

## THE IMPACT OF DEFENSE EXPENDITURE ON ECONOMIC PRODUCTIVITY IN APEC COUNTRIES

Zhou Dongming, Liu Siqu

Military Economics Academy, Wuhan, China

**Abstract:** *Evaluating the effects of defense spending on macroeconomic performance, in particular, on economic productivity is a critical issue. This study integrates Malmquist Productivity Index (MPI) with bootstrapping to establish statistical inferences that provide a complete, effective analysis of the impact of defense expenditure on economic productivity between 1990 and 2010 for APEC countries. The findings indicate that the average MPI with defense expenditure is higher than that without defense expenditure. Additionally, region based productivity analysis indicates that the appropriate allocation of defense expenditure can increase regional economic productivity effectively across Americas, Oceania and Asia. Moreover, the results further prove that the effective defense expenditure strategies undertaken by government are important for improving economic productivity of countries.*

**Keywords:** *Defense Expenditure; Economic Productivity; APEC*

### 1. INTRODUCTION

Defense expenditure is an important part of government spending on defence spending, defense spending at the same time limited by the size of the country's fiscal situation, the country's fiscal situation ultimately depends on the level of economic development. Therefore, a higher level of economic development can lead to more resources into national defense spending. De Grasse (1993) confirmed that defence spending can create jobs, increase purchasing power, to promote economic growth. Benoit (1978) demonstrated that increased defense spending is beneficial to the formation of human capital, especially in developing countries, soldiers are generally with a good physical training, and trained in a variety of military skills, which is conducive to economic growth. Moreover, Ram (1996) reviewed the defense will guide effect, whole construction machinery industry also has on economic growth, for example by building highways, airports, docks and other infrastructure to promote economic development. So, in the long run, defense spending, directly or indirectly promote the economic growth.

But the Deger and Smith (1983) in this paper, the increased defence spending will hinder the economic growth, Sivard (1996) also suggests that the same point of view, think that defence spending away from other economic activities (such as education and health spending). Safdari et al. (2011) argue that in developing countries, there is no clear correlation between defense spending and economic growth, but in industrialized countries, a one-way or two-way link between the two. Chang et al. (2011) using Feder - Ram and he Keynesian model, by studying the multinational economic development model found that defense spending is crowding out effect on economic growth. Feridun et al. (2012) further confirm although defence spending is positive or negative effect on economic growth, but the core values of defense spending is to protect national security.

Background, geographical conditions, historical development around the world differ in thousands ways of resources endowment, each country internal politics and foreign aggression levels are also different. So, the relationship between the countries on defense spending and economic growth are different.

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Therefore, select a representative sample of regions and countries as analysis object, dig deep relationship between, it is very necessary.

Asia - Pacific Economic currency(APEC) is important in the asia-pacific region Economic Cooperation BBS, also is the highest level of inter-governmental Economic Cooperation mechanism in the asia-pacific region. In promoting regional trade and investment liberalization, strengthen economic and technical cooperation between members played an irreplaceable role. APEC beginning in 1989, until now there are 21 member economies. APEC is created for people in the region of stability and prosperity in the future, set up the asia-pacific economic family and make great contribution to the world economy. This paper is intended to study the effect of APEC national defense expenditure to the economic productivity, temperament, summed up the intrinsic link between defense spending and economic growth.

With appropriate analysis object, also must use the appropriate research methods, in order to draw accurate conclusions. Malmquist (1953) first proposed to create "Productivity Index Malmquist the Productivity Index(MPI)" as a measure of input and output of the ratio of the distance function. There is a lot of experience to prove that the MPI only need a small amount of data you can integrate the relationship between the input and output, and relative to the other methods, the MPI program of calculation is more simple. Simar and Wilson (1999) found that MPI has allowed to contain random errors, also can obtain the advantages of effectively estimate. Therefore, this article using the MPI, and combined with the Data Envelopment Analysis (DEA) ", review of APEC countries from 1990 to 2010 defense spending impact on economic productivity.

This article structure arrangement is as follows: the first part is literature review, the second part expounds research methods, the third part introduces the sample and data collection, the fourth part describes the empirical test results, the last part is the conclusion of this article.

## 2. METHODOLOGY

**2.1 Measuring productivity change: the Malmquist Productivity Index (MPI).** MPI is by Malmquist (1953) first put forward, over the years, through with Caves, et al. (1982) and Fare et al. (1994) as the outstanding representative of many scholars research and improvement, has now evolved into model for total factor productivity growth, reflecting the effectiveness of the process and the return of the multiple input and output process. MPI computing is in all factors of production (Total Factor the Productivity, TFP) under the condition of, changes in production (Efficiency Change, hereinafter referred to as EC) and Technical Efficiency Change, Technical Change, TC) for short. Assume that in every period, the state's production levels are saturated production status. As shown in equation (1), when the MPI values greater than 1 indicates that growth in productivity. When the MPI values less than 1 indicates that a drop in productivity.

$$MPI = \left[ \frac{D^{t_2}}{D^{t_1}} \right] \times \left[ \frac{D^{t_2}}{D^{t_1}} \times \frac{D^{t_1}}{D^{t_2}} \right]^{\frac{1}{2}} = EC \times TC \quad (1)$$

MPI equation calculation is similar to the DEA, main is to use linear equation is calculated. Benefit from the DEA effective marginal analysis skills, MPI equation and the parameters in the display is as follows:

If there are  $j = 1, L, n$  countries, in  $t = t_1, t_2$  two time period, use of  $X_k^{t_1} = (x_{1k}^{t_1}, x_{2k}^{t_1}, L, x_{pk}^{t_1})$ ,  $i = 1, L, p$  kind of investment, production  $Y_k^{t_1} = (y_{1k}^{t_1}, y_{2k}^{t_1}, L, y_{qk}^{t_1})$ , output  $r = 1, L, q$ . Fixed returns orientation into DEA linear equation as shown in (2) - (5), equation (2) and (3) display is in a period of observation changes the marginal productivity of at some point, equation (4) and (5) display is relative to a period of observation the marginal productivity of at some point within a period of time before change. Equation (2) - (5) involving parameter must be one country in the two phase over the time period of data.

$$D^{t_1} = \underset{\theta, \lambda}{Min} \theta$$

$$\begin{aligned}
 st - y_{rk}^{t_1} + \sum_{j=1}^n \lambda_{kj}^{t_1} y_{rj}^{t_1} &\geq 0, r = 1, L, q \\
 \theta x_{ik}^{t_1} - \sum_{j=1}^n \lambda_{kj}^{t_1} x_{ij}^{t_1} &\geq 0, i = 1, L, p \\
 \theta, \lambda_{kj}^{t_1} &\geq 0
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 D^{t_2} &= \underset{\theta, \lambda}{\text{Min}} \theta \\
 st - y_{rk}^{t_2} + \sum_{j=1}^n \lambda_{kj}^{t_2} y_{rj}^{t_2} &\geq 0, r = 1, L, q \\
 \theta x_{ik}^{t_2} - \sum_{j=1}^n \lambda_{kj}^{t_2} x_{ij}^{t_2} &\geq 0, i = 1, L, p \\
 \theta, \lambda_{kj}^{t_2} &\geq 0
 \end{aligned}
 \tag{3}$$

$$\begin{aligned}
 D^{t_1} &= \underset{\theta, \lambda}{\text{Min}} \theta \\
 st - y_{rk}^{t_1} + \sum_{j=1}^n \lambda_{kj}^{t_2} y_{rj}^{t_2} &\geq 0, r = 1, L, q \\
 \theta x_{ik}^{t_1} - \sum_{j=1}^n \lambda_{kj}^{t_2} x_{ij}^{t_2} &\geq 0, i = 1, L, p \\
 \theta, \lambda_{kj}^{t_2} &\geq 0
 \end{aligned}
 \tag{4}$$

$$\begin{aligned}
 D^{t_2} &= \underset{\theta, \lambda}{\text{Min}} \theta \\
 st - y_{rk}^{t_2} + \sum_{j=1}^n \lambda_{kj}^{t_1} y_{rj}^{t_1} &\geq 0, r = 1, L, q \\
 \theta x_{ik}^{t_2} - \sum_{j=1}^n \lambda_{kj}^{t_1} x_{ij}^{t_1} &\geq 0, i = 1, L, p \\
 \theta, \lambda_{kj}^{t_1} &\geq 0
 \end{aligned}
 \tag{5}$$

**2.2 Bootstrap in Malmquist productivity index.** Efron and Tibshirani(1993) by the method of guidance, through repeated sampling estimate sample distribution.

This method has also been Caves, et al. (1982) and Fare et al. (1992) scholars research and praise highly. The MPI as a deterministic model, does not contain random errors, all of the error is coming from the marginal inefficiencies.

In the input oriented model, a high efficiency estimate, sometimes is close to 1.

But in the output oriented model, if certainty marginal samples has not been taken into account, the efficiency estimates will be very low.

In the related literature, to estimate the effectiveness of noise samples attention more and more high, although further studies on the efficiency of the national ignored this problem.

In cases of multiple input and multiple output, guide way is by correction of the inherent bias and provide a confidence interval to investigate the MPI point estimation sample diversity the only effective method (Simar and Wilson, 2000). Guide method of estimation process is a process by copying the data processing, repeated parameter estimation, the observed values used to estimate the true distribution (Brummer, 2001). Simar and Wilson (1998,2000) by the method of smooth curve guide, select appropriate smoothing parameters, after 3000 iterations, created out of the 95% confidence interval.

### 3. DATA SELECTION AND DESCRIPTION

This article studies the APEC national defense expenditure to the economic productivity, the influence of the MPI used to measure the change in the economic productivity, involves the four variables, respectively is: gross domestic product (GDP), fixed capital stock, human capital stock, defence spending. Description as shown in table 1:

Table 1 Descriptions of input and output variables in MPI model.

Classes	Variables	Abbreviation	Unit
Output	GDP	GDP	US\$ millions
Input	Capital	C	US\$ millions
	Labor	L	Million
	Defense Expenditure	DE	US\$ millions

APEC as a whole is analyzed first, research the relationship between the four variables to each other, a detailed description as shown in table 2.

Table2 The correlation coefficient between the variables

correlation index	GDP	C	L	DE
GDP	1,000			
C	0,997	1,000		
L	0,961	0,939	1,000	
DE	0,894	0,899	0,787	1,000

## The impact of defense expenditure on economic productivity in APEC countries

Judgment of macroeconomic performance, depends on to the least defence spending, in exchange for the largest GDP output. As shown in figure 1, the APEC defence spending of average from 2001 to 2006 increased more obviously, is growing rapidly after 2007. Therefore, to study the effect of defense expenditure to the economic productivity is essential.

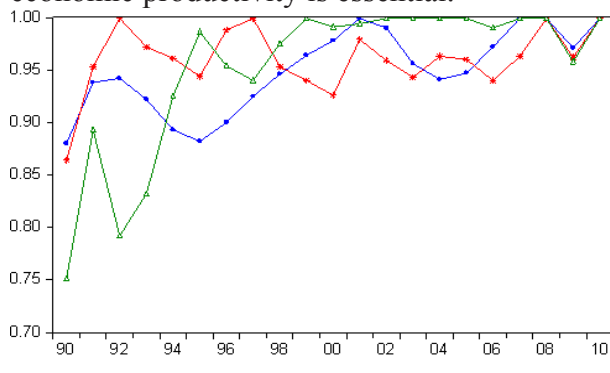


Fig. 1. Mean and standard deviation

### 4. EMPIRICAL RESULTS AND DISCUSS

APEC countries from 1990 to 2010, this article selects the data, first analysis excluding defence spending, fixed capital stock and human capital stock only two parameters variables, the change of GDP. Then introduces defense spending as a variable to the model, observe the change of GDP.

**4.1 the national defense expenditure to the economic productivity.** APEC countries on defense spending (MPI\_D) and regardless of the variation of the MPI in defense spending (MPI) as shown in figure 2, can be observed, from 1990 to 1990, meter when defence spending MPI values were greater than or equal to the MPI in excluding defence spending. Especially in 2000, the gap between the two largest, up 5.4%.

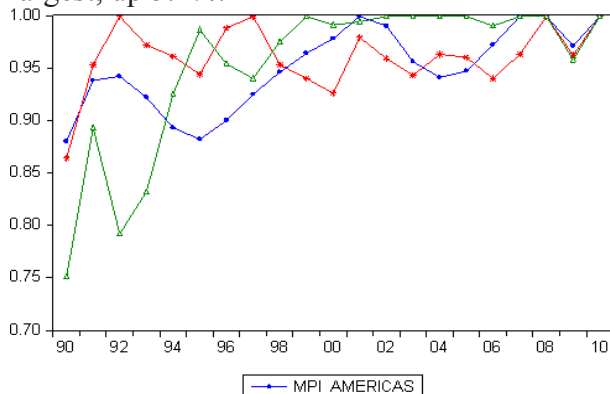


Fig. 2. Cumulative change in the MPI.

Further more as shown in table 4, when no defense spending, the median number of MPI APEC countries is 0.784, this value to reveal the APEC countries average annual productivity growth of 0.784%. At the same time, can be found that the stimulating effect of the EC for the MPI is greater than the TC.

And we can see, in defense spending, the median number of MPI APEC countries is 0.830, this value is greater than any the MPI values when defence spending, appropriate configuration of defence spending, productivity growth can promote the national economy.

The promoting effect is through a variety of means to realize. For example, through the establishment of military enterprise, create more jobs, and increase the purchasing power of workers; By perfecting the education mechanism, to improve the quality of human resources; Through a lot of infrastructure (e.g., highway, airport and wharf, etc.). Military industrial enterprises and other enterprises can establish close cooperation mechanism, promote each other, improve together, finally, reach the role of stimulating national economic productivity.

**4.2 Regional defense expenditure to the economic productivity.** Above is the APEC nations of the world as a whole to analyze the stimulating effect of the defense expenditure to the economic productivity, here again the APEC countries according to the location where is divided into three regions, and to do further analysis. In so doing, because competition for national governments, mainly comes from the inside of the area. As shown in figure 3, before 1998, the region's productivity change values (MPI\_ASIA) below (MPI\_AMERICAS) in the americas and Oceania region (MPI\_OCEANIA), and after 1998, the region's productivity change value increases rapidly, more than the americas and Oceania region. Has this kind of phenomenon, the main reason is that countries generally in the two world wars in Asia suffered huge economic losses, some countries have serious internal politics, sectarian strife, the gap between rich and poor is huge, many factors are intertwined, lead to low productivity.

In gradually to the integration of politics, economy, etc., especially in the Asia countries to strengthen the internal connection, Russia and Japan and other countries increased the military production and extend the arms trade, the region's economic productivity increase quickly, and keep in a higher level of growth.

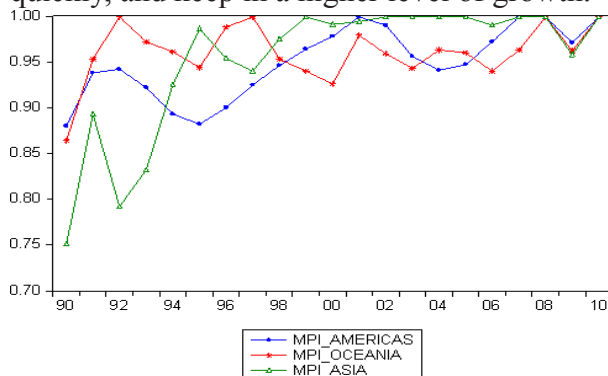


Fig. 3. Cumulative change in the MPI for three regions.

## 5. CONCLUSION

This article studies the impact on economic productivity on defence spending, data from APEC nations. Research shows that from 1990 to 2010, the APEC countries economic productivity growth when meter defence spending is higher than no defence spending. From the perspective of regional analysis, Americas economic productivity growth is higher than ocean states and Asian countries, this mainly comes from the United States arms trade stimulated the development of the military enterprise, drive the Americas and other countries and regional economic growth. Instead, many Asian countries since the end of the second world war, all from one year to cut defence spending. Through the analysis, the main conclusions are as follows:

**5.1 Encourage private resources into national defense field.** Through the above analysis, found that a country's economy will directly or indirectly benefited from the defense industry development. The organic restructuring of private and public resources, the government can through appropriate defense resources autonomy, improve the defense industry, stimulate economic growth.

Further, encourage private resources into the field of national security for weapons and equipment research and development, production, maintenance and other activities, resources equipped to the military's ability to do from short-term to long-term potential of military transformation. The government should reduce public sector investment in the defense industry, foreign procurement, increase lending to the private credit to encourage them.

**5.2 Stimulate the defence industry international competitiveness.** The government can through formulating the plan of "joint defence industry", such as requiring foreign companies to invest in their own or the means such as technology transfer, foreign companies for their own defense industry responsibility clearly, detailed details must be clearly written in about defense procurement, transportation, nuclear power and other specific plans. Do this is through the purpose of stimulating domestic defence industry competitiveness in the global market, and promote the development of domestic industry and stimulate the development of the economy's long-term prosperity (Dowdy, 1999). Specific incentives include technology transfer, cooperation, research and development, personnel training, to expand the international market, etc.

**5.3 Strengthen the international cooperation between powerful countries.** Competition in the international countries reform the industry structure, guiding the industry cooperation, mutually make up for technical shortcomings, to reduce technical protection, etc. Between countries should strengthen cooperation, especially the weak should strengthen and tactical missiles, ground attack weapons, satellite and other powerful national defence industrial base state of cooperation, to improve their status in international negotiations (Neal and Taylor, 2001).

In short, the success of management to national defense that needs to be a good coordination between the government and defense industry sector, seeking economic security and national security is the direction of the countries are trying to (Pieroni, 2009).

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