RESEARCH ON THE MOTIVATION OF CONVENTIONAL WEAPONS EXPORTING - EMPIRICAL ANALYSIS BASED ON PANEL MODEL

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Abstract: *Today the principal motivation for arms sales by key suppliers may be based as much, if not more, on economic considerations as those of foreign or national security policy. The exact relationship is examined by regression analysis of panel data, military expenditure and total demand during 1992-2011 for seven major exporting countries, which are USA, Western-European weapon suppliers (United Kingdom, France, Germany and Italy), Russia and PRC. The variant-coefficient and fixed-effects panel model is used to try to contain policy variables such as the development strategy of defense industry, military diplomacy as well as measurable variables such as military expenditure, in order to find out the variables' influence on arms export from empirical angle. This article reveals the evolution of major countries' arms export after the Cold War and provides some illustrations for participating in the global business of arms.*

Keywords: *Arms export, Export motivation, Empirical analysis.*

1. INTRODUCTION

In 21st century, the global arms sales revived after the doldrums of the very beginning, and maintain rapid growth in spite of the global economic crisis since recent years. The latest CRS report [1] indicated that the total orders of global arms have largely increased for this decade. We have to attach great importance to the phenomenon and what are reasons for this new round of arms sales? Based on the new development trend of arms trade theory of the last decade, the motivations of arms trade have switched from political and military factors to economic factors. The new classical trade model[2] indicated that the fundamental reason of arms trade is the different comparative advantages of each country; Anderton(1995) [3] explained the economic motivations of arms trade through scale economy and learning economy, etc.; Levine, Sen and Smith(1994)[4] attributed the cause of arms trade to economic interests and suppliers' reaction to recipient countries' behavioral safety;

based on the analysis of Snider(1987)[5], Pickar(2003)[6] indicated: international arms trade is good for saving the military expenditure. Bajusz and Louscher(1998)[7] defined the reasons of arms trade: maintaining domestic defense industry, keeping scale economy, reducing the research and development cost of arms etc. Finding out reasons of arms trade is relatively easy; however, establishing the theoretic and empirical study framework is very hard. In this article, the authors attempt to analyze arms sales' causes of major countries after the Cold War from the economics angle; use the method of empirical studies based on panel data and depict the real intentions of major arms exporting countries.

2. DATA SOURCES AND MODEL SPECIFICATION

2.1 Data sources. We need to strictly define the "arms", which mainly refer to conventional weapon systems here, because it is comparatively easy to get statistics of conventional weapons transaction.

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According to the rank of conventional weapons' exporting countries offered by Stockholm International Peace Research Institute, we selected seven post-Cold War biggest conventional weapons' exporting countries (the USA, Russia, UK, France, Germany, Italy and PRC) as empirical study's objects. All data of arms export and military expenditure in this article are from weapon transaction database and yearbook of Stockholm International Peace Research Institute [8]. We collected those seven countries' data of arms export and military expenditure from 1992 to 2011, the export data are measured in constant US dollar of 1990, and the military expenditure data are measured in constant US dollar of 2010, both of these two time series eliminate effects of exchange-rate fluctuation and inflation, and have longitudinal comparability.

1.2 Variable selection

2.2.1 Strategic variable. Supporting and promoting the development of defense industry is a salient factor to affect the arms export of big countries, and also a variable that we tried to control in the regression analysis, however this strategic variable has non-observability, so we have to find a suitable proxy to describe. Generally speaking, equipment purchase and R&D expenditure are directly related to the realization of the defense industry development strategy. However it is difficult to obtain the internationally comparable data of time series about equipment procurement and R&D expenditures, on the contrary, the data of military expenditures are easier to get. So we selected military expenditure as the proxy variable for defense industry development strategy.

2.2.2 Economic variable. Investigating the economic factors of each country's real level of arms export can be explained separately from supply side and demand side:

1. Variable reflects supply capacity. The major factor that affects the supply of conventional weapons is not the price, but each country's technology and production scale of arms. The more advanced the technology and the stronger production capacity of arms, and the stronger supply capacity is.

Arms production processes have the features of scale economy, and assume that the price of investment is fixed, when production increased, scale economy can lead to a decrease of unit cost, so the scale economy is one of strong causes for arms export.

2. Variable reflects demand level. The actual sales volume is also affected by the total demand. Different from general merchandise trade, the core factors that affect the demand of arms are not price and exchange rate, but each country's security environment, and safety menace confronted with such as arms race, regional wars and conflicts. Moreover, the common macro-economic factors, such as global economic periodic change, and the fluctuation of international oil price can affect the total import demand of arms. In this article, we use the global total import volume (or total export volume) of arms to represent the total import demand of arms.

2.3 Specification of Model. Due to many qualitative factors, we consider establishing Fixed Effects Panel Model. In the selection of independent variables, we choose military expenditure and total demand for sure. Military expenditure represents strategic factor affecting arms export, while total demand stands for economic factor affecting arms export. It is not easy to decide which of the rest factors should be controlled. Jeffrey M. Wooldridge (2009) [9] thought, 'we should add such explanatory variables which influence the dependent variable but are not relevant to the existing independent variables.' In accordance with this criterion, we can exclude the world price of weapons, since price and demand are existing obvious linear relationship in theory. We also can give up world economic cycle, global security situation, and global oil price. These variables are directly relevant to aggregate demand of arms. According to the analysis above mentioned, we could simplify the model as follows:

$$\ln ex_{it} = c + \beta_1 \ln milt_{it} + \beta_2 \ln WD_{it} + \alpha_i + u_{it}$$
$$i = 1 \cdots n, \quad t = 1 \cdots T \tag{1}$$

$\ln ex_{it}$ is the log value of a country's arms export in a year; $\ln milt_{it}$ is the log value of a country's military expenditure in a year; $\ln WD_{it}$ is the log value of total demand in a year. We adopt Log-Log Model, because coefficients in log-log model represent elasticity in economic sense. Random variable α_i in this equation indicates unmeasured or unquantifiable factors concerning to individual country, such as subsidy policy for defense industry, arms control policy, the technological level for producing arms, and scale of production. c is intercept, u_{it} is stochastic error term.

3. EMPIRICAL ANALYSIS

1.1 Panel unit root and cointegration test

The panel data in this paper is large T and less N, to ensure that the equation is not spurious, it's important to test for nonstationarity. We use Eviews 7.2 to conduct panel unit root test, and table 1 shows the results:

Table 1. Panel unit root t

variables	method	type	results	P-value
$\ln ex_{it}$	LLC	(c, 0, 2)	-2.80733	0.0025*
	IPS	(c, 0, 2)	-2.67736	0.0037*
$\ln WD_{it}$	LLC	(c, 0, 0)	1.84661	0.9676
	IPS	(c, 0, 0)	0.44852	0.6731
$\ln milt_{it}$	LLC	(c, 0, 3)	0.95708	0.8307
	IPS	(c, 0, 3)	0.74072	0.7706
$D(\ln WD_{it})$	LLC	(c, 0, 0)	-3.51975	0.0002*
	IPS	(c, 0, 0)	-5.4061	0.0000*
$D(\ln milt_{it})$	LLC	(c, 0, 2)	-4.45744	0.0000*
	IPS	(c, 0, 2)	-4.28316	0.0000*

Note: * indicates 5% level of significance

We here adopt homogeneous panel unit root test method LLC and heterogeneous panel unit root test method IPS.

Table 1 indicates that dependent variable $\ln ex_{it}$ is stationary at the 1% level of significance, while $\ln WD_{it}$ and $\ln milt_{it}$ all accept null hypothesis, so the two series both have unit roots. First difference of $\ln WD_{it}$ and $\ln milt_{it}$, we get new variables $D(\ln WD_{it})$ and $D(\ln milt_{it})$; these two variables reject null hypothesis of having unit root at 1% level of significance, indicate the first differentiated variables are stationary.

The independent variable is integrated of order zero, however, two explanatory variables are integrated with order one.

What shall we do? Even though two independent variables are non stationary, it is possible for linear combinations of non stationary variables to be stationary and making the error term of the equation stationary. Therefore, we can carry out cointegration test.

Table 2. Panel cointegration test

Pedroni	Panel				Group		
statistics	v	ρ	PP	ADF	ρ	PP	ADF
t-value	-0.1	-1.4*	-3.8*	2.0*	-0.28	-4.8*	-1.8*

Note: * indicates 5% level of significance

Table 2 indicates that Panel v-Stat and Group ρ-Stat accept null hypothesis, nevertheless the rest five statistics reject null hypothesis at 5% level of significance. All in all, we think these variables are cointegrated and have long-run equilibrium relationships.

1.2 Selection of panel models

There are three different kinds of panel models, Type one is a model with varying coefficients and intercepts; Type two is with same coefficients but disparate intercepts; and type three is a model whose coefficients and intercepts are all the same.

The first step to establish a panel model is to make sure which type it belongs to. We can first estimate restricted model, define F statistic, and carry out joint hypothesis test.

The two multiple hypotheses are as following:

H1: $\beta_1 = \beta_2 = \cdots = \beta_N$

H2: $\alpha_1 = \alpha_2 = \cdots = \alpha_N$, $\beta_1 = \beta_2 = \cdots = \beta_N$

First, we estimate three kinds of model respectively, and get sum of squared residual $S_1 = 15.9$, $S_2 = 19.9$, $S_3 = 93.6$.

By computation, we get $F_1 = 2.48$, $F_2 = 32.23$ Given 5% level of significance, the critical value of F statistic is $F\alpha_2 (18, 119) = 1.69$, $F\alpha_1 (12, 119) = 1.83$. Since $F_2 > 1.69$, we reject H_2; $F_1 > 1.83$, we reject H_1.

Therefore, in our paper, the model should be type one, that is, variant-coefficient model.

The result illustrates the arms export can not only be affected by cross-section unit, but also have structural difference among different countries.

It is easy to explain that the seven biggest arms export countries have distinct economic and political regimes, experience different stages of economic development. Hence variant-coefficient model can better fit the data and explain the diversity of country's structure.

1.3 Regression results

We know in this paper, α_i represents subsidy policy for defense industry, arms control policy, the technological level for producing arms, and scale of production. These omitted variables are obviously correlated with the explanatory variables in the model; therefore, fixed effects panel model is preferred here.

Table 3: estimates of variant-coefficients and fixed-effects panel model

Variables	estimates	t-statistics	variables	estimates	t-statistics
Milt_us	-0.91	-2.42*	WD_us	2.00	3.33*
Milt_rus	0.35	1.45	WD_rus	-0.6	-1.00
Milt_uk	-1.88	-2.52*	WD_uk	0.51	0.87
Milt_germ	-0.97	-0.95	WD_germ	0.72	1.24
Milt_fran	-3.08	-1.36	WD_fran	1.03	1.76**
Milt_ita	2.27	1.89**	WD_ita	2.23	3.06*
Milt_cha	0.08	0.63	WD_cha	1.17	2.00*

Note: * indicates 5% level of significance, ** indicates 10% level of significance.

In Table 3, R^2=0.90, adjusted R^2=0.88, the estimated model fits the data well. We also find that the coefficient of military expenditure is statistically significance for USA, UK and Italy and the coefficient of total demand is statistically significance for USA, France, Italy and China. Given distinct volume of arms export of these countries, the model may have cross-section heteroskedasticity. Besides, NATO member nations usually are involved in collaborative development and production of weapons and abide by the same export control rules.

European Union member nations have similar national industrial and market structure, they intend to organize arms export cartel, and easily reach collective agreements in quality and quantity.

Hence, the volume of arms export in allies must be correlated at the same year. By observing Variance-Covariance Matrix of residuals, we do find cross-sectional heteroskedasticity and contemporaneous correlation in the residual matrix, so the estimates of model are biased and do not satisfy properties of BLUE. In order to get rid of them, we use the method of SUR, the feasible generalized least squares estimator; then we get new estimates of model as follows:

Table 4: estimates of adjusted variant-coefficients and fixed-effects panel model

variables	estimates	t-statisticals	variables	estimates	t-statisticals
Milt_us	-0.79	-7.02*	WD_us	1.96	8.08*
Milt_rus	0.46	2.48*	WD_rus	-0.65	-1.04
Milt_uk	-1.67	-6.31*	WD_uk	0.49	2.17*
Milt_germ	-2.1	-2.42*	WD_germ	0.72	2.29*
Milt_fran	0.4	0.27	WD_fran	0.95	1.69**
Milt_ita	1.63	1.59	WD_ita	2.00	3.12*
Milt_cha	0.19	2.50*	WD_cha	1.12	1.43

Note: * indicates 5% level of significance, ** indicates 10% level of significance.

In Table 4, after eliminating cross sectional heteroskedasticity and contemporaneous correlation, R^2=0.982, adjusted R^2=0.98, the overall-fitness of estimated model has been noticeably improved. The significance of single variable is also enhanced. Estimation results of adjusted model are better than origin model for both overall-fitness and single variable significance.

Since these three variables are cointegrated and we can first explain long-run relationship between arms export and military expenditure based on empirical results. (1)For US, UK and Germany, the relationship between arms export and military expenditure is negative, that is to say, military expenditure decreases 1% with every 0.79%, 1.67%, 2.1% increase of arms export respectively. (2) For Russia and China, the relationship between arms export and military expenditure is positive and statistically significant, that is, defense expenditure increased 1% with every 0.46%, 0.19% increase of arms export. (3)When dealing with France and Italy, the linear relationship between arms export and military expenditure is insignificant.

It shows that arms export of the two countries does not economize their military expenditure, and does not exert additional pressure on it either. (4)Focusing on the elasticity of arms export to total demand, we find that for US, UK, Germany, France and Italy, there exists significant positive relationship between arms export and total demand, that is, total demand increases 1% with every 1.96%, 0.49%, 0.72%, 0.95%, 2% increase of arms export. From the perspective of significance of estimates, U.S. and Italy are the most significant. When concerned with the value of coefficient, Italian arms export is most sensitive to the change of total demand, and the next is U.S. (5)In contrast, for Russia and China, there does not exist significant linear relationship between their arms export and world demand on weapons.

4. CONCLUSIONS

First, the market share and technological sophistication collectively determine the saving effect of arms export on military expenditure. According to empirical results, the negative relationship between arms export and military expenditure for US, UK and Germany reflects their strong defense industrial base and advanced weapon R&D and production technology. They have developed into stage of expanding arms export to promote saving on military expense. During the post-Cold War, the three developed countries gain abundant profits through arms exporting, on the one hand economize procurement expense of weapons, and on the other hand finance for high-tech weapons R&D, so alleviate the pressure of military expenditure.
Second, there maybe exist positive relationship between arms export and military expenditure. Generally speaking, high military expenditure means sufficient procurement and R&D funds which will maintain the defense industrial base. Moreover scale economy and study economy plus high input of R&D will keep weapon industry possess cost and technology advances which will further promote weapons export.

The empirical results of Russia and China conform to the rationale above mentioned. Whether Russia is at the stage is doubtful. It can be interpreted that steady policy of high military expenditure seems to neutralize the savings brought by the arms export. But China is definitely at the stage because weapons made in China cannot compete with western developed countries and Russia in either sophistication or maturity.

Third, for western developed countries, their arms exports are all sensitive to the change of total demand. It can be inferred that their market shares are quite high in the international arms market and they have developed an especially large and diverse base of arms equipment clients globally. Once global security and economic circumstances has changed, such as local wars breaking out, recovery of economy or accumulation of much oil dollars, western countries can increase their orders immediately.

Meanwhile we can speculate their elasticity of weapons production is quite high, when faced with fluctuation of demand, they can promptly adjust the volume of production; provide timely delivery and effective service to assure their clients.

This indicates that in the major western developed nations, the policy of civil-military integration and the strategy of boosting defense industry by arms export have made remarkable effects.

Fourth, Russian arms export does not have saving effect on military expenditure. The technological advancement of Russian armaments cannot be compared with its western competitors, so Russia mainly depends on competitive price to expand its arms customer base and profits gained are relatively low. Besides Russia has pursued "strong defense" strategy, and hoped to revitalize military industry as the engine of economic growth. Therefore, its constant high military expenditure neutralizes the economy caused by weapons export, and the relationship between the two variables appears positive. Otherwise the empirical results show that its arms export is not sensitive to the change of demand.

We find that the sales orders of Russia mainly come from two big Asian clients for a decade, that is, China and India. Especially in recently years sales to the two countries take up above 80% of all its exporting volume. Even though Russia has gained lasting and stable orders from the two countries, but highly dependence on Chinese and Indian market leads to its exporting market too much narrow and concentrated, which is the main cause why Russian weapons export is not sensitive to the demand fluctuation of the world market.

Fifth, As for China, under the pressure of western advanced equipments and Russian dumping of cheap weapons, the situation China faced is much severe. In order to keep up with the competitors, China needs to increase R&D funds and usually purchases high-tech equipments from foreign countries, and this undoubtedly leads to pressure on military expenditure. On the one hand, we find that China is not sensitive to the change of demand. it shows that Chinese weapon production mainly meets the demand of its own armed forces, and rarely treats the international sales as important. It reflects that weapons made in China are not competitive enough to gain favor of the international clients.

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