Economics Model Analysis of Defence Expenditure and Economic Growth in the US

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Abstract. This paper expounds on the relationship between defence expenditure and economic growth. By selecting defence expenditure and economic indicators including GDP, gross value of imports and exports, fuel import and export value and foreign direct investment in the US from 1991 to 2010 as sample spaces, the paper is modeled on some analytical methods as ADF test, cointegration analysis and Grainger causality test. The paper analyzes the long-term equilibrium relationship between defence expenditure and economic growth, concluding that economic growth is the Granger cause of defence expenditure growth. Meanwhile, defence expenditure growth will have a positive impact on economic growth.

The relationship between defence expenditure and economic growth is one hot topic in modern economics and military economics. Chinese and foreign scholars have conducted discussion and modeling analysis on this issue from different perspectives. Zhoulai Lu [1] summarizes various research results between “defence expenditure” and “economic growth” both at home and abroad, and the typical models are “Keynesian model”, “Feder-Ram model” and “public products model”. Chen [2], Xiaopeng Tang [3], Zhongyan Wang [4] and Zhengqian Xu [5], etc. conduct modeling analysis on the relationship between China’s defence expenditure and economic growth with the methods of Grainger test and cointegration test, etc. Based on the samples of defense expenditure and important economic indicators in the US from 1991 to 2010, the thesis carries out a detailed modeling analysis and deliberates on this hot issue combined with the modeling results of the above thesis.

Empirical Research

Data Selection

The paper selects the US military expenditure (ME) as a measure of military power, chooses the US GDP as a measure of economic development, and selects total foreign trade volume (EX), fuel import and export value (OR) and foreign direct investment (CA) as the indicators measuring the degree of export-oriented economy. In order to eliminate the differences between different indicators caused by different measurement units, the writer of the paper unifies measurement units of all indicators as “one hundred million dollars”. The United States’ military and economic statistics from 1991 to 2010 is shown in Table 1[6,7]:

Table 1: Relevant economic indicators in the US from 1991 to 2010

Year	Military expenditure (ME)	Foreign trade (EX) (one hundred million dollars)	Fuel import and export (OR) (one hundred million dollars)	Foreign direct investment (CA) (one hundred million dollars)	GDP (one hundred million dollars)
1991	2803	9301	677.316	314	55541
1992	3051	10021	703.657	426.6	57109
1993	2976	10682	649.964	779.5	60277
1994	2881	12018	691.872	752.1	63370
1995	2789	13556	743.231	920.7	70384
1996	2714	15471	897.7	919	74187
1997	2763	15877	957.933	1218.4	78440
1998	2743	16265	1035.187	1461	87202
1999	2810	17522	1143.808	1425.5	92069
2000	3017	20412	1546.384	1426.26	98988
2001	3027	19083	1422.489	1139.8	100653
2002	4320	18963	1339.254	1197.4	104290
2003	4920	20279	1781.083	1518.8	109486
2004	5360	23454	2355.858	2224	116573
2005	5620	26338	3241.563	1530.69	125643
2006	5710	29547	3836.122	2216.64	131639
2007	5860	31686	4186.918	3137.87	138112
2008	6290	34569	4440.325	3304.91	142969
2009	6800	26613	3421.755	2480.74	138636
2010	6983	32474	4550.613	3289.05	144471

Due to the significant differences in the order of magnitude of various statistical indicators, there may be heteroscedasticity and violent fluctuation. In an attempt to eliminate the possibility of the existence of violent fluctuation, we deal with the natural logarithm processing of the above five indicators sequences. Then, after the selection of the logarithm, the sequence is expressed as LME, LEX, LOR, LCA and LGDP. The analysis of the relationship of these indicators in this paper is the quantitative analysis of the logarithmic sequence. The data of the selection of the logarithm of the above five indicators sequences is shown in Table 2.

Table 2: Natural logarithm of relevant economic indicators in the US from 1991 to 2010

Year	LME	LEX	LOR	LCA	LGDP
1991	7.938446	9.1378772	6.518137929	5.749392986	10.92488
1992	8.023225	9.21243817	6.556291022	6.055846806	10.95272
1993	7.998335	9.276315361	6.476916977	6.658652688	11.00671
1994	7.965893	9.394160805	6.539400967	6.622869294	11.05675
1995	7.933438	9.514584533	6.611006898	6.82513425	11.16172
1996	7.906179	9.646722583	6.799835937	6.823286122	11.21434
1997	7.924072	9.6726268	6.864777838	7.105293802	11.27009
1998	7.916807	9.696770839	6.942337366	7.286876412	11.37598
1999	7.94094	9.771212513	7.042118326	7.262277908	11.43029
2000	8.012018	9.923878242	7.343674581	7.262810913	11.50275
2001	8.015327	9.856553165	7.260163433	7.038608087	11.51943
2002	8.371011	9.850244991	7.199868022	7.087907818	11.55493
2003	8.501064	9.917341147	7.484976885	7.325675828	11.60355
2004	8.586719	10.06279634	7.764660271	7.707062655	11.66627
2005	8.634087	10.17876804	8.0838109	7.333473893	11.7412
2006	8.649974	10.29373749	8.252217239	7.703747815	11.78782
2007	8.675905	10.36363022	8.339720181	8.051299505	11.83582
2008	8.746716	10.45071261	8.398482851	8.10316452	11.87038
2009	8.824678	10.1891551	8.137908856	7.816312182	11.83961
2010	8.851234	10.38819505	8.423017228	8.098354048	11.88083

Sequence Stationarity Test

ADF test of the above five natural logarithm series is carried out with the help of EViews7. From the test results, the five sequences are all non-stationary and first order difference sequence is stationary. They were all integrated of order one I (I) and can carry on cointegration analysis.

Cointegration Analysis of Defence Expenditure and Economic Indicator

Adopting cointegration test on the basis of model regression residuals, the paper carries out cointegration test on natural logarithm sequence of defence expenditure and various major economic indicators in the US from 1991 to 2010. As a comprehensive indicators influenced by many factors, we can draw a conclusion that there will not be a very strict cointegration relationship between defence expenditure and economic indicators. Therefore, this paper chooses 10% instead of more strict 5% and 1% as the inspection of critical value, and test results is shown in Table 3:

Table 3: Analytical results of defence expenditure and economic indicators

Sequence	Regression model	T statistic	10% criticality	Conclusion
LME, LGDP	LME=-2.93+0.98LGDP	-2.13	-1.60	(1, 0) Cointegration
LME, LEX	LME=-0.66+0.77LEX	-1.59	-1.60	Non Cointegration
LME, LOR	LME=4.74+0.48LOR	-2.01	-1.60	(1, 0) Cointegration
LME, LCA	LME=5.06+0.45LCA	-1.68	-1.60	(1, 0) Cointegration

It is thus obvious that there is a long-run equilibrium relationship between defence expenditure and the economic indicators such as GDP, fuel import and export and foreign direct investment. Although there is no cointegration relationship between defence expenditure and total foreign trade volume in the model, the absolute value of T statistic is only 0.1 less than the critical value.

Granger Causality Test of Defence Expenditure and Economic Indicators

Granger Causality Test of LME and LGDP

Granger causality test results of the above two sequences with lagged value 2 by EViews7 is shown in Table 4.

Table 4: Granger causality test result of LME and LGDP

Null Hypothesis	Obs	F-Statistic	Prob
LGDP does not Granger Cause LME	18	5.95823	0.0146
LME does not Granger Cause LGDP		0.00147	0.9985

As shown above, we reject the first hypothesis “LGDP does not Granger cause LME” (i.e., LGDP is not the cause of the change of LME and the absolute value of F statistic is greater than the 1% critical value) because LGDP is the cause of the change of LME. But we should not reject the second hypothesis “LME does not Granger Cause LGDP” (i.e., LME is not the cause of the change of LGDP and the absolute value of F statistic is less than the 10% critical value).

Therefore, the law presented in the data in the US from1991 to 2010 is below: the change of GDP is the Granger cause of defence expenditure and the delay is two years.

Granger Causality Test of LME and LOR

Granger causality test results of the above two sequences with lagged value 1 by EViews7 is shown in Table 5.

Table 5: Granger causality test result of LME and LOR

Null Hypothesis	Obs	F-Statistic	Prob
LOR does not Granger Cause LME	19	1.74031	0.2057
LME does not Granger Cause LOR		2.77445	0.1152

As shown above, we don’t reject the first hypothesis “LOR does not Granger cause LME” (i.e., LOR is not the cause of the change of LME and the absolute value of F statistic is less than the 5% critical value). But we reject the second hypothesis “LME does not Granger Cause LOR” (i.e., LME is not the cause of the change of LOR and the absolute value of F statistic is greater than the 1% critical value) because LME is the cause of the change of LOR.

Therefore, the law presented in the data in the US from1991 to 2010 is below: the change of defence expenditure is the Granger cause of the change of fuel import and export, and the delay is one year.

Granger Causality Test of LME and LCA

Granger causality test results of the above two sequences by EViews7 is shown in Table 6.

Table 6: Granger causality test of LME and LCA

Null Hypothesis	Obs	F-Statistic	Prob
LCA does not Granger Cause LME	19	0.13646	0.7167
LME does not Granger Cause LCA		5.55235	0.0315

As shown above, we don't reject the first hypothesis "LCA does not Granger cause LME" (i.e., LCA is not the cause of the change of LME and the absolute value of F statistic is less than the 10% critical value). But we reject the second hypothesis "LME does not Granger Cause LCA" (i.e., LME is not the cause of the change of LCA and the absolute value of F statistic is greater than the 1% critical value) because LME is the cause of the change of LCA.

Therefore, the law presented in the data in the US from1991 to 2010 is below: the change of defence expenditure is the Granger cause of foreign direct investment and the delay is one year.

Conclusion

The paper conducts stationarity test, cointegration test and Granger causality analysis on military indicators and various economic indicators in the US from 1991 to 2010. It selects the indicator "military expenditure" representing military strength and four indicators representing economy: GDP, foreign trade, fuel import and export and foreign direct investment. The statistical analysis of the five data after selecting natural logarithm proves the relationships between them.

The original sequence of these five time series is non-stationary, but first order difference of them is stationary. It shows that they are not self-related sequences and the change is not simply influenced by time, but also influenced by other factors. So this conclusion is the basis of follow-up analysis.

We have analyzed the cointegration relationship between defence expenditure and four economic indicators. The analysis result proves that defence expenditure has cointegration relationship with all the four economic indicators. Though some cointegration relationship can show up only at levels of 5% or even 10%, which is not rigid cointegration relationship, this also shows the complexity of the relationship between military force and economic development. They are all affected by a great many factors and complete description of its change rules can not be fully delineated by these indicators. But our analysis demonstrates the overall relationship between military and various economic indicators.

By Granger causality analysis, we also find that GDP is the Granger cause of defence expenditure in the US from 1991 to 2010, and the effect of which is reflecting in the first year and second year after the change of GDP, mainly in the second year. In other words, defence expenditure will make constructive adjustments in the following one or two years when the main GDP indicators measuring American economy change. Clearly, the conclusion not only reflects the direct impact of the economy on military forces, but also shows that the US adopts the strategic initiatives

of revising defence expenditure vigorously to make it coordinate with economic development.

In addition, when doing Granger causality analysis, we find the change of defence expenditure is Ganger cause of fuel export and import and foreign direct investment in the US from 1991 to 2010. Namely, the last two sequences are the indicators chosen by as to measure the degree of economic openness. American's adjustment of defence expenditure will have positive effect on economic growth. While it should be point out that with regard to Granger causality test result, this kind of causality is not very distinct and economic growth is also affected by other factors.

To sum up, quantitative analysis of military force and economic indicators in the US from 1991 to 2010 embodies the following laws: after the change of GDP, the US will adjust defence expenditure actively in the following one or two years in order to make it coordinate with economy. In the mean time, the change of defence expenditure will have a certain impact on economic growth of the United States, which reflects dialectical relationship between military force and economic growth.

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