 1963-1965 was the period for national economy adjustment.

During 1968-1977 (regime 2), the defense expense accounts for central fiscal expenditure ratio is high. This was a period when priority was given to defense construction instead of economic development. There are mainly three reasons: firstly, from 1966-1976 there was Culture Revolution. During this period, from 1967 to1972 the People's Liberation Army of China adhered to the principle "three supporting and two armies" and maintained the social stability. The military had a great responsibility and defense expenditure increased. Secondly, Mao Zedong overestimated the seriousness of the international environment. From the middle of 1960s, with the breakup of China-Soviet Union relationship, China's security environment deteriorated, Mao Zedong deemed that World War was unavoidable and was around the corner. China started to implement development strategy which centered on war preparation. The whole country spared no effort to build "Three Battlefronts", and all the citizens were on alert and made preparations in case there was a war or famine. The army was also on high alert for a long time. Economic development gave way to defense construction, the size of army grew dramatically, and defense expenditure was huge. In 1969, the central government decided to establish national aerial defense leading panel and provincial or municipal aerial defense leading panel. Under the guidance of those organizations, there was a wide spread of digging bomb shelter among people. In 1972, the presentation of guideline slogan "dig deep hole, store large amount of grain, no hegemony" further boosted the hot tide of war preparation in China, which added the defense expense. Thirdly, local war directly increased defense expense. In 1969, there occurred Zhenbao Island self-defense battle. In 1974, there occurred Xisha island self-defense battle.

During 1978-2010 (regime 1), the defense expense accounts for central fiscal expenditure ratio is low, which was a period when priority was given to economic development rather than defense construction.

The reason is as following: in 1978, the Third Session of the Eleventh Central Committee of the Party determined that the focus of the party should be shifted to modernization construction of socialism. And this meeting is a starting point from which China entered a new era of renovation, opening to the outside and modernization construction of socialism.

The classification schedule obtained by using MS-AR model meets with the real case of China quite well, which indicates that time series for defense expense accounts for central fiscal expenditure ratio is indeed affected by a certain potential variable, and this variable is national strategy.

4.4 Regime switching probability matrix and status duration period of MS-AR model. Table 5 displays regime switching probability matrix and status duration period of MS-AR. Data in the table indicates that both regimes have high stability.

Table 5. Regime switching probability matrix and status duration period of MS-AR

	Regime 1	Regime 2	Sample number	frequency	Average duration period
Regime 1	0.9760	0.0240	46.9	0.8872	41.58
Regime 2	0.1891	0.8109	10.1	0.1128	5.29

If China is in a period when the defense expense accounts for central fiscal expenditure ratio is small, the lasting probability of regime 1 is 0.9760, the frequency for China stays in this period is 88.72%, and the average lasting period is about 42 years. If China is in a period when the defense expense accounts for central fiscal expenditure ratio is high, the lasting probability of regime 2 is 0.8109, the frequency for China stays in this period is 11.28%, and the average lasting period is about 5 years. The probability of China switching from regime 1 to regime 2 is 0.024, and the probability of China switching from regime 2 to regime 1 is 0.1891, the probability of switching between these two regimes has the feature of asymmetry. Observed from the perspective of average duration period, the period when the defense expense accounts for central fiscal expenditure ratio is high lasts only for 5 years, which is much shorter compared with the 43 years, during which the defense expense accounts for central fiscal expenditure ratio is small. Moreover, even during the period when the defense expense accounts for central fiscal expenditure ratio is high, Chinese government increased defense expenditure passively and defensively for the purpose of war preparation. Observed from the perspective of switching probability asymmetry, the probability of switching from regime 1 to regime 2 is low, which indicates that it is a normal state for China's defense expense accounts for only a small proportion in central fiscal expenditure, and there is hardly any substantial increase. Meanwhile, the chance for China shifting from the period when the defense expense accounts for central fiscal expenditure ratio is high to the period when the defense accounts for central fiscal expenditure ratio is small is eight times bigger than the chance of shifting from the latter to the former.

This means China is more likely to shift from the path of giving priority to defense construction to the road of focusing on economic development.

5.CONCLUSIONS & POLICY SUGGESTIONS

From the above study we know that: during 1953-1967, the ratio of defense expense accounts for central fiscal expenditure was low, and defense construction was subject to economic construction; during 1968-1977, the ratio of defense expense accounts for central fiscal expenditure was high, and priority was given to defense construction rather than economic construction; during 1978-2010, the ratio of defense expense accounts for central fiscal expenditure was low, and priority was given to economic construction instead of defense construction. And the classification schedule obtained by using MS-AR model meets with the real case of China quite well, which indicates that time series for defense expense accounts for central fiscal expenditure ratio is indeed affected by a certain potential variable, and this variable is national strategy. The period when the ratio of defense expense accounts for central fiscal expenditure is high lasts only for 5 years, which is much shorter compared with the 43 years, during which the ratio of defense expense accounts for central fiscal expenditure is low.

The probability for China shifting from the period when the ratio of defense expense accounts for central fiscal expenditure is low to the period when the ratio of defense accounts for central fiscal expenditure is high is quite slim. Meanwhile, the chance for China shifting from the period when the ratio of defense expense accounts for central fiscal expenditure is high to the period when the ratio of defense accounts for central fiscal expenditure is low is eight times bigger than the chance of shifting from the latter to the former.The analysis result of this paper shows that: in recent years, although our country's defense expenditure increased, China is still in the period when the ratio of defense expense accounts for central fiscal expenditure is small. Therefore, the recent increase of the defense expenditure is moderate and reasonable, and is not excessive. In addition, the empirical result of this paper fully illustrated that our country's defense policy is defensive. The defense construction of China is subject to economic construction, and the defense expenditure would not have substantial increase as long as there is no serious threat to national sovereignty and security.

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