Enhancing Engine for Economic Growth in Management of Defence Sector

By

Colonel Sung, Woo-Young
Ministry of National Defence, Republic of Korea

Student of the National Defence College
The National Defence Course : Class 59
Academic Year 2016-2017

PREFACE

The Republic of Korea, which had been suffered from Japanese' imperialism for 36 years in modern history, experienced catastrophic Korean war and still confronted with North Korea who is most aggressive in the world, has tackled chronic dilemma between security and economic growth. How this country could achieve such a dramatic economic growth spending astronomical military expenditure?

The effect of military expenditure on the economy is a controversial area of research among economists. Majority of economists take the view that unproductive public expenditure generally slows down economic growth. When it comes to military spending, however, they have often argued the opposite that public expenditure boosts economic growth. They regarded military as no more than 'a necessary evil'. In another word, while most countries need some level of security to deal with internal and external threats, there are opportunity costs, as the money could be used for other purposes that might improve welfare. However, they used to ignore the part of 'necessary' in the economic model to estimate the economic growth effect of military expenditure.

'Defense' or 'Security' of the nation is definitely a kind of public good that gives us utility. According to the economic theory, people consume products or services to maximize their utility as their marginal utility of the each good or service equal in general equilibrium. If the economy is in the state of general equilibrium, military spending is not a sort of 'evil', because it is an optimal choice to maximize utility or welfare.

Whether states choose to accelerate their military expenditure in response to widespread industrialization and rapid domestic economic growth is a question of considerable policy relevance to the ASEAN countries. Basically, military is for the national security. However, in the modern era, military is challenged to contribute to not only for defense itself but also economy. Fortunately, the major findings of this research is saying that military can meet those demands of the times and suggest a bit of what we should do to make it. I sincerely hope that this research can be a step forward to the peace and prosperity of the region.

I would like to express our deep gratitude to the National Defence College of Thailand, for the opportunity to study on my long-cherished theme, especially I owned heartfelt appreciation to LTG. Chainan, superintendent of NDC, for all support and guidance. I am also extremely thankful to directing staffs, MG Nopadol, and MG Krisada for intellectual and expert advices. I will not forget Capt. Prapob and NDC staffs, Col. Park, Defense Attache from ROK, and Mrs. Krisana and Miss Paninee in the Embassy of ROK for encouraging and supporting to make successful completion of the research and my stay in Bangkok joyful and blissful.

Finally, my deepest gratitude is dedicated to my wife and families for their sacrifices and understanding throughout year and for cheering me up to completing the course.

(Colonel Sung, Woo Young)
Student of National Defence College
Course NDC: Class 59
Researcher

CONTENTS

CONTENTS (Cont.)

CONTENTS (Cont.)

Chapter 1. Introduction

Background

With the end of the Cold War there were considerable reductions in military expenditure, but in more recent years the declining trend has bottomed out and military expenditures are increasing. While Southeast Asia nations have seen the highest growth in military spending since 2000, military expenditure as a share of GDP remained lower for this income group relative to the others.

According to Stockholm International Peace Research Institute (SIPRI), the military expenditure of the South East Asia region was increased by 8.8% in 2015, while global military expenditure increased by 1% rate. As matter of fact, ASEAN members has steadily increased their military spending for last decades, and this trend seems to go further as long as the territorial disputes such as South China Sea issue are going on.

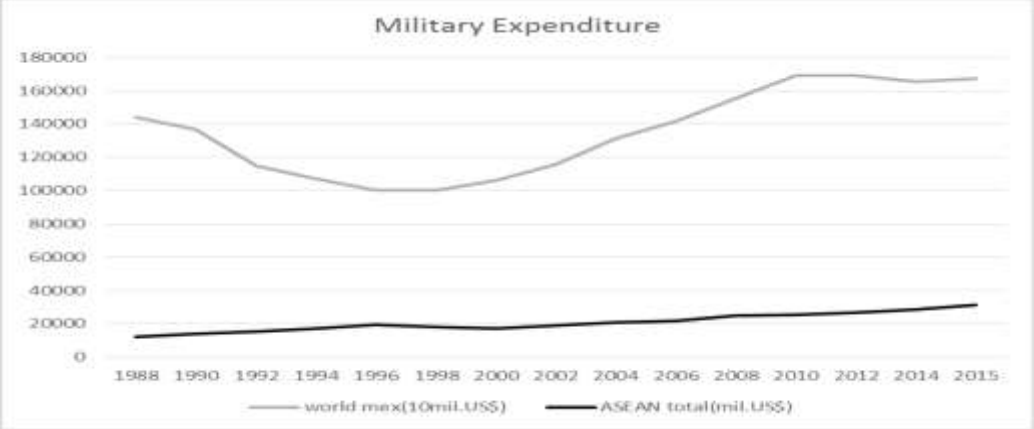


Figure 1-1 Trend of Military expenditure in the world and ASEAN

Moreover, this trend may even be accelerated in the furture due to their military modernization programs and economic growth. It seems that ASEAN's capability to afford additional military spending is still enough considering the fact that ASEAN military expenditure ratio of GDP, 1.45% is lower than world average 2.27%, and still decreasing as shown in Figure 1-2. On the other hands, developing countries are typically confronted with the two challenges, economic growth and management of

regional conflicts. In fundamental understanding, military is merely a burden for the economy and no more than parasite sector which doesn't contribute to production.

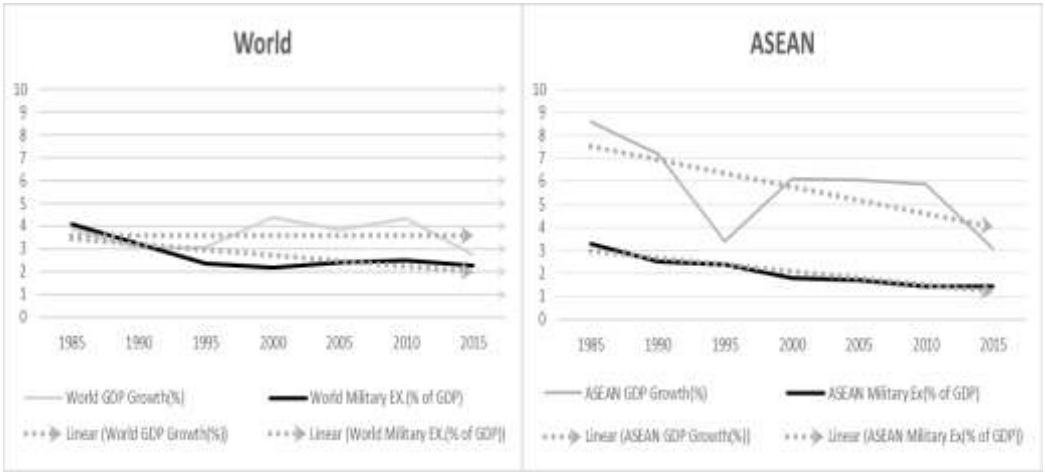


Figure 1-2 Military expenditure ratio and Economic growth rate

The disintegration of the Soviet bloc and the apparent end of to the cold war had created expectations that lower defence spending will results in a "peace dividend." This expectation is based on the idea that lowering military spending will lead to economic prosperity. However, even global military expenditure decreased dramatically from 1986 to end of 1990's, the evidence of the peace dividend is not consistently across all regions and still ambiguous with no obvious evidence.

However, according to numerous defense economics research, military expenditure shows both negative and positive sides for the economy. For developing countries seeking their two goals simultaneously, they need to set up their national strategy and defence policy on the basis of more deliberate and accurate analysis on the linkages between military sector and private sector.

Objectives of Research

The purpose of this paper is to answer the two questions, "is the ASEAN Countries' defence spending desirable for their economic growth?" and "How can their military contribute to economy more effectively". To answer these question, we need to investigate the

relationship between defence spending and economic growth.

This paper also aims some academic contributions. The basic question addressed in most studies is whether a high 'military burden' (usually defined as the share of military expenditure in GDP) tends to lower economic growth in developing countries. Despite so many empirical research effort on this area in 1980s and early 90s, they couldn't reach to consistent results with theoretical background at that time. In 1990s, due to emerging of 'Endogenous Economic Growth Theory', there was considerable progress in this area. In previous neoclassical theory, the economic growth rate in long term is determined by exogenous factor such as saving rate or technology progress. However Endogenous economic growth theory emphasizes on that endogenous factors of the economy such as human capital or government system create 'sustainable economic growth'. This also implies that the long term economic growth rate is determined by these endogenous factors, and government's public service also can either accelerate or decelerate economic growth.

Especially 'the Public Model', represented by Barro(1990) [1] provides excellent methodology to analyze the government sector's role in economic growth showing the optimal state in the general equilibrium. More recently, Barro's model was specified and extended to consider defence sector nominally. It allows us to estimate the growth effect of government spending and to assess optimal defence spending ratio of GDP to maximize economic growth rate. In this connection, this paper tries to measure the optimal level of defence spending. Furthermore, various possible channels in which defence sector affects private sectors are explored.

Scope and Methodology

Even the purpose of this study is to draw a meaningful implication for ASEAN country, the empirical test covers 61 countries in global including 6 ASEAN member group from1970 to 2014.

[1] Barro, Robert J. "Gov't Spending in Simple Model of Endogenous Growth," *Journal of Political Economy*, 98, oct. 1990, Part II, pp. 103-105.

In chapter 2 and 3, this paper reviews previous theories on the relationships between defence sector and private sector focusing on how defence sector affect the accumulation of production factors. Then, Barro's Public Model(1990) is extended to 3 sectors model to introduce defence sector, and then, the meaning of externality as a criteria to assess the optimal combination of government spending is defined.

Moreover, in order to measure the externality, Feder's two sectors model(1986)[2] that provides good empirical design to measure the externality and the productivity gap between heterogeneous economic sectors, is also revised as the 3 sectors model including private, defence and non-defence-government sector. In chapter 4, using revised 3 sector model, productivity gap and externality of each government spending is measured by various groups.

Utilization

This paper may show us the optimal average defence expenditure in global and region. On top of that, we may deliver some implication for defence policies to maximize potential economic growth. Those policies may cover military education and training, defence acquisition, R&D in defence industry, priority of readiness against external threat and internal threat and so on. These results eventually can be utilized not only to establish defence policy and national strategy to manage defence sector to minimize negative effects and maximize the positive effects on economic growth, but also to persuade public to ensure the appropriate level of defence expenditure. Furthermore some implications can be exploited to make consensus of regional countries on deterring potential arms race or peaceful resolution of conflicts.

[2] Feder, Gershon, 1986, Growth in semi-industrial countries: A statistical analysis, in: H. Chenery et al., eds., Industrialization and growth: A comparative study (Oxford University Press, Oxford).

Chapter 2. Literature Review; Interaction between defence and Economic Growth

Defence activities cause various effects on economy through the process of budgeting, procuring or operating their military.[1] In the fundamental point of view on the military since Adam Smith who established modern economics, military is mere parasitic sector which is raised by the economy and doesn't make any contribution to the economy. With this intuitive understanding, defence spending was regarded as wasteful consumption and burden for their government and economy.

It is in early 1970s that disputes on the economic effects of the military expenditure triggered. Emile Benoit(1973, 1978)[2] announced the results of his empirical study that there were positive correlation between military expenditure and economic growth rate. He suggested that military expenditure brings out some positive byproducts for the economy as below.

a. Dual use of infrastructure; in underdeveloped countries, the military purpose infrastructure such as roads, harbors, airports, bridges, and communication facilities can be used by private sector. On top of that, military may provide some services for disaster relief and restoration, mapping, measuring the land and so on.

b. Technology spillover; Technologies developed by defence R&D activities can be utilized in private sector and contribute to technology progress.

c. Improving the quality of labor; Military provides skillful and disciplined labor to the economy.

d. Introducing foreign aid; In 1970s, the countries spending higher military expenditure received more economic aid from abroad.

Benoit's studies were followed by numerous studies focusing on

[1]. Defence sector generally means subsector of the higher structure such as defence industry, military and military system etc. This paper defines defence sector more comprehensively. As activities and systems of national defence including budgeting, acquisition, and production, consumption, accumulation of defence goods.

[2]. Benoit, Emile, Defence and Economic Growth in Developing Countries, Lexington Books, 1973.

various factors and linkages between military and economy. For more comprehensive understanding on those studies, it is needed to investigate what causes the long term economic growth and how to account them.

1. Accounting Economic Growth

In theoretical approaches to account long term economic growth, variation in gross production is determined by accumulation of production factors such as labor population, physical and human capital, and technology. A neoclassical production function with physical capital(K) and human capital(H), and Labor(L) in Cobb-Douglas production function form can be assumed as below.

$$Y = AK^{\alpha}L^{\beta}H^{\gamma}$$

Then, the equation of income(Y) growth is deployed, as

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha\frac{\dot{K}}{K} + \beta\frac{\dot{L}}{L} + \gamma\frac{\dot{H}}{H} \qquad (2\text{-}1)$$

$$\dot{A} = \frac{\partial A}{\partial t}, \quad \dot{K} = \frac{\partial K}{\partial t}, \quad \dot{H} = \frac{\partial H}{\partial t}, \quad \dot{L} = \frac{\partial L}{\partial t}.$$

If we consider discount rate δ, the accumulation of physical capital is expressed as below,

$$\dot{K}/K = I/K - \delta \qquad (2\text{-}2)$$

If the productivities of each production factor is constant, we can derive equation(2-3)

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha\frac{\dot{I}}{K} + \beta\frac{\dot{L}}{L} + \gamma\frac{\dot{H}}{H} \qquad (2\text{-}3)$$

That is called as‘ Growth Accounting Equation’ in which one country's economic growth rate can be expressed with increasing rate of each production factor and progress in technology. In this flame, the

effects of defence spending on economic growth will be determined by variations of each production factor and technology caused by variation of defence spending. This is shown in the equation below.

$$\frac{\partial\left(\frac{\dot{Y}}{Y}\right)}{\partial\left(\frac{M}{Y}\right)} = \frac{\partial\left(\frac{\dot{A}}{A}\right)}{\partial\left(\frac{M}{Y}\right)} + \alpha\frac{\partial\left(\frac{I}{K}\right)}{\partial\left(\frac{M}{Y}\right)} + \beta\frac{\partial\left(\frac{\dot{L}}{L}\right)}{\partial\left(\frac{M}{Y}\right)} + \gamma\frac{\partial\left(\frac{\dot{H}}{H}\right)}{\partial\left(\frac{M}{Y}\right)}$$

(2-4)

Therefore, to discuss economic growth effects of military expenditure, it is needed to investigate deliberately how the variation of military expenditure affects accumulation of each production factor and economic performance.

2. Effects on the Accumulation of Production Factors

2.1 Accumulation of Physical Capital

2.1.1 Effects of Shifting Resource

To build, maintain and operate military power, considerable amount of resources are required. Those resources are transferred from the economy in the form of taxes or mobilization. Government reallocates scarce resources to defence sector from non-defence sector affecting consumption and investment. In the fundamental point of view, it is definitely a burden to the economy.

However, in the case that the economy is not in state of full employment of the labor or production facilities, defence sector can utilize the unemployed resources without causing any burden to the economy, and it could even stimulate supply side of the economy. After the great recession in 1920s, based on the Keynes' effective demand theory, military expenditure has been regarded as one of important components of effective demand to boost up the economy. In the context, though military expenditure is not productive itself, it creates effective demand and eventually increases gross production and income. As a matter of fact, military expenditure was regarded as a feasible and useful tool for fiscal policy to tune up the business cycle in many countries,

because defence projects compete with private sectors for production factors less than other fiscal projects, thus may arise less inflation, and even it is easier to persuade their people to afford it.[3] On the other hand, even if the economy were not under the full employment state, if specific resources were scarce in the economy, and defence sector siphon off them, it would occur bottleneck effects on related industry[4] and decelerate the economic growth.

However, the Keynesian effective demand theory was challenged by monetarists who emphasize, so called ‘crowding-out effect’ that is the effective demand must be crowded out by increase of interest rate or inflation. Basically, Keynesian and Monetarists approaches deal short term effects and those cannot account in long term economic growth analysis.

In another negative point of view, so called 'the opportunity cost theory' insists that the effects of defence sector on economic growth should be measured in economic values of the opportunity that we lost investing the resources to defence sector rather than more productive sectors. In this context, opportunity cost is calculated not in terms of accountant figures, but in substitute investments to production capacity, gross production or employment which could be brought with same amount of defence spending. For instance, it is not enough to argue that military facilities such as roads and satellites provide some services to the civilian population, if it is not enough to compensate for opportunity cost of the expenditure. It also has to be shown that the ‘indirect’ provision of these services through military expenditure is more efficient than the direct provision of civilian facilities. Otherwise, civilian needs are better served through direct provision. This point is quite crucial in interpreting empirical findings on spillover effects of defence sector.

The assumption of opportunity cost is based on the idea that the economy is not in optimal state, and there is certain gap in marginal productivity between defence and non-defence sector. Therefore we can say that opportunity cost approach is another version of the fundamental

[3] H.G. Mosley(1985), The Arms Race: Economic and Social Consequences, Lexington Books, 1985.pp. 30-32

[4] Lee, Jee-Soon, "Government Spending and Economic Growth," J. Kwon, ed., Korean Economic Development, 1990, pp3-51

point of view that defence sector is not or less productive.

2.1.2 Security Effects

In the case of the security channel, the provision of national defense fosters the security of persons and property rights from domestic or foreign threats, which is essential to the operation of markets and to the incentives to invest and innovate. This is a very old argument dating back to Adam Smith, who noted that the first two duties of the state were to protect its citizens from foreign and domestic oppression or violence. It has been often noted in the literature that wars and a lack of security are major obstacles to development in many poor countries. Defense expenditures, thus, can strengthen the incentives to accumulate capital and produce more output, leading to higher economic growth

In 1960s, when government's role had been spotlighted, some economists had got to perceive that defence sector produces the public good, 'Security' which ensures stable economic activities.[5] They insist that military formulate desirable conditions for investment or hosting foreign direct investment. Yager and Neu(1991) have shown the case of USA that military expenditure enhances the international trading.

Barro(1990) emphasizes on that defence spending stimulate the investment, ensuring the right for intellectual property and improving possibility to realize profit from investment. Nowadays, national security is getting more important to protect foreign market, raw material supplier, and line of sea for transportation, to enhance negotiation power and to assure the ownership for overseas property. This is contradict with previous fundamental view but it is still focusing on fundamental role of defence.

On the top of that, developing countries are usually encouraged to import their weapon from their alliances. Arms trading is likely to enhance the political or military bond between importing and exporting countries. The statistics of arms trading often stands for political or military bond between supplier and receiver. Furthermore, arms trading

[5] Defence good can be regarded as a public goods, as it fulfils the characteristics of non-exclusive and non-rivalry

will bring security effects to receiver in addition to actual value of arms transferred. That is because arms transfer commonly occurred within alliances, and majority of suppliers are military powers such as USA, Russia, UK, so importer would be granted from their alliance's military power.

However, security effect inherited negative sides too. Too high rate of military expenditure can drive arms race and deteriorate regional conflicts so that the international and internal economy would shrink up.

Nevertheless, it is true that security effects had been excluded in previous empirical studies because it is not easy to measure them as it is related to non-economic factors such as internal or international politics and sociocultural background.

2.1.3 Effect of Deficit in International Balance

Military forces are continuously motivated to procure the superior weapon and equipment to the potential enemies. To develop and produce new modern equipment, considerable initial investment and high technology are essential. Thus defence industries are generally operated in the range where return of scales is increasing.[6] Therefore some major countries are specialized to specific platform or weapon system in an international political block, and the other countries usually depend their weapon on import from them.

Given that some of the biggest military spenders in the world are also some of the biggest arms exporters, then the interaction between arms exports and military spending could have a non-linear effect on growth. In the case of arms imports, a component of military spending has to be allocated to pay for these purchases. Arms purchases are not cheap, and some countries have to resort to external borrowing in order to pay for their arms imports or some portion of their military budget in general. Of course, foreign borrowing does not necessarily lead to slower economic growth. In fact, reasonable levels of foreign borrowing might even stimulate growth. Dunne et al. (2003) suggest that, in evaluating the impact of debt on growth, it is important to consider how the external debt is being used. If it is used to increase productive capacity, external

[6] J.H Nam(1993), "International Trade', Kyungmunsa, pp. 141-148

borrowing may even facilitate development. However, if the scarce foreign exchange resources are spent on arms imports instead of investment goods that are essential for self-sustaining growth, then the effect of external borrowing on growth is likely to be negative. Looney (1989) investigates how military expenditures and arms imports affect debt in resource-constrained countries and unconstrained countries and finds arms imports to be a significant contributor to Third World indebtedness. In another empirical study, Looney and Frederiksen (1986) find that the unconstrained developing countries are able to support higher level of arms imports. GunlukSenesen and Sezgin (2002) find that the growth in arms imports has a significant positive effect on external debt, while no such effect is found for the growth in military spending.

However, offshore procurement requires considerable amount of foreign currency and developing countries are commonly suffered from deficit of in international account. It will reduce availability of foreign exchanges for private sector and may resulted in negative effect on economic growth.

2.2 Human Capital Accumulation

Military has both of negative and positive aspects to formulate human capital. As Emile Benoit pinpointed out earlier, defense sector may spillover useful skill to private sector. Military is even regarded as a sort of educational institute in some countries. On the other hand, there are some arguments on whether military expenditure competes with human capital related budget or not.

2.2.1 Decreasing Public Health and Education

The relationship between military expenditure and education/health related government expenditure has been one of the most attractive agenda in defence economics. Government expenditure for education and public health directly influence on accumulation of human capital, and military budget may competes with educational budget. However, there were disputes in previous empirical tests showing different evidences. Deger(1986) brought the empirical result that military expenditure trade off the budget for public education, and Russett(1969), Peroff(1977),

Akari and Glover(1977), Looney(1986) also had shown the similar results. Kennedy(1974), Ames and Goff(1975), Hayes(1975), Verner(1983) etc. insist that there is no clear evidence of tradeoff between military budget and public education budget, or even it exists, it is ignorable.

Fredericksen and Looney(1983) tried to explain the reason why economists couldn't get consistent results. He insists that there is asymmetry in government behavior. In the stage of retrenchment, they cut off budget for public education or health rather than military budget, while they increase education budget steeply in the stage of expansion. Military is rigid to gross government budget, but education and health related budget are relatively flexible, so that correlation between two sectors was not clear in empirical tests. Despite of those disputes, we may come to a general conclusion that increase in military expenditure under strict budget constraint results in deceleration of economic growth reducing educational budget.

2.2.2 Human Capital Spill-over

This effect refers that useful human capital inflows from military to the economy. One version of this idea is that the military establishment contributes to the process of modernization by fostering values such as efficiency, discipline and national unity (Benoit, 1978) Military persons are educated and trained in the military. The skillful labors who are cultivated in military can be employed by private sector after their retirement. It is well known that considerable numbers of military pilots, engineers, technicians, experts on public health are hired by private sectors. Even veterans without specific skills or technologies, they were trained, disciplined and physically improved in the military. Those educational effects of military would be valuable especially in underdeveloped countries, but it is noticeable that even in USA, conscription system is supported in the context that military is fairly effective to enlighten Harlem.

In other hands, this educational effect may also save the cost for defence activities. As an example, military pilots are willing to bear the low wages during the military service expecting higher income after few

years of military service.[7] Not only that, some scientists and engineers are also willing to involve in military projects or studies for their specific career. The argument used to be popular among political scientists in 1960s, but little empirical evidence has materialized in support of it.

2.2.3 Human Capital Siphon-off

Defence sector needs experts and technicians for R&D, defence industry or operating their high-tech equipment. Askari and Glover(1977) pinpointed out that modern military needs more skilled personnel and it will be a significant burden especially for underdeveloped countries.

According to the endogenous economic growth theory emphasizing the fact that human capital is one of the key elements for economic growth,[8] siphon effect is clearly negative for economic growth reducing human resource available to private sector. This negative effect can be mitigated when military cultivates them for themselves, but we aware that they were also potential labors who could be employed in non-defence sector.

Even in the formation of human capital, there may be negative spillovers. As examples, the use of civilian facilities for military purposes and the environmental damage caused by military training. It is by no means obvious that military training and socialization enhance a person's preparedness to contribute to civilian life. In some countries, demobilized soldiers are notoriously problematic citizens.[9]

2.3. Effects on Economic Performance

Defence sector may deliver externalities on private sector through not only direct effects on the process of accumulation of capital but also indirectly affects the productivity of private sector in various channels.[10]

---

[7] Neu C. R., "Defence-Related Industries and Trade Relations," RAND.1990, p. 24

[8] Refer to Uzawa(1992), Barro and Sala-i-martin(1995)

[9] Jean Drèze , "Military Expenditure and economic growth", Clark, D.E. (ed.) 2006, The Elgar Companion to Development Studies

[10] Refer to Askari and Glover(1977), Benoit(1973, 1978), Chan(1987), Deger(1986), Deger and sen(1983), Kenndy(1983), Lingren(1988) etc insist on the negative effects of the defence sector on economic growth

2.3.1 Technology Progress

It is broadly known that the R&D activities in defence sector project spill over to private sector. As examples of positive effects of military purpose R&D to non-military sector, we can refer to progress of technology in aerospace, transportation, nuclear program, and radar and so on. These technologies are broadly exploited in private sector. [11] Research and development (R&D) for military purposes often has civilian applications, even the internet is a revamped offspring of the Pentagon.

The R&D argument has some relevance in industrialized countries, where sophisticated technology has extensive civilian applications. In developing countries, where advanced military technology has much less to contribute to basic civilian needs, military R&D is unlikely to give a major boost to technological innovation in the civilian sector.

Some proponents of military spending argue that some research projects will not be carried out in the private sector due to the high-risk environment and public-good characteristics of the final product. If this is true, then military R&D can be a net producer of positive technological externalities. As technology is a nonexclusive good, private industry is limited to use technologies which is acquired from their own R&D exclusively. On top of that, almost every R&D project inherit considerable risks of failure. Because of these, individual industry tends to hesitate or avoid to develop new technology which is useful for the economy. Defence sector can fairly contribute to progress of technology by way of supporting or participating the R&D projects or sharing the defence technologies directly.[12]

Considering the tendency of developed or technologically advanced nations to dominate the arms trade market, one could argue that arms exports reflect a high level of technological development in arms exporting nations. Thus, developed nations could experience greater technological externalities or spillovers from higher military spending that arms exports might proxy for. This idea could be consistent with the

---

[11] "Conceptual Linkages Between Defence Spending and Economic Growth and Development: A Selective Review,": in James E. Payne and Anandi P. Sahu, ed., *Defence Spending and Economic Growth*, Westview Press, 1993. p. 26

[12] Neu, ibid. pp. 20-22

non-linear growth effect from the interaction between military spending and arms exports.

On the other hand, it could be argued that arms imports may help the importing countries to acquire new technology through reverse engineering or through the necessary training of military personnel required for operating high-tech weapons systems. In some instances, arms imports may result in direct technological transfers when they take the form of a licensed production of military weapons or some of their parts. India and Russia, for instance, signed a major defense deal for the purchase of 310 new Russian T-90 main battle tanks and their production under a Russian license in India. This agreement allows India to manufacture some critical components of the T-90 tanks. Between 1993 and 2005, China acquired the rights to produce 200 SU-27 and 250 SU-30 fighters domestically under a Russian license. This tendency toward more licensed production, rather than finished arms imports, is becoming more and more prevalent in the international arms trade, which has become increasingly competitive in the last decade or so. Given this tendency, it would be worthwhile to hypothesize about the reasons that governments have for preferring domestic production of arms instead of arms imports.[13]

However, these effects should be compared with the negative effect that R&D resources shifted from private sector to military sector. In the developing countries, we can observe strong tendency that government initiate and drive the R&D activities. In that case, defence R&D may bring the result of reduction in the budget for other purpose R&D.

Furthermore, if the new technology is capital-embodied technology, military expenditure would be more negative reducing the investment of the capital itself.

2.3.2 Other Negative Externality

Increase of military expenditure of a specific country would be regarded as threat for neighbor countries or potential enemy, and might

[13] PAVEL YAKOVLEV, ARMS TRADE, MILITARY SPENDING, AND ECONOMIC GROWTH, Defence and Peace Economics, 2007, Vol. 18(4), August, pp. 317–33

raise regional tension or even causes arms race. These are surely harmful for international trading and transaction, and would resulted in shrinking of the economy.

J.S. Lee(1990) insists that high military expenditure tends to bring out dictatorship which is backed up by military power, and to provide sustainability to the military regime.[14] Moreover, excessive militarization of the society escalates the internal conflicts, and even causes inefficiency of the economy with their intervention to economic activities.[15]

There are also arguments on military-industrial complex. It is known that military-industrial complex encourages militarization and lead to inefficiency disturbing optimal decision on military spending or R&D investment. In addition, there may be a 'distortion effect': aside from displacing other investments, military expenditure may reduce the efficiency of resource allocation in the economy, e.g. by distorting relative prices and fostering rent-seeking activities. However, when military expenditures are not driven by basic security needs and are due to the rent-seeking activities, military expenditures may provoke arms races or damaging wars. Supportive of this argument is Aizenman and Glick's (2003) finding, indicating that economic growth increases with higher military spending when a country faces higher military threats, and that economic growth decreases with higher military spending when a country experiences high levels of corruption. In this case, less military spending would be desirable and could lead to positive security effects on economic growth.

As another negative effect, we can refer to the inefficiency in defence industry and market. The entry barrier, such as high initial cost and strict regulations in the defence industry inherit imperfect market structure and market failure.

2.3.3 Other Positive Externality

A. Security Effects

As referred in 2.1.2, military expenditure is eventually for

[14] Lee, Jee-Soon, "Government Spending and Economic Growth,": in J. Kwon, ed., Korean Economic Development, 1990. p. 333

[15] Refer to Mintz(1985), Lens(1970)

national security. It make society more stable and safe, so that economic system works well. It is hard to expect rapid economic growth under the serious external threat.

The capability to ensure smooth supply of raw material and transportation of the goods will be essential to improve economic performance.[16] Employee can be absorbed in production activities in the stable atmosphere. However, the exceed expenditure can cause adverse effects on production process as mentioned in former provision.

B. Formation of Infrastructure

This is the effects that private sector's productivity is improved using infrastructure which is for military use. Military expenditure in developing countries may have other types of spillover effects, such as civilian uses of military infrastructure and the role of the army in disaster relief. Military constructs road, harbor, airport, communication network including satellites, water management system and even local cities for military purpose. Those can be utilized for production process. This military projects or activities also contribute to balanced development through their territory especially when those are conducted in the remote or underdeveloped area.[17]

Furthermore, military carry out mission other than war, they are mobilized for humanitarian assistance and disaster reliefs or internal stabilization operation. It may save the cost for government's reserve for the purpose, and resulted in improvement of stability and soundness of the society.[18]

C. Economy of Scale and Monopoly Profit

If the economy of the scale is not achieved in certain industry, the marginal production cost continuously goes down until gross production reach to optimal amount. The existence of economies of scale in the defense industry leads to lower average unit costs as the size of military output increases. Therefore, the countries with more demand

---

[16] Neu, C. R., "Defence-Related Industries and Trade Relations," RAND.

[17] Neu, ibid.

[18] Deger and Sen, "Military Expenditure and Developing Countries,": : in Keith Hartley and Todd Sandler, ed., *Handbook of Defence Economics*, Elsevier, 1995

of military have comparative advantages and competitiveness in the defence industry. Moreover, these countries would be granted from monopoly profit in global market. These profits would finally exceed the initial cost and burden, and appeared in bigger figures of gross national income.

It will not only motivates individual companies to invest to the industry despite of high cost in the initial phase of the industry, but also reduces the total production cost of the economy as a result.

3. Effects of Economic Growth on Defence Sector

3.1 Increasing the capacity to afford military expenditure

Military is afforded by the economy. As the economy grows, the capability to afford military expenditure is enlarged. Typically, in developing countries under strict budget constraints, defence expenditure responses sensitively to the gross national income and government budget, so that it tend to be expanded as the economy grows.

On the other hand, except few major arms export countries, majority of nations depend on import for their procurement. For developing countries which is suffered from chronic deficit in international account, their military expenditure is restrained from availability of foreign currency. As an economy grows, its international account is enlarged, their foreign currency reserve increase, and military expenditure would be expanded. In this context, the military expenditure is possibly increased with economic growth.

3.2 Creating demand for defence

Considering that defence sectors is to protect their territory, lives and wealth of their people, it is reasonable to assume that demand for defence or security would increase as the economy grows.[19] It motivates the government to enforce their military to cover enlarged overseas market and assets.

[19] Maizel and Nissanke(1986), Pivetti(1994), Harris(1986), Looney and Frederiksen(1988) commonly regard the wealth of nation as a key determinant of military expenditure.

On the other hand, the capacity of production is generally regarded as national power. It means that not only physical military power but also production capacity itself can be counted in national power to project their political will to foreign countries. Economic capacity can substitute to military power for national security. However, as we can see in the Japan case, it seems that the effects of substitution is overwhelmed by effects of creating defence demand.

3.3. Improving the productivity of defence sector

Private sector also spillovers technology progress to defence sector. It allow the defence sector to produce defence goods in the lower cost and military to carry out their mission more efficiently. Those will be resulted in reduction of military expenditure.

Adam Smith(1776) pointed out that cost to build military forces is increased with civilization of the society and advance in the technology. In accordance with a technology progress, military tends to be more modernized with high technology, and it cost more.

Moreover, the study on a substitution between capital and labor in the defence sector conducted by Clark(1976)[20] had shown that defence sector become more capital intensive.

4. Previous Empirical Test Cases

As mentioned in chapter 2, disputes of the effects of the defence sector on the economy triggered in the 1970s when world military expenditure is dramatically increasing. After that, despite of many following research efforts, no strong conclusions about the relationship between military spending and economic growth can be drawn from the literature. The inconsistent results have led Chan(1985)[21] to conclude that a review of the literature in this area is "as likely to bewilder as it is

[20] Clark, Rolf, "Capital-Labor Ratios in a Military Service: A Putty-Clay Applications," *Capital Labor Ratio*, 1976, Santa Monica, CA: Rand.

[21] Chan, Steve, "The Impact of Defence Spending on Economic Performance: A Survey of Evidence and Problems," *Orbis*, 29, 1985, p. 405.

<Table. 3-1> Empirical tests other than the externality model

Study	Samples	Results
Benoit (1973, 1978)	44 developing nations 1950-1965	significant (+) effect
Kennedy(1974)	52 developing nations 1950-1965	not significant
Deger and Smith (1983)	SEM 50 developing nations 1965-1973	(+) effect on growth, (-) effect on investment (-) net effect
Lim(1983)	54 developing nations 1950-1973	significant (-) effect
Fredericksen and Looney(1983)	37 nations 1960-1978	different by possession of natual resource
Nabe(1983)	SEM 21 African nations 1967-1976	significant (-) effect
Deger(1983), Deger and Sen(1983 a, b)	SEM 50 developing nations 1965-1973	significant (-) effect
Faini, Annetz and Taylor(1984)	22 nations 1951-1970(Panel data)	significant (+) effect in developing, African, Latin not significant in advanced and Asian cty
Deger(1986 a, b)	SEM 50 developing nations 1965-1973	(+) effect on growth, (-) effect on investment (-) net effect
Landau(1986)	65 developing nations 1960-1980	significant small (+) effect
Chowdhury(1986)	Granger Casuality Test 55 developing nations Variable periods	not significant
Joerding(1986)	Granger Casuality Test 57 developing nations 1962-1977	adverse relation
Lebovic and Ishaq (1987)	SEM 20 Middle east nations 1973-1982	significant (-) effect
Stewart(1991)	Simulation, 13 African nations and 19 Latin Nations 1953- 1970	compare to non-military expenditure, higher (+) effects
Scheetz(1991)	SEM, 4 Latin Nations 1969-1987	significant (-) effect to investment

to enlighten".[22]

In fact, some theoretical and methodological problems that have plagued research on this question may be at the root of the conflicting results(Smith 1992).[23] One of most important of these problem is the lack of strong theory underlying the empirical work in this area. In 1980s, researchers couldn't formulate empirical model based on classical theory in economics. Few studies have attempted to solve it, then specifying ad hoc empirical model. Not surprisingly, the various studies that have been generated by these effort have differed widely in their theoretical prediction and empirical results.

Some have suggested that defence spending affects economic growth positively because of human capital and infrastructure development, whereas others have emphasized possible positive effects on growth through stimulation of effective demand[24]. Still others, however, have insisted that military spending crowds out civilian investment hurting overall economic performance. The study on a substitution between capital and labor in the defence sector conducted by Clark(1976) had shown that defence sector become more capital intensive because of increase of wage and opportunity cost of labor.

Much of the work in this area also suffered from limited research designs. Most of studies rely on cross-sectional data. However the cross sectional approach, although useful for comparative analysis, fails to capture the important dynamic element of the relationship between defence spending and the economy(ward et al. 1991).[25] In 1990s, due to appearance of endogenous growth theory, studies on defence sector's role in economic growth resumed and made more significant progress, as examples,

---

[22] Mintz and Chi Huang Source: The American Political Science Review, Vol. 84, No. 4 (Dec., 1990), pp. 1283-1293.

[23] Smith, Theresa Clair, "The Insurance Factor? An Assessment of War Costs," Journal of Peace Research, Vol. 22, No. 2, 1985.

[24] Kennedy, Gavin, *Defence Economics*, London: St Martin's Press, 1983.

[25] Ward, M.D., D.R. Davis M. Penubarti, S. Rajmaira and M. Cochran, "Military Spending in India - Country Survey 1," *Defence Economics,* 1991.

Biswas and Ram(1986),[26] Macnair (1995), Ram(1994) and so on.

<Table. 3-2> Empirical tests considering externality

Study	Samples	Results
Biswas and Ram (1986)	2 sectors, 58 nations, 1960-1977	not significant
Alexander(1990)	4 sectors,(incl. export) 9 advanced nations 1974-1985	not significant
Atesoglu and Mueller (1990)	2 sectors, USA, 1949-1989	significant small (+) effect
Huang and Mintz (1990, 1991)	3 sectors, USA, 1952-1988	not significant
Adam,Behrman and Boldwin(1991)	3 sectors Developing nations 1974-1986	not significant
Ward et al.(1991)	3 sectors, India, 1950-1987	significant (+) effect
Ward and Davis (1992)	3 sectors, USA, 1948-1996	(+) externality effect significant (-) net effect
Biswas(1993)	2 sectors, 74 developing nations, 1981-1989	significant (+) effect
Landau(1993)	2 sectors. nonlinear model 71 developing nations, 1969-1989	transit from(=) to (-) effects when mil. exp. over 4-9% of GDP
Atesoglu and Mueller (1993)	3 sectors USA, 1948-1989	significant small (+) effect
Ram(1994)	2 sectors, 71 developing nations 1965-1973, 1973-1980, 1980-1990	different by periods and samples
Macnair et at. (1995)	3 sectors 10 NATO members 1951-1988	significant (+) effect
Mintz and Stevenson (1995)	3 sectors 103 nations 1950-1988	not significant
Sung(1996)	3 sectors 43 nations 1970-1995	significant (+) effect

[26] Ram, R., "Government Size and Economic Growth: A New Framework and Some Evidence from Cross Section and Time Series Data," *American Economic Review*, Vol. 76, pp. 191-203.

However empirical evidence for effects of defence sector is still not very clear as shown in the <Table 3-2>. The thing significantly different from previous results is that defence sector has rather positive effects on the economic growth than negative effects.

Ward el.(1992)[27] studied on India case with 3 sectors model including civilian, defence and nondefence sector, and showed that the productivity of defence sector is even lower than civilian sector, the externality of the defence sector on civilian sector is obviously positive. It means that defence sector use the resources inefficiently but it contribute to economic growth indirectly through their activities

On the other hand, Landau(1993)[28] considered nonlinear relations between defence sector and economic growth. He showed that the ratio of military expenditure to GDP exceeds 4-9%, the net effect on economy turns to negative from positive.[29] That means current military expenditure is lower than optimal level and there are motivation to increase the military expenditure for their economic growth.

The other problem to study this area in 1990s was that not enough long time series data is available. It takes long time to observe the relationship between defence sector and economic growth in long term. As an example, if defence sector influence the human capital, the effect will have time lag and will affect for considerable times, but generally, time series data is not so long at that time. Nowadays, after the boom of research on this issue, more than 20 years has been passed, it is quite challengeable to estimate the relationship with more and longer data.

---

[27] Ward, M.D., D.R. Davis, "Sizing up the Peace Dividend: Economic Growth and Military Spending in the United States, 1948-1996," *American Political Science Review*, 86, 1992, pp. 748-755.

[28] Landau,, "The Economic Impact of Military Expenditures," Policy Research Working Paper WPS 1138, World Bank, 1993.

[29] He also tested assumption on channels in which defence sector influences economy, such as security effect on policy efficiency, shifting resources from productive investment and he concluded that those assumptions were supported.

Chapter 3
Extension of
Endogenous Growth Model with Defence Sector

As shown in chapter 2, there are various factors and linkages between military expenditure and economy, but those can be summarized into two aspects, the opportunity cost and the externality of military sector. The net economic growth effect of the military expenditure can be determined when we compare the opportunities that we lost shifting resources to military sector from other sectors to positive externality of military sector to the economic growth

The endogenous economic theory introduces not only accumulation of physical capital but also endogenous factors of each economy such as security for stable economic activities, human capital, therefore government's public service could improve or deteriorate the economic performance and accumulation of capital, so that government or public sector could either accelerate or decelerate economic growth in the model. Considering the fact that the externality including spin-offs and siphon-off effects, and human capital ensure the property of constant return to scale of production function in the frame of the endogenous growth theory, this paper investigates whether the defence sector can take such roles or not.

Especially Public Model, represented by Barro(1990) provides excellent methodology to analyze the government sector's effect of economic growth showing the optimal state in the general equilibrium.

More recently, Barro's model was specified and extended to consider defence sector nominally. It allows us to estimate the growth effect of government spending and to assess optimal defence spending for economic growth.

1. Extension of Barro's Public Sector Model

Barro(1990) model should be extended to include defence sector in the model as follow.

Optimization problem can be defined as

$$\max \int_0^{\infty} e^{-\rho t} u(c, G_c, M)dt \tag{3-1}$$

$$u(c, G_c, M) = \frac{(c^{\alpha} G_c^{\beta} M^{\varepsilon})^{1-\theta} - 1}{1-\theta} \tag{3-2}$$

$$\text{s.t} \quad \dot{k} = (1-\tau) Ak^{\eta} G_k^{\gamma} M^{\xi} - c \tag{3-3}$$

$$k, G_k, M \geq 0$$

Each variable represent, c consumption, G_c government spending for consuming, G_k productive government spending, and M is defence spending. Hamiltonian Function to solve this maximization problem.

$$H = \frac{(c^{\alpha} G_c^{\beta} M^{\varepsilon})^{1-\theta} - 1}{1-\theta} e^{\rho t} + \lambda_t [(1-\tau) Ak^{\eta} G_k^{\gamma} M^{\xi} - c] \tag{3-4}$$

From the 1st order condition=0, we can find new condition as

$$c = \{\alpha [Gc^{\beta} M^{\varepsilon}]^{1-\theta}\}^{\frac{1}{1-\alpha(1-\theta)}} \tag{3-5}$$

Then state-costate equation will be

$$\frac{\dot{\lambda}_t}{\lambda_t} = \rho - (1-\tau)\eta Ak^{\eta-1} G_k^{\gamma} M^{\xi} \tag{3-6}$$

$$\dot{k} = (1-\tau) Ak^{\eta} G_k^{\gamma} M^{\xi} - \{\alpha [Gc^{\beta} M^{\varepsilon}]^{1-\theta}\}^{\frac{1}{1-\alpha(1-\theta)}} \tag{3-7}$$

and transversality condition is given like (8)

$$\lim_{t \to \infty} e^{-\rho t} \lambda_t k_t = 0 \tag{3-8}$$

The optimal path will rendered with equation derived from (3-5), (3-6), (3-7), (3-8). For the constant endogenous character in the model, let's assume that ratio of each term in government expenditure maintain consistency as below,

$$G_c = hG = \delta G_c \tag{3-9}$$

$$G_k = iG = \delta G_k \tag{3-10}$$

$$\dot{M} = dG = \delta M \tag{3-11}$$

then using $G = N\tau Ak^{\eta}G_k^{\chi}M^{\xi}$, and (9), (10), (11), we can calculate G_c, G_k, M, as a component of constants and endogenous variables.

$$G_c = N\tau Ak^{\frac{1}{1-\chi-\xi}}\frac{h}{\delta}\left(\frac{i}{\delta}\right)^{\frac{\chi}{1-\chi-\xi}}\left(\frac{d}{\delta}\right)^{\frac{\xi}{1-\chi-\xi}} \tag{3-12}$$

$$G_k = N\tau Ak^{\frac{1}{1-\chi-\xi}}\left(\frac{i}{\delta}\right)^{\frac{1-\xi}{1-\chi-\xi}}\left(\frac{d}{\delta}\right)^{\frac{\xi}{1-\chi-\xi}} \tag{3-13}$$

$$M = N\tau Ak^{\frac{1}{1-\chi-\xi}}\left(\frac{i}{\delta}\right)^{\frac{\chi}{1-\chi-\xi}}\left(\frac{d}{\delta}\right)^{\frac{1-\chi}{1-\chi-\xi}} \tag{3-14}$$

and we also can get state-costate equation expressed with variables and constants.

$$\frac{\dot{\lambda}_t}{\lambda_t} = \rho - \eta\Phi \tag{3-15}$$

that is $\Phi = (1-\tau)A^{\frac{1}{\eta}}(N\tau)^{\frac{1-\eta}{\eta}}\left(\frac{i}{\delta}\right)^{\frac{\chi}{\eta}}\left(\frac{d}{\delta}\right)^{\frac{\xi}{\eta}}$

$$\frac{\dot{k}}{k} = \Omega k^{\frac{\eta}{1-\chi-\xi}} - \Psi k^{\frac{(B+\chi\beta)(1-\theta)}{(1-\chi-\xi)(1-\alpha(1-\theta)}} \tag{3-16}$$

$$\Omega = (1-\tau)(N\tau)^{\frac{\chi+\xi}{1-\chi-\xi}}A^{\frac{1}{1-\chi-\xi}}\left(\frac{i}{\delta}\right)^{\frac{\chi}{1-\chi-\xi}}\left(\frac{i}{\delta}\right)^{\frac{\xi}{1-\chi-\xi}}$$

$$\Psi = \left(\frac{\alpha}{\lambda_t}\right)^{\frac{1}{1-\alpha(1-\theta)}}(N\tau A)^{\frac{\xi+\chi\eta}{1-\chi-\xi}}\left(\frac{h}{\delta}\right)^{B}\left(\frac{i}{\delta}\right)^{\frac{(B+\beta\chi}{1-\chi-\xi}}\left(\frac{d}{\delta}\right)^{\frac{\beta(1-\chi)+\chi\xi}{1-\chi-\xi}}$$

Let the return of scale be constant, and assume $\eta+\chi+\xi=1$, then we can get

$$\frac{\dot{\lambda}_t}{\lambda_t} = \rho - \eta\Phi \tag{3-17}$$

$$\frac{\dot{k}}{k} = \Phi k - \Psi k^{\frac{(B+\chi\beta)(1-\theta)}{\eta(1-\alpha(1-\theta))}} \tag{3-18}$$

With these, production function could be rewritten,

$$y = [A(N\tau)^{\chi+\xi}i^{\chi}d^{\xi}\delta^{-(\chi+\xi)}k^{\eta}]^{\frac{1}{1-\chi-\xi}} \tag{3-19}$$

In the steady state, the relation between the variations of potential price of capital λ_t and k, should be the same by boundary condition, so that we can figure out the solution of (3-5),

$$\frac{\dot{c}_t}{c_t} = -\left(\frac{1}{1-\alpha(1-\theta)}\right)\frac{\dot{\lambda}_t}{\lambda_t} \tag{3-20}$$

and as capital accumulation rate should be same to that of consumption, we can write rate of capital increase like follows.

$$\begin{aligned}\frac{\dot{k}}{k} = \gamma &= -\left(\frac{1}{1-\alpha(1-\theta)}\right)\frac{\dot{\lambda}_t}{\lambda_t} \\ &= \left(\frac{1}{1-\alpha(1-\theta)}\right)\{\Phi\eta - \rho\} \\ &= \left(\frac{1}{1-\alpha(1-\theta)}\right)\left\{(1-\tau)\eta A^{\frac{1}{\eta}}(N\tau)^{\frac{1-\eta}{\eta}}\left(\frac{i}{\gamma}\right)^{\frac{\alpha}{\eta}}\left(\frac{d}{\gamma}\right)^{\frac{\beta}{\eta}} - \rho\right\}\end{aligned} \tag{3-21}$$

The relationship between government spending and economic growth rate and shown in graph 1, optimal government spending must meet this condition.

$$\frac{\partial\gamma}{\partial\tau} = \frac{(1-\eta-\tau)\gamma[\gamma A+\rho]}{\tau(1-\tau)[\eta\gamma A+(1-\eta)(\gamma A+\rho)]} = 0$$

that is , $A = 1-\alpha(1-\theta)$ (3-22)

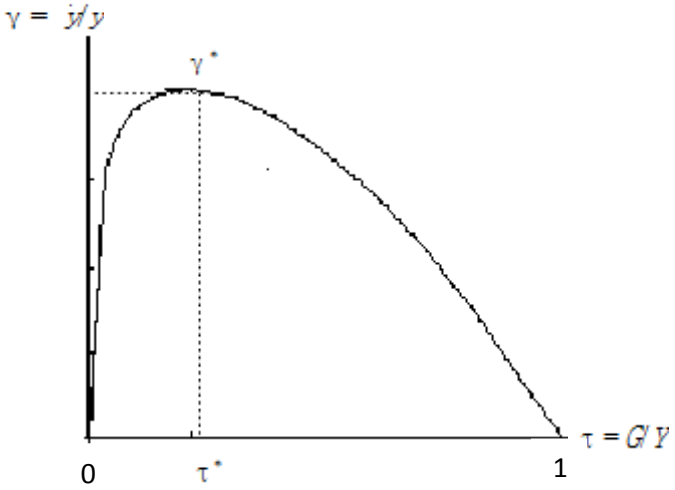
The relationship between economic growth rate γ and government spending τ would be clearer when $\theta = 1$. Substitute this in (2-26), then we can have

$$\frac{\partial\gamma}{\partial\tau} = \frac{(1-\eta-\tau)\gamma}{\tau(1-\tau)(1-\eta)} \tag{3-23}$$

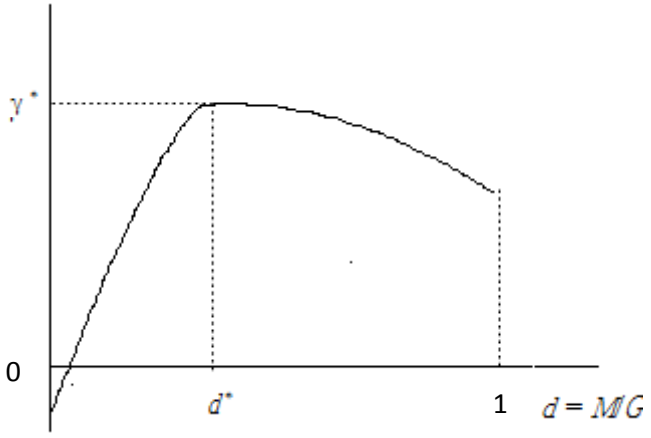
When we establish ratio of government expenditure to the total economy as the same of the elasticity of government spending, the economic growth will be maximized.

With the 1st order condition for optimization $\frac{\partial\gamma}{\partial\tau} = 0$ determines $\tau^* = 1-\eta$. To define optimal ratio of composition in government spending, derivate (3-21) with ratio of defence spending, then 1st order condition for optimization is showed in (3-24)

$$\frac{\partial \gamma}{\partial d}\left\{\frac{\eta\gamma+(\gamma+\rho)(1-\eta)}{(\gamma+\rho)\eta\gamma}\right\}=\frac{\xi}{\eta}\frac{1}{d}-\frac{\chi}{\eta}\frac{1}{i}=0 \qquad (3\text{-}24)$$



<Graph 1> Government Spending and Economic Growth



<Graph 2> Defence Spending and Economic Growth

Therefore optimal composition of government spending can be achieved when the elasticity of each expenditures in government expenditure be the same and ratios of each expenditures should be matched with ratios of their productivity elasticity.

$$\frac{i^*}{d^*}=\frac{\chi}{\xi} \qquad (3\text{-}25)$$

Now, if we can estimate these productivity elasticity through the

empirical test, we can evaluate the optimal composition of government expenditures.

2. Extension of Feder's externality model

In 1982, Feder proposed an externality model to estimate differences in heterogeneous sector's productivities at the first time. This model was highlighted as it has a good framework with neoclassical production function and is possible to be adopted directly to linear regression analysis. In the following vision, it was extended to include export, government, military, financial sectors. After that Ram(1986) utilized the model to measure the effects of defence sector on economy, majority of studies on the subject based on the model. In this paper, the revised model assumes three sectors in the economy: private, defence and non-defence-government sector.

$$Y = C + M + N \tag{3-26}$$

$$C = F(K_C, L_C, M, N) \tag{3-27}$$

$$M = G(K_M, L_M) \tag{3-28}$$

$$N = T(K_N, L_N) \tag{3-29}$$

$$L_C + L_M + L_N = L \tag{3-30}$$

$$K_C + K_M + K_N = L \tag{3-31}$$

$$\frac{G_K}{F_K} = \frac{G_L}{F_L} = 1 + \delta_M \tag{3-32}$$

$$\frac{T_K}{F_K} = \frac{T_L}{F_L} = 1 + \delta_N \tag{3-33}$$

Each variable represent K capital, L labor, M, N, C indicate three sectors; military, nonmilitary, civilian each, and subscriptions in which concerned factors be used.

In this framework, derivate equation (3-26), (3-27), (3-28), (3-29) with time, and using (3-32), (3-33), we can obtain economic growth equation as below.

$$\frac{\dot{Y}}{Y} = \alpha \frac{I}{Y} + \beta \frac{\dot{L}}{L} + \left(\frac{\delta_M}{1+\delta_M} + F_M\right)\frac{\dot{M}}{M}\frac{M}{Y} + \left(\frac{\delta_N}{1+\delta_N} + F_N\right)\frac{\dot{N}}{N}\frac{N}{Y} \quad (3\text{-}34)$$

Moreover, to estimate differences of productivity and externality in a linear regression, assume the production function of private sector as below

$$C = N^{\theta_N} M^{\theta_M} \Phi(K_C, L_C)$$

and using the fact that, and definition of productivity elasticity of military and non-military sector, θ_N and θ_M, rewrite equation (3-34) than we can get final economic growth equation.

$$\frac{\dot{Y}}{Y} = \alpha\frac{I}{Y} + \beta\frac{\dot{L}}{L} + \frac{\delta_M}{1+\delta_M}\frac{\dot{M}}{Y} + \theta_M\frac{\dot{M}}{M}\frac{C}{Y} + \frac{\delta_N}{1+\delta_N}\frac{\dot{N}}{Y} + \theta_N\frac{\dot{N}}{N}\frac{C}{Y} \quad (3\text{-}35)$$

or

$$\frac{\dot{Y}}{Y} = \alpha\frac{I}{Y} + \beta\frac{\dot{L}}{L} + \left(\frac{\delta_N}{1+\delta_N} + F_N\right)\frac{\dot{N}}{Y} + \frac{\delta_M}{1+\delta_M}\frac{\dot{M}}{M}\frac{M}{Y} + \theta_M\frac{\dot{M}}{M}\frac{C}{Y} \quad (3\text{-}36)$$

In chapter 4, equation (3-34), (3-35) or (3-36) will be used to estimate the externalities and productivities of each government sectors.

3. Assessment of Optimal Spending Ratio of GDP

Provision 1 of chapter 3, Barro's Public Model provides criteria to consist sub-government spending in the government budget to maximize economic growth rate. That is optimal composition of government spending can be achieved when the elasticity of each expenditures in government expenditure be the same and ratios of each expenditures should be matched with ratios of their productivity elasticity.

The model include government consumption as a government sector. However we need to introduce total government spending in the model, to calculate optimal defence spending ratio of GDP using the estimates which will be derived from the Feder's externality model.

The public model with total government spending(G_N) is defined as below,

$$\max \int_0^{\infty} e^{-\rho t} u(c, G_N, M) dt \tag{4-1}$$

$$u(c, G_N, M) = \frac{(c^{\alpha} G_N^{\beta} M^{\varepsilon})^{1-\theta} - 1}{1-\theta} \tag{4-2}$$

$$\text{s.t} \quad \dot{k} = (1-\tau) A k^{\eta} G_N^{\chi} M^{\xi} - c \tag{4-3}$$

$$k, G_N, M \geq 0$$

If government decide share of defence and nondefence spending in steady state, like (4-4) and (4-5),

$$\dot{G}_N = nG = \delta G_N \tag{4-4}$$

$$\dot{M} = dG = \delta M \tag{4-5}$$

We can get an equation of growth which is similar to case of previous public model.

$$\frac{\dot{k}}{k} = \gamma = \left(\frac{1}{1-\alpha(1-\theta)}\right)\left\{ (1-\tau)\eta A^{\frac{1}{\eta}} (N\tau)^{\frac{1-\eta}{\eta}} \left(\frac{n}{\gamma}\right)^{\frac{\chi}{\eta}} \left(\frac{d}{\gamma}\right)^{\frac{\xi}{\eta}} - \rho \right\} \tag{4-6}$$

By the 1st order condition $\frac{d\dot{\gamma}}{d\tau} = 0$, we can get criteria to compose the optimal government spending ratio of GDP when $\tau^* = 1 - \eta$.

$$\frac{n^*}{d^*} = \frac{\chi}{\xi} \tag{4-7}$$

This is basically not different form equation (3-25). That means that coefficients of $\frac{\dot{M}}{M}\frac{C}{Y}$ and $\frac{\dot{N}}{N}\frac{C}{Y}$ represent the optimal ratio of GDP for each government spending.

Chapter 4
Empirical Test; Estimation of Productivity and Externality of Defence Sector

As shown in previous chapters, defence sector affects economic growth either positively and negatively in various ways and it cannot be explained based on intuition. It is a matter of measurement. Net effect of defence sector on economic growth can be calculated if we can estimate 2 factors, opportunity cost and Externality.

The opportunity cost of defence sector comes from the difference of productivity from non-defence sector. That means the negative or positive effects on aggregate output of the economy transferring valuable resources to less productive sector from more productive sectors or adverse direction. Another factor, externality of defence sector means defence activities' contributions to whole economy growth. To measure the net economic growth effect of defence sector, it is needed to estimate those two figures and compare them. This chapter examines these two factors empirically and is to find out net economic growth effect of defence sector.

We have to be noticed that the externality of defence sector in the public model of Barro(1990) means the elasticity of production, and if we can estimate it, we are able to discuss on optimal proposition of defence spending in the government spending or gross output of the economy.

Although the purpose of this study is to determine the economic growth effect of ASEAN countries, the empirical test conducted with worldwide data simultaneously to get more general evidence of appropriation of the model first.

1. Panel data sets

163 countries in the Pen World Data set were reviewed to examine the availability of the essential data for the test. As a result, 61 countries was selected. Among 10 member countries of the ASEAN, only 6 counties, Thailand, Malaysia, Singapore, Indonesia, Philippine, Vietnam, are included in the sample set, and other 4 countries are excluded These

countries hadn't reported or announced details of their government spending, even some countries didn't have proper or credible official statistics until mid of 1990's.

The panel data set for this study consist of time series and cross sectional data together and it covers data from 1970 to 2014 for 61 country. As we use 5 year average value, each individual countries has only 9 observations. The list of individual countries is attached in appendix 3.

This world wide data set established based on mainly the Pen World Data Set 10.0(2016) so called ICP data by Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer which has excellent structure to compare across the countries as it revaluated national aggregate data such as GDP and Government Expenditures with proper deflators and Purchase Power of Parity. This PWT referred various sources such as World Development Indicator(WDI) by World Bank, Government Finance Statistics(GFS) by International Monetary Fund etc collectively.

The common tendency of current studies using ICP data is to regard government consumption as a substitute variable for total government spending. Defence related spending data comes from ACDA(US. Arms Control and Disarmament Agency), SIPRI (Stockholm International Peace Research Institute) and IISS (International Institute for Strategic Studies).

The main source of defence spending is WMEAT reports(ACDA), which covers for the whole period of estimate, and utilizes data from SIPRI supplementary. Insofar, WMEAT reports military expenditures on the basis of outlays or disbursements, in contrast to proposed or approved budgetary allocations or "obligational authority," although source data of the latter types are used when disbursements-basis expenditure data are unavailable. Insofar as possible given data quality constraints, WMEAT reporting of military expenditures attempts to follow the NATO definition.

In this definition, (a) civilian-type expenditures of the defence ministry are excluded and military-type expenditures of other ministries are included; (b) grant military assistance is included in the expenditures of the donor country; and (c) purchases of military equipment on credit are

<Table 4-1> Definition of variable and calculation detail

Variables	definition and calculation	Sources
Y	Real GDP (2010 constant)	PWT data set
$\dot{Y}/Y$	Increasing rate of real GDP	"
I/Y	Investment / GDP (1985 constant)	"
$\dot{L}/L$	Increasing rate of Population	"
M	Defence spending(Real GDP * ratio of GDP)	ACDA
$\dot{M}/M$	Increasing rate of military spending (exponential growth rate)	"
N	1. non-military government spending a. (Proposition of Gov't spending from ICP) × RGDP b. (Gov't Spending Ratio in GDP from GFS) * RGDP	PWT data set GFS/ACDA
$\dot{N}/N$	Increasing rate of non-military spending (exponential growth rate)	"
C	Production for Private Sector(Y-N-M)	PWT data set
NCM	Defence Spending ratio in GDP of neighboring countries (/ GDP)	ACDA
MPR	Number of troops per 1000 population	"
MEXP	Defence spending per capita (1985 constant)	"
ZNCMEX	Average of neighboring Countries' military expenditure ratio of GDP	
ZASS	Assassinated personnel per million	Barro & Lee data set
ZTYR25	Average school year for over 25 yr. old	"
ZNOSCH25	Ratio of no schooling for over 25 yr. old	"
NOMPR	NOSCH25 * MPR	"
ZAIM	Arms import/Gross import(1985 constant)	ACDA
ZREVOL	average number of revolution per year	"

* Pen World Table (version 9.0), Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" American Economic Review
* World Development Indicator (WDI), World Bank, 2017

included at the time the debt is incurred, not at the time of payment.16 Nevertheless, for many non-NATO These defence related spending data was deflated with GDP deflator to transfer real term which is coincide with data from the Pen World Data.

2. Method of Estimation

To estimate productivity and externality of each sector, equations below will be estimated.

$$\frac{Y}{Y} = C + \alpha_1 \frac{I}{Y} + \alpha_2 \frac{L}{L} + \left(\frac{\delta_N}{1+\delta_N} + C_N\right)\frac{N}{Y} + \left(\frac{\delta_M}{1+\delta_M} + C_M\right)\frac{M}{Y} \quad (3\text{-}18)$$

$$\frac{Y}{Y} = C + \alpha_1 \frac{I}{Y} + \alpha_2 \frac{L}{L} + \left(\frac{\delta_N}{1+\delta_N}\right)\frac{N}{Y} + \left(\frac{\delta_M}{1+\delta_M}\right)\frac{M}{Y} + \theta_N \frac{N}{N}\frac{C}{Y} + \theta_M \frac{M}{M}\frac{C}{Y}$$

(3-19)

$$\frac{Y}{Y} = C + \alpha_1 \frac{I}{Y} + \alpha_2 \frac{L}{L} + \left(\frac{\delta_N}{1+\delta_N} + C_M\right)\frac{N}{Y} + \left(\frac{\delta_M}{1+\delta_M}\right)\frac{M}{Y} + \theta_M \frac{M}{M}\frac{C}{Y}$$

(3-20)

In the equation (3-18), as the coefficients of defence and non defence sector appears in non-linear forms, we cannot get detail information about the economic effect of defence sector, but it give us the intuition whether the variation of each spending affect economic growth or not and it enhance the credibility of the results from estimation with equation (3-19)

As mentioned in chapter 3, each coefficient of the equation (3-19), α_1 represents the productivity of capital in civil sector, α_2 means $F_L(L/Y)$, while $\left(\frac{\delta_N}{1+\delta_N}\right), \left(\frac{\delta_M}{1+\delta_M}\right)$ gives us specific information that is needed to compare productivities of either defence sector or non-defence sector to private sector. θ_N, θ_M means the elasticitis of defence and non-defence spending ratio of GDP for economic growth rate.

Equation (3-20) is a combination of equation (3-18) and (3-19),

allows us to estimate productivity gap and externality of defence sector separately.

Panel data set for this test combines time series and cross sections. There are number of advantages to using panel data. It provides more observations for estimation and the researchers are able to undertake in depth analysis of complex economic hypotheses by controlling for influences corresponding to both individual and time heterogeneity.

Following the common method in econometric analysis with panel data, this research undertakes Ordinary Least Square estimation (OLS) first and compares the test results with those of Fixed Effect Model (FEM) and Random Effect Model(REM) to define most appropriate method for inconsistent and unbiased coefficients.

The fundamental econometric model is as below.

$$y_{j,t} = \alpha_j^* + \beta' x_{j,t} + \lambda_t + u_{j,t} \qquad \begin{matrix} j = 1, 2, \cdots N \\ t = 1, 2, \cdots T \end{matrix} \tag{2-1}$$

The disturbance term in the model consists of three terms, individual characteristics (α_j), time characteristics (λ_t), and random error term($u_{j,t}$). The most common analysis method for such a model is Fixed Effect Model that is reasonable when we can be confident that the difference between countries can be viewed as parametric shifts of the regression function. On the other hand, if we can assume that these parametric shifts has characteristic of normal distribution, we can get more efficient and inconsistent coefficient with Random Effect Model. This REM is based on idea that dependent variable is affected by numerous independent variables and these effects can be summarized as a disturbance.

It is known that estimates from FEM and REM show big difference when not enough observations are included in the sample. In the case that there is model specification error, estimates of FEM are still consistent but not efficient. while those of REM has efficiency but not consistency. The panel data set for this study has relatively enough observations in cross section but it has 9 or less observations in time series. Which method is appropriate depends on the ways of sampling and commonness among countries in the sample. If samples were selected based on specific criteria, FEM will be desirable. Otherwise, if we are

confident that the sample can represent the whole population, REM is more desirable.

As the sample countries in data set was selected by availability, it is somewhat random but, as we discuss chapter 3, it is quite possible that the independent variables can be affected by various characteristics of individual country such as other economic, politic, social and cultural factors. In this case, the Fixed Effect Model is expected to get more efficient and consistent estimate However, some model specification tests such as LM-Test(Lagrange Multiplier Test) and Hausman-Test are available to determine which method is the best among 3 options.

3. Results of Estimation

3.1 Estimation for Whole Sample Group

<Table 4-2> summarizes the results of OLS, FEM and REM estimation with whole sample. Coefficients of N/Y and M/Y in Model 1, represent these net effects of defence and non-defence government spending on the whole economy. However the figures of coefficients for defence and non-defence sector in Model 1 are not easy to interpret because those coefficient is appeared the nonlinear form of productivity differences terms and externality terms as shown in equation (3-19). Those coefficients show us only how significantly a specific sectors affect economic growth and provided reference to interpret the results of estimation with model 2

As shown in the table, estimates related both defence and non-defence variables, N/Y and M/Y are significant and it is noticeable that coefficients are positive. That means each government sectors contribute to economic growth rate positively in net. Let's investigate the results of Model 2 which allow us to estimate externality and productivity difference separately. Fortunately, three methods of estimation do not bring different results fundamentally. Productivities of the each government sectors are inferior to private sector while externality is appeared as positive.

To refer to detail figures, we should determine which econometric

<Table 4-2> Estimation for Whole Sample.

Model 1	OLS		FEM		REM	
	coeff.	t	coeff.	|t	coeff.	t
constant	0.011	2.98	1.46	1.46	0.011**	2.97
L/L	0.372**	2.97	- 0.062	-0.25	0.370**	2.59
I/Y	0.025*	2.01	0.064**	2.95	0.025*	2.01
N/Y	1.155**	10.31	1.091**	9.72	1.154**	10.31
M/Y	3.105**	8.30	2.874**	7.62	3.102**	8.30
R^2	0.2823		0.2238		2823	
F-test	45.82 (0.000) : OLS < FEM					
LM-test	0.68 (0.409) : OLS < REM					
Hausman test	251.88 (0.000) : FEM < REM					

Model 2	OLS		**FEM**		REM	
	coeff.	t	**coeff.**	**|t**	coeff.	t
constant	0.011**	3.05	**0.011**	**1.93**	0.011*	3.05
L/L	0.303*	2.19	**-0.070**	**-0.29**	0.303	2.19
I/Y	0.017	1.40	**0.042***	**1.97**	0.017**	1.40
N/Y	-0.093**	-2.71	**-0.100****	**-2.82**	-0.093**	-2.71
M/Y	-0.348**	-3.77	**-0.340****	**-3.57**	-0.348**	-3.77
$\frac{N}{N}\frac{C}{Y}$	0.167**	4.51	**0.145****	**3.67**	0.167**	4.51
$\frac{M}{M}\frac{C}{Y}$	. 0.104**	4.42	**0.090****	**3.62**	0.104**	4.42
Implied $1+\delta_N$	0.915		**0.909**		0.915	
Implied $1+\delta_M$	0.741		**0.746**		0.741	
R^2	0.3341		0.3121		0.3341	
F-test	45.32(0.000) : OLS < FEM					
LM-test	0.04(0.842) : OLS < REM					
Hausman-test	25.02(0.003) : FEM < REM					

**: significant in 1% confidence level, *: 5% significant in 5% confidence level,
( ): Probability to reject null hypothesis

method is to be used. As F-test statistics cannot delete null hypothesis that FEM is better than OLS, and Hausman test rejects the null hypothesis that REM is more desirable than FEM. Thus we can reach the conclusion

that FEM is the most desirable to get more consistent and efficient estimates.

According to the result of FEM estimation, the productivity of defence sector is 25.4% lower than private's sector, while nondefence sector, is 9.1% lower. This is accordance with traditional view that military expenditure is certain burden to the economy and brings opportunity cost, but this cost should be compared with externalities of each sectors.

As we discussed in chapter 3, coefficients of $\frac{\dot{N}}{N}\frac{C}{Y}$ and $\frac{\dot{M}}{M}\frac{C}{Y}$ can be interpreted as elasticity of private production, in other words, that is externality of each sector to economy. Values of coefficients of $\frac{\dot{N}}{N}\frac{C}{Y}$ and $\frac{\dot{M}}{M}\frac{C}{Y}$ are 0.145 and 0.090 as shown in the table 4-2. Those means that 10% increase of defence spending brings 0.9% increase of production in private sector, while 10% increase of non-defence spending causes about 1.45% increase of production.

As we found in equation 3-25, in chapter 3, optimal composition of government spending can be achieved when the elasticity of each expenditures in government expenditure be the same and ratios of each expenditures should be matched with ratios of their productivity elasticity. That means the coefficient of $\frac{\dot{N}}{N}\frac{C}{Y}$ and $\frac{\dot{M}}{M}\frac{C}{Y}$ represent optimal government spending ratios of GDP. Therefore, saying in average, total government spending should be about 24.5% of GDP, and 14.5% and 9% of GDP should be allocated to non-defence and defence spending each to maximize the economic growth. This result is accordance with the study of Landau(1993) which showed that relation between military expenditure and economic growth turns to negative from positive around 4-9% level of military spending ratio of GDP.

However this result doesn't lead directly to conclusion that we have to increase defence expenditure to 9% of GDP. The reason for it will be discussed in end of chapter 4, after path analysis on how externality of defence sector affect the economic growth. The thing we should be noticed, the results implies considerable motivation of for individual countries to increase their defence spending not only for security itself but also for economic growth.

Moreover, this results represent mere average values though the whole sample countries which are various in level of defence industry. To

explore this structural gap among the sample countries, the whole sample group divided into 2 group, 21 advanced and 40 developing group countries and same estimations were done.

3.2 Estimation for advanced and developing country group

Table 4-3 shows estimates for advanced country group. The sample for the estimation is consist of 21 countries which GDP per capita is over 20,000 US$ evaluated constant in 2010 base by 2000. In the condensed model 1, the coefficient of N/Y and M/Y is also clearly significant and positive as the test for whole sample, but the test fails to get meaningful estimates of government sectors in model 2. This is coincide with results of numerous previous studies. As one of reasonable explanations, we can mention to existence of economy of the scale. As we discussed in chapter 2, defence industry which requires considerable initial investment and high cost of R&D tends to have characteristics of economy of scale.[1] If demand for the industry is not enough, inefficiency would be inherited in the industry. It is possible that some countries in the group achieved economy of the scale in the defence industry, while rest in the group are operating their defence industries with a political reason rather than economic. In that case, the productivity of the defence sector could be measured unobvious.[2] However the test show us that there are no obvious structural gap between private and defence sector in advanced country group. It is interesting that externality of government sector is not significant in advanced country group. Especially, considering that externalities of the defence sector comes from security effect, spin off effect, or human capital formation and so on, we can guess those effects of defence sector don't work well in high income group.

The results from the test for middle and low income group is extremely contrasted to the case of the high income group and casting

[1] Regarding on reterns of scale in defence industry, refer to Keith Hartley and Todd Sandler, ed., *Handbook of Defence Economics*, Elsevier, 1995.

[2] Brauer, Jurgen, "Military Investments and Economic Growth in Developing Nations," *Economic Development and Cultural Change*, 1991.

<Table 4-3> Estimation for advanced countries group

Model 1	OLS		FEM		REM	
	coeff.	t	coeff.	|t	coeff.	T
constant	-0.003	-0.82	- 0.005	-0.81	- 0.003	-0.82
L/L	0.753**	3.68	0.065	0.36	0.753**	3.68
I/Y	0.048**	3.21	0.048*	2.87	0.048**	3.21
N/Y	0.145**	4.88	0.159**	5.05	0.145**	4.88
M/Y	0.091**	3.54	0.071**	2.60	0.091**	3.54
R^2	0.4433		0.4103		0.4433	
F-test	1.17 (0.284)		: OLS < FEM			
LM-test	0.08 (0.776)		: OLS < REM			
Hausman test	9.24 (0.055)		: FEM < REM			

Model 2	OLS		**FEM**		REM	
	coeff.	t	**coeff.**	**|t**	coeff.	t
constant	- 0.001	-0.29	**- 0.002**	**-0.43**	- 0.001	-0.29
L/L	0.767**	3.72	**0.144****	**0.43**	0.767**	3.72
I/Y	0.040*	2.47	**0.057***	**2.33**	0.040*	2.47
N/Y	- 0.122	-0.60	**- 0.108**	**-0.47**	-0.122	-0.60
M/Y	- 0.098	-1.86	**- 0.103**	**-1.90**	-0.098	-1.86
$\frac{\dot{N}}{N}\frac{C}{Y}$	0.309	1.32	**0.316**	**0.18**	0.309	1.32
$\frac{\dot{M}}{M}\frac{C}{Y}$	- 0.008	-0.15	**- 0.038**	**-0.70**	- 0.008	-0.15
Implied $1+\delta_N$	-		-		-	
Implied $1+\delta_M$	-		-		-	
R^2	0.4486		0.3256		0.4486	
F-test	12.45(0.000)		: OLS < FEM			
LM-test	2.37(0.123)		: OLS < REM			
Hausman-test	5.20(0.518)		: FEM < REM			

**: significant in 1% confidence level, *: 5% significant in 5% confidence level,
( ): Probability to reject null hypothesis

<Table 4-4> Estimates of developing countries group

Model 1	OLS		FEM		REM	
	coeff.	t	coeff.	|t	coeff.	t
Constant	0.018**	3.44	0.014*	1.92	0.018**	3.44
L/L	- 0.030	-0.14	- 0.049	-0.16	-0.030	-0.14
I/Y	0.031*	1.77	0.053*	1.85	0.031*	1.77
N/Y	0.223**	8.70	0.211**	8.20	0.223**	8.70
M/Y	0.560**	6.54	0.533**	6.15	0.560**	6.54
R^2	0.2793		0.2757		0.2793	
F-test	30.37 (0.000)		: OLS < FEM			
LM-test	0.63 0.429)		: OLS < REM			
Hausman test	27.75 (0.000)		: FEM < REM			

Model 2	OLS		**FEM**		REM	
	coeff.	t	**coeff.**	**|t**	coeff.	t
constant	0.016**	3.21	**0.015***	**2.05**	0.016**	3.21
L/L	0.022	0.05	**- 0.013**	**-0.05**	0.022	0.05
I/Y	0.033*	1.32	**0.033***	**1.19**	0.033*	1.32
N/Y	- 0.088*	2.24	**-0.095***	**2.35**	- 0.088*	2.24
M/Y	- 0.337**	3.23	**-0.314****	**2.93**	- 0.337**	3.23
$\frac{N}{N}\frac{C}{Y}$	0.172**	3.96	**0.147****	**3.21**	0.172**	3.96
$\frac{M}{M}\frac{C}{Y}$	0.088**	3.26	**0.086****	**3.04**	0.088**	3.26
Implied $1+\delta_N$	0.919		**0.913**		0.919	
Implied $1+\delta_M$	0.748		**0.761**		0.748	
R^2	0.3315		0.3302		0.3315	
F-test	29.91(0.000)		: OLS < FEM			
LM-test	0.14(0.713)		: OLS < REM			
Hausman-test	17.59(0.007)		: FEM < REM			

**: significant in 1% confidence level, *: 5% significant in 5% confidence level,
( ): Probability to reject null hypothesis

<Table 4-5> Estimation for ASEAN Member Group

Model 1	OLS		FEM		REM	
	coeff.	t	coeff.	|t	coeff.	t
constant	0.026**	3.29	0.030	0.29	0.026**	3.29
L/L	0.052	0.12	0.183	0.01	0.052	0.12
I/Y	0.018	1.04	0.000	0.621	0.018	1.04
N/Y	0.108**	2.35	0.085	1.59	0.108*	2.35
M/Y	0.159**	4.58	0.157**	4.46	0.159**	4.58
R^2	0.4490		0.4342		0.4490	
F-test	1.08 (0.386)		: OLS < FEM			
LM-test	0.05 (0.815)		: OLS < REM			
Hausman test	10.77 (0.029)		: FEM < REM			

Model 2	**OLS**		FEM		REM	
	coeff.	**t**	coeff.	|t	coeff.	t
constant	**0.028****	**3.24**	0.035	2.17	0.028**	3.24
L/L	**- 0.003**	**-0.01**	0.037	0.06	- 0.003	-0.01
I/Y	**0.011**	**0.56**	- 0.012	-0.32	0.011	0.56
N/Y	**- 0.073**	**-0.26**	- 0.088	-0.26	- 0.073	-0.26
M/Y	**- 0.150****	**-2.20**	- 0.138*	-1.98	- 0.150**	-2.20
$\frac{\dot{N}}{N}\frac{C}{Y}$	**0.234**	**0.63**	0.225	0.51	0.234	0.63
$\frac{\dot{M}}{M}\frac{C}{Y}$	**0.004**	**0.01**	0.020	0.26	0.004	0.01
Implied $1+\delta_N$	-		-		-	
Implied $1+\delta_M$	**0.869**		0.878		0.869	
R^2	0.4549		0.4317		0.4549	
F-test	1.04(0.4101)		: OLS < FEM			
LM-test	0.07(0.7949)		: OLS < REM			
Hausman-test	9.85(0.1310)		: FEM < REM			

**: significant in 1% confidence level, *: 5% significant in 5% confidence level,
( ): Probability to reject null hypothesis

more insights for the developing countries. As shown in Table 4-3, the productivity gap between defense and private sector is not much different from that of whole sample group and appeared even higher. Provably, it is not because productivity of defence sector in developing country group is higher than advanced country group, but because productivity of private sector is not so higher than defence sector in developing countries.

In so far as externality, the coefficients of and are 0.147 and 0.086 as shown in the table 4-4. Those means that 10% increase of defence spending brings 0.86% increase of production in private sector, while 10% increase of non-defence spending causes about 1.47% increase of production. The results is consistent with estimation for whole sample.

Then, how about ASEAN countries? Table 4-5 shows us estimates of ASEAN 6 members. The result of estimation for these countries is quite different from middle and low income group, even though 5 ASEAN members are included in to middle and low income group. Only constant efficient of is significant, but nothing else. As the results, productivity of defence sector is about 87% of the private sector, which is less lower than in whole middle and low income group. Externality of government sectors is not revealed by the test. Coefficients of the government sector is not significant statistically and even the value of the coefficient appeared smaller than whole sample.

The results of empirical test up to now propose possibility that each group or individual country has an endogenous factor related to externality of defence sector. We need further analysis on how externality works on the economy.

4. Analysis of varying coefficient model; a path analysis

4.1 Model Specification

To examine the path which defence sector project externality to economy, we can establish a Varying Coefficient Model. It assumes that coefficient of $\frac{M}{M}\frac{C}{Y}$ is a function of some exogenous variables representing possible paths or elements of externality. Let's set up a

model which has K of fixed coefficients and 1 varying coefficient as below.

$$y_{it} = c_i + \beta_1 x_{1,it} + \cdots + \beta_K x_{K,it} + \nu_i w_{it} + u_{it}, \quad \forall\ i = 1,2,\cdots,N, \quad t = 1,2,\cdots,T.$$
$$\nu_i = \delta_0 + \delta_1 z_{1i} + \cdots + \delta_\omega z_{\omega i} + \eta_i, \quad u_{it} \sim N(0,\sigma_u^2) \qquad (4\text{-}2)$$

And then, substituting with varying coefficient in the model, we get the econometric model equation (4-3)

$$y_{it} = c_i + \beta_1 x_{1,it} + \cdots + \beta_K x_{K,it} + \delta_0 w_{it} + \delta_1 z_{1i} w_{it} + \cdots + \delta_\omega z_{\omega i} + \eta_i w_{it} + u_{it},$$
$$\forall\ i = 1,2,\cdots,N, \quad t = 1,2,\cdots,T.,$$
$$u_{it} \sim iidN(0,\sigma_u^2), \qquad (4\text{-}3)$$

Regarding on error term, if it has the distribution of $\eta_i \sim iidN(0,\sigma_\eta^2)$ in model (4-3), OLS can get neither consistent nor efficient estimate because of explanatory variable w_{it} included in error term $v_{it} = \eta_i w_{it} + u_{it}$. On the other hand, if we can assume $\eta_i = 0 \quad \forall i$, then, error term gets property of $v_{it} = u_{it}$, it is possible to get consistent and efficient estimates with OLS. Therefore, it is matter whether η_i is 0 or a variable with certain distribution. To examine this, set up the hypothesis as below

H_0 : $\eta_i = 0$

H_A : $\eta_i \sim iidN(0,\sigma_\eta^2)$

We can get $\hat{v}_{it}$ performing OLS with model (4-3) under the null hypothesis. Then, if heteroschadasticity test does not reject the null hypothesis, we can say $\eta_i = 0$. It is known that, after regression of $\hat{v}_{it} = a + bw_{it}$ under the null hypothesis, 1/2 of gap between TSS(Total Sum of Squares) and RSS(Residual sum of squares) has a distribution of with freedom of degree of numbers of independent variables. In this study, Goldfeld-Quandt test was used as a heteroschadasticity[3] test with the model as below.

[3] In statistics, a collection of random variables is heteroschadastic, if there are sub-populations that have different variabilities from others. Here "variability" could be quantified by the variance or any other measure of statistical dispersion. Thus heteroschadasticity is the absence of homoschadasticity.

$$\frac{Y}{Y} = c_j + \alpha\frac{I}{Y} + \beta_1\frac{L}{L} + \beta_2\frac{N}{Y} + \beta_3\frac{N}{N}\frac{C}{Y} + \beta_4 + \frac{M}{Y} + \gamma_j\frac{M}{M}\frac{C}{Y} + u_i$$

$$\gamma_j = \delta_0 + \delta_1 NCM + \delta_2 TYR25 + \delta_3 NOMPR + \delta_4 ASS + \delta_5 AIM + \eta_j$$
$$= f(Z) + \eta_j$$

Results of a Goldfeld-Quandt test found that statistic value of (TSS-RSS)/2 $\sim \chi^2(1)$ is 0.0520 and its confidence level is 0.819, so that cannot reject the null hypothesis $\eta_j = 0$. Therefore it allows further OLS estimation with the assumption that coefficient of $\frac{M}{M}\frac{C}{Y}$ has $\gamma_j = f(Z)$.

As discussed in chapter 2, externality of the defence sector is derived as a collective results of various effects such as security effect, spin-off or siphon-of, militarization effect and so on. Unfortunately, it is limited to find suitable data to introduce all those factors in the model, so that we have to choose some substitute variables to check those effects indirectly with reasonable assumption. Therefore only some of key effect will be examined in this study. Exogenous variables (Z) affecting coefficient of defence sector's externality considered in model are as below,

a. Neighbor countries' military expenditure ratio (ZNCMEX): This is a substitute variable to level of external threat. We can expect security effects of defence sector will be increased with the high threat.

b. Assassinated person per million (ZASS): This is introduced in the model to substitute to level of internal threat.

c. Average school year of over 25 years old population (ZTYR25): This is an indicators of how human resource is abundant. As discussed in chapter 2, siphon-off effect of defence sector will be reduced and eventually the negative externality of defence sector will be decreased.

d. No schooling population rate (NOMPR): As we discussed, we can expect that military training or education can contribute to human capital formulation, and it is more effective in the poorer educational environment. The actual data is multiplied by value of military personnel per 1,000 population.

e. Arms import as a ratio of GDP (ZAIM): According to previous studies, arms import may bring both of positive and negative effect on the economy. This indicator is to examine just whether arms import affects

the economic growth.

In the matter of fact that, other various substitute variables such as military expenditure per military personnel, revolution frequency and other conflict related indicators was introduced in the model, but it failed to get any significant results.

4.2 Results of estimation; paths for transferring externality

Table 4-6 show us the results of the estimation when we introduce the variables one by one, and some combinations of them.

Neighbor countries military expenditure ratio of GDP is significantly positive as we expected in not only model 5, but also model 7, 8, 9. It provides robust evidence for fact that defence sector produces the security and ensure stable environment for economic activities.

At this moment, we may discuss on the optimal level of defence spending which was mentioned above. By the result of estimation with whole sample and middle/low income group, the optimal defence spending ratio of GDP reached near 9% which is so higher than actual spending. It implies considerable motivation for individual countries to increase their defence spending not only for security itself but also for economic growth. Then, do we have to increase the defence spending to maximize economic growth? The optimal defence expenditure ratio of GDP is invalid, when we consider dynamics of international reaction. As we saw, the result of path analysis with neighbor countries military expenditure variable show us, there are strong interaction between externality and neighbor countries' military expenditure. That means, if average level of the military expenditure is raised, optimal level of defence spending will be raised at the same time. In other words, the optimal defence spending level itself should be reduced by decreasing actual defence spending.

Average school year of over 25 years old population(ZTYR25) is not very significant in model 4 which introduce the variable alone, but appeared significant positive in the model 7, 9. It is indirectly appeal fact that, if human capital is abundant in the economy, transfer of human resources to defence cannot be a heavy burden to economy, moreover it improves efficiency of defence sector.

<Table 4-6> Results of estimation with varying coefficient model

	Model.3		Model.4		Model.5		Model.6	
	coeff.	t	coeff.	t	coeff.	t	coeff.	t
constant			- 0.0150	-2.09	0.0079		- 0.230	-0.46
L/L	- 0.0243	- 0.05	0.8340**	4.29	0.2031**	0.02	0.200**	3.63
I/Y	0.2034**	3.69	- 0.1400**	-5.55		3.73	- 0.782*	-2.03
N/Y	- 0.0740	-1.92	- 0.0663	-1.76	- 0.0605	-1.57	- 0.078	2.03
M/Y	- 0.0233	-0.07	0.1418	0.47	- 0.0772	-0.23	0.140**	4.01
$\frac{N}{N}\frac{C}{Y}$	0.1253**	3.49	0.1300**	4.06	0.1326**	3.82	0.277	0.91
$\frac{M}{M}\frac{C}{Y}$	0.0723**	3.99	0.0655**	2.21	0.0430	1.63	0.728**	3.11
ZAIM	**0.0049***	**2.01**	-	-	-	-	-	-
ZTYR25	-	-	0.0066	0.97	-	-	-	-
ZNCM	-	-	-	-	**1.3803***	**2.53**	-	-
ZNOMPR	-	-		-	-	-	0.111	1.73
R^2	0.5985		0.5923		0.6035		0.596	

	Model.7		Model.8		Model.9	
	coeff.	t	coeff.	t	coeff.	t
constant						
L/L	- 0.123	-0.03	- 0.027	-0.05	- 0.006	-0.02
I/Y	0.266*	4.76	0.258**	4.52	0.265**	4.78
N/Y	- 0.078	-1.76	- 0.067	-1.77	- 0.079	-1.77
M/Y	- 0.176	-0.48	- 0.024	0.07	- 0.175	-0.48
$\frac{N}{N}\frac{C}{Y}$ $\frac{M}{M}\frac{C}{Y}$	0.009	-0.05	0.054	1.18	0.011	-0.26
ZAIM	0.006*	2.18	0.005	1.80	0.006*	2.186
ZNCM	1.234*	1.92	1.180*	1.82	1.222*	1.940
ZTYR25	0.017*	2.05	-	-	0.017*	2.075
ZNOMPR	- 0.001	-0.10	0.000	-0.32	-	-
ZMEXP	- 0.000	-0.24	- 0.000	-0.45	0.000	0.321
ZASS	0.006*	2,18	- 0.704	-0.20	- 0.154	-0.444
R^2	0.591		0.5805		0.5902	

**: significant in 1% confidence level, *: 5% significant in 5% confidence level,

However, no school rate (NOMPR) which is multiplied by military personnel per population is not significant in every model. It seems that human capital spillover effect of defence sector is ignorable.

Arms import rate (ZAIM) brought some interesting results. Coefficient of the ZAIM is significant positive in model 3 and model 7, 9. It is different from presumption that arms import would be harmful for economy transferring scarce foreign currency to defence factor, and reduce import of essential capital for economy. As we survey on returns of the scales in defence industry, for majority of the sample countries, it costs less when they import their military equipment than when they produce them for themselves. It is also possible that Arms trading might enhance the political or military bond with exporting countries and bring additional security effects

Assassination rate(ASS) which was introduce as an indicator of internal instability is significant positive only in the model 7, while the coefficient shows negative in other models. It seems that defence sector's role for internal security is ignorable.

Chapter 5. Conclusions

This study re-examine and measure the effect of the national defence sector on the economic growth. Regarding on the fact that the externality and human capital ensure the property of constant return to scale of production function in the frame of the endogenous growth theory, this paper investigates whether the national defence can take such a role.

For this, the linkage between the defence expenditure and the economic growth in previous theoretical and empirical studies was surveyed and the externality by the national defence sector was measured. In order to measure the externality on the private sector by the national defence sector, the method proposed by Feder(1986), which is appropriate in measuring the externality and the difference of productivity between heterogeneous economic sectors, was expanded and revised. The revised model assumes three sectors in the economy: private, defence and non-defence-government sector.

The empirical test with the panel data of 61 countries from 1970 to 2014 found strong evidence of externality of defence sector to private sector in developing country group. It has been argued in several ways how the national defence gives the externality. Path analysis with various substitute variables suggests possibility that the defence sector gives the externality mainly through national security and human capital.

The empirical findings may also interpreted as the followings:

Firstly, the decrease of defence spending driven by the industrial nations since 1990's had little or no impact on the economic growth. It can be suggested that so called, “peace dividend” was not realized from the decrease in defence spending.

Secondly, the optimal level of defence spending to maximize the economic growth is higher respectively than their actual values. However, this does not imply that defence spending should be increased. If average level of defence spending arises, optimal ratio of defence expenditure rises again. This implies that efforts for international peace are crucial, rather than increasing defence spending.

Thirdly, nevertheless, the empirical results means each individual nation has incentive to increase its defence spending especially in developing countries group. As long as regional conflicts and tension is maintained or increased, developing countries are willing to increase their defence expenditure inevitably.

Even the empirical test in this paper couldn't derive much significant estimates of ASEAN group, it still provides some implications for ASEAN members to enhance their own economic growth engine.

First of all, considering the productivity gap between defence sector and private sector, efficiency of defence management should be improved, so that produce maximum security with minimum resources.

Secondly, it is highly recommended that each member of ASEAN specialize its defence industry on specific area, and promote regional exchange and cooperation in defence industry. As mentioned, a prime preposition to achieve the economy of scale and to ensure efficiency of defence industry is the sufficient demand of the market. It may results in not only enhancement of alliance, but also improvement of interoperability among ASEAN forces.

Thirdly, as the incentives underlying the decisions of management in defence sector are not same as the incentives facing private sector, the externality of defence sector is not properly considered in defence policy and its implementation. Defence management should be more focused on cultivating positive externality of defence sector as below,

a. Stimulation of the military project related local development; Military infrastructure such as a transportation, communication network, and water management is more effective in remote area where those are relatively scarce. It also facilitates the balanced development of national territory and contribute directly or indirectly to economic development.

b. Development of HA/DR capability and peace keeping; As a readiness for other operation than war, the role of military for humanitarian assistance and disaster reliefs relief government's burden and contribute to internal stability. Moreover, participating in the international PKO mission will contribute to enhance their value of national brand in international society

c. Enlargement of the educational opportunity for military

personnel and improvement of military education to cultivate human capital; Human capital is crucial to economic growth and military can take an educational roles for cultivating useful skill and fostering the democratic citizenship. Moreover, more opportunities for personal or professional development including education reimbursement programs and various programs for medical and health are also recommended for enhancing the engine for economic growth.

d. Activation of offset trade in arms trading to spill over high technology or to create demand for national industry; Arms imports provide good opportunities to introduce in direct technological transfers when they take the form of a licensed production of military weapons or some of their parts. As we see in ROK cases, it provide short cut to catch up the advanced technology and to increase the spillover effects to private sector.

e. Mitigation of restrictions to improve economic performance of private sector; It is needed to improve defense regulations and promote private's benefits to the extent that military operations are not affected. This includes protection civilian property rights, and mitigation of restriction on the areas surrounding military installations in a reasonable manner. These measures reduce the cost of production in private sector and stimulate the economy.

Although this paper provides strong theory of economics and econometrics methodology, plagued limitations are still inherited. Studies on defence spending include various political and social factors. These factors are hard to be quantified and has very complicate and numerous cause-and-effect relationship each other. Nevertheless, this paper used only few substitute variables of them, there are possibility that some important factor is omitted, it could cause misspecification problems. Especially, it is highly recommended to develop the model specifying technical spillover effect for further studies. Moreover, the empirical model in this paper doesn't consider dynamics, and cannot catch how the externality of defence sector spillover abroad. The game theory or arms race model may provide useful tool for following study. However this study is one of follow-up study to Barro(1990) and 3 sector model in this study can be extended to other various government spending.

APPENDIX

1. LIST OF SAMPLE COUNTRIES

Group	Entries
Developed (high income)	Austria, Australia, Belgium, Canada, Denmark, Finland, France, Greece, Germany, Ireland, Japan, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, U.K., U.S.A
Developing (middle and low income)	Algeria, Argentina, Bolivia, Brazil, Cameroon, Chile, Colombia, Dominican Rep, Ecuador, El Salvador, Ghana, Guatemala, Guyana, Honduras, India, Indonesia, Iran, Israel, Rep. of Korea, Malawi, Malaysia, Mali, Mexico, Nicaragua, Pakistan, Panama, Paraguay, Peru, Philippines, Senegal, Sierra Leone, South Africa, Sri Lanka, Thailand, Vietnam, Togo, Trinidad T., Tunisia, Turkey, Uruguay, Venezuela, Vietnam

2. LIST OF NEIBHORING COUNTRIES

Country	Neighboring Countries	
Algeria	Mauritania, Niger, Morocco, Tunisia, Mali, West Sahara, Libya	7
Argentina	Brazil, Bolivia, Paraguay, Chile, Uruguay	5
Australia	Indonesia, Papua New Guinea, New Zealand	3
Austria	Germany, Italy, Hungary, Czechoslovakia, Switzerland, Yugoslavia	6
Belgium	France, Luxembourg, Germany, Netherlands, U.K	5
Bolivia	Peru, Brazil, Paraguay, Chile, Argentina	5
Brazil	Colombia, Venezuela, Guyana, Peru, Bolivia, Paraguay, Argentina, Uruguay, Suriname, French Guyana	10
Cameroon	Nigeria, Gabon, Cent. Af Rep, Congo, Equatorial Guinea Chad	5
Canada	U.S.A	1
Chile	Peru, Bolivia, Argentina	3
Colombia	Panama, Venezuela, Ecuador, Peru, Equatorial Guinea Chad	5
Denmark	Haiti, Jamaica, Trinidad Tobago, Cuba, Rep Bahamas, Antigua, Grenada, Barbados, Martinique	3
Dominican R.	Haiti, Jamaica, Trinidad Tobago, Cuba, Bahamas, Antigua, Grenada, Barbados, Martinique,	9
Ecuador	Colombia, Peru	2
El Salvador	Guatemala, Honduras, Nicaragua	3
Finland	Soviet Union, Sweden	2
France	Spain, U.K. Belgium, Luxembourg, Germany, Switzerland, Italy	7
Germany	Belgium, Netherlands, Denmark, Sweden, Poland, Czechoslovakia, Austria, Switzerland, France, Luxembourg, U.K	11
Ghana	Cote d'Ivoire, Togo, Burkina Faso	3

2. LIST OF NEIBHORING COUNTRIES (Cont.)

Country	Neighboring Countries	
Greece	Albania, Bulgaria, Turkey, Italy, Yugo	5
Guatemala	Mexico, Honduras, El Salvador, British Honduras	4
Guyana	Venezuela, Brazil, Suriname, Peru, Paraguay, Argentina, Uruguay, French Guyana	8
Honduras	Guatemala, El Salvador, Nicaragua	4
India	Malaysia, Singapore, Philippines, Australia, Myanmar	5
Indonesia	Malaysia, Singapore, Philippines, Australia, Papua New Guinea	5
Iran	Turkey, Iraq, Saudi-Arabia, Kuwait, Pakistan, Russia(Soviet Union), Qatar, Bahrain, U.A.E, Oman, Afghanistan	11
Ireland	U.K	1
Israel	Egypt, Syria, Jordan, Saudi-Arabia, Lebanon	5
Japan	Korea, N, Korea, Russia, China	4
Rep. of Korea	N. Korea, Japan, Russia, China	4
Malawi	Tanzania, Zambia, Mozambique	3
Malaysia	Thailand, Singapore, Philippines, Indonesia	4
Mali	Senegal, Mauritania, Niger, Cote d'Ivoire, Algeria, Guinea, Burkina Faso	7
Mexico	U.S.A, Guatemala, Cuba, British Honduras	4
Netherlands	Belgium, Germany, U.K	3
New Zealand	Australia	1
Nicaragua	Honduras, El Salvador, Costa Rica	3
Norway	Sweden, Denmark, U.K. Iceland	4
Pakistan	India, Russia, Afghanistan, China ran	5
Panama	Costa Rica, Colombia	2
Paraguay	Brazil, Bolivia, Argentina	3

2. LIST OF NEIBHORING COUNTRIES (Cont.)

Country	Neighboring Countries	Num.
Peru	Colombia, Ecuador, Brazil, Bolivia, Chile	5
Philippines	Taiwan, Malaysia, Papua New Guinea, China, Indonesia, Hong Kong, Vietnam	7
Portugal	Spain	1
Senegal	Mauritania, Gambia, Cape Verde, Mali, Guinea, Guinea-Bissau	6
Sierra Leone	Liberia, Guinea	2
Singapore	Malaysia, Indonesia	2
South Africa	Zimbabwe, Mozambique, Namibia, Lesotho, Botswana, Swaziland	6
Spain	Portugal, France, Morocco	3
Sri Lanka	India, Maldives, Islands	3
Sweden	Norway, Finland, Russia, Poland, Denmark, Germany	6
Switzerland	France, Germany, Austria, Italy	4
Thailand	Malaysia, Myanmar, Cambodia, Laos	4
Vietnam	China, Cambodia, Laos, Taiwan, Philippines	5
Togo	Benin, Burkina Faso, Ghana	3
Trinidad T.	Dominican Rep, Venezuela, Antigua, Grenada, Barbados, Martinique	6
Tunisia	Algeria, Malta, Libya	3
Turkey	Bulgaria, Greece, Russia, Syria, Iraq, Iran	6
U.K.	Ireland, France, Iceland, Norway, Denmark, Germany, Netherlands, Belgium	8
U.S.A	Canada, Nicaragua, Russia, Cuba	4
Uruguay	Brazil, Argentina	2
Venezuela	Dominican Rep, Trinidad T., Colombia, Guyana, Brazil, Antigua, Grenada, Barbados, Martinique	9
Vietnam	China, Cambodia, Laos, Taiwan, Philippines	5

Bibliography

Abell, John, " Defence Spending and Unemployment Rates: An Empirical Analysis Disaggregated by Race," *Cambridge Journal of Economics*, 14, 1990, pp. 405-419.

ACDA, *World Military Expenditures and Arms Transfers*, Daniel Galik, ed., Various Issues.

Adams, F.G., J.R. Behrman and M. Boldin, "Government Expenditures, Defence, and Economic Growth in the LDCs: A Revised Perspective," *Conflict Management and Peace Science* , 11, 1991, pp. 19-35.

Alexander, W. Robert J., "The Impact of Defence Spending on Economic Growth: A Multi-Sectoral Approach to Defence Spending and Economic Growth with Evidence from Developed Economies," *Defence Economics*, 2, 1990, pp. 39-55.

_____, "Defence Spending: Burden or Growth-Promoting?" *Defence and Peace Economics*, Vol. 6, 1995, pp. 13-25.

Altman, Stuart H. and Alan E. Fechter, "Military Manpower Procurement: The supply of Military Personnel in the Absence of a Draft," American Economic Association.

Amacher, Ryan C, *The Economics of the Military Draft*.

_____, James C. Miller III, Mark V. Pauly, Robert D. Tollison and Thomas D. Willett, "The Economics of the Military Draft,": in *The Military Draft*, Martin Anderson, ed., Starnford: Hoover Institution Press, 1982, pp. 347-89.

Amsden, Alice H., "Kaldor's 'The Military in Development': A Comment," *World Development*, vol. 5, no. 8, 1977, pp. 753-761.

Aschaur, Alan David, "Is Public Expenditure Productive?" J*ournal of Monetary Economics*, 23, 1989.

Askari, Hossein and Michael Glover, *Military Expenditures and the Level of Economic Development*, Austin: University of Texas at Austin, 1977.

Atesoglu, H.S., and M.J. Mueller, "Defence spending and economic growth," *Defence Economics*, 2, 1990, pp. 19-27.

Ball, Nicole, "Measuring Third World Security Expenditure : A Research Note," *World Development*, Vol. 2, 1984, pp. 157-164.

Barnaby, Frank, "The Scale of World Military Expenditures," *Disarmament and World Development*, Richard Jolly, ed., Institute of Development Studies, University of Sussex.

Barro, Robert J. "Gov't Spending in Simple Model of Endogeneous Growth," *Journal of Political Economy*, 98, oct. 1990, Part II, pp. 103-105.

_____, "A Cross Country Study of Growth, Saving and Gov't,": in B. Douglas Bernheras and John B. Stoven, ed., *National Saving and Economic Performance*, Chicago: Univ. of Chicago Press, 1991.

, "Democracy and Growth," *NBER*, Working Paper no.4909, Oct. 1994.

_____ and Jong-Wha. Lee, "International comparisons of educational attainment," *Journal of Monetary Economics*, 32, 1993, pp. 363-394.

_____ and _____, *Data Set for a Panel of 138 Countries*, 1994.

_____ and _____, "International Measures of Schooling Years and Schooling Quality," *Economic Reform and Growth*, Vol. 86, No.2.

_____ and X. Sala-i-Martin, *Economic Growth*, McGraw-Hill, 1995.

_____ and _____, "Public Finance in Models of E. Growth," *Review of Economic Studies*, 59, Oct. 4, pp. 645-661.

Bartel, Ann P. and F. Lichtenberg, "The Comparative Advantage of Educated Workers in Implementing New Technology."

Becker, Gary S. and Robert J. Barro, "A Reformation of the Economic Theory of Fertility," *Quarterly Journal of Economics*, 103, Feb. 1988, pp. 1-25.

Benhabib, Jess and M. Spiegel, "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data," *Journal of Monetary Economics*, 34, 1994, pp. 143-173.

Benoit, Emile, *Defence and Economic Growth in Developing Countries*, Lexington Books, 1973.

_____, "Growth and Defence in Developing Countries," *Economic Development and Cultural Change*, 1978.

Berthelemy, J. C. and S. Sen, *Government and Growth*, mimeo, Univ. of Birmingham, 1995.

_____, R. Herrera, and S. Sen, "Military Expenditure and Expenditure and Economic Growth Perspective," *Economics of Planning*, 1995.

Biswas, Basubeb, "Defence Spending and Economic Growth in Developing Countries,": in J.E. Payne and A.P. Sahu, ed., *Defence spending and economic growth*, Westview Press, 1993, pp. 223-235.

_____, "Defence Spending and Economic Growth in Developing Countries,": in James E. Payne and Anandi P. Sahu, ed., *Defence Spending and Economic Growth*, Westview Press, 1993.

_____ and R. Ram, "Military Expenditures and Economic Growth in Less Developed Countries: An Augmented Model and Further Evidence," *Economic Development and Cultural Change*, 1986.

Brauer, Jurgen, "Military Investments and Economic Growth in Developing Nations," *Economic Development and Cultural Change*, 1991.

Brito, D., "A Dynamic Model of Arms Race," *International Economic Review*, 13, 1972, pp. 359-375.

Chan, Steve, "The Impact of Defence Spending on Economic Performance: A Survey of Evidence and Problems," *Orbis*, 29, 1985, pp. 403-434.

_____, "Military Expenditures and Economic Performance,": in *World Military Expenditures and Arms Transfers*, Washington, DC: US Arms Control and Disarmament Agency, 1986, pp. 29-37.

Chowdhury, Abdur R., "A Causal Analysis of Defence Spending and Economic Growth," *Journal of Conflict Resolution*, Vol. 35, No. 1, 1991, pp. 80-97.

Clark, Rolf, "Capital-Labor Ratios in a Military Service: A Putty-Clay Applications," *Capital Labor Ratio*, 1976, Santa Monica, CA: Rand.

Cooper, Richard V. L., "The Allocation of Mid Resources: Capital-Labor Substitution."

_____, "The Social Cost of Maintaining a Military Labor Force," *Defence Advanced Research Projects Agency*, Aug. 1975.

Crane, Keith, "The Economic Implications of Reductions in Military Budgets and Force Levels in Eastern Europe," RAND.

Dabelko, David and James M. Mccormick, "Opportunity Cost of Defence: Some Cross-National Evidence," *Journal of Peace Research*, Vol. 14, No. 2, 1977.

Deger, Saadet, "Economic Development and Defence Expenditure," *Economic Development and Cultural Change* 35, 1986a, pp. 179-196.

_____, "Military Expenditure in Third World Countries: The Economic Effects," Routledge & Kegan Paul, 1986b.

_____, and R. Smith, "Military Expenditure and Growth in Less Developed Countries," *Journal of Conflict Resolution*, 27, 1983, pp. 335-353.

_____ and S. Sen, "Military Expenditure, Spin-off and Economic Development," *Journal of Development Economics*, 13, 1983, pp. 67-83.

_____ and _____, "Optimal Control and Differential Game Models of Military Expenditures in Less Developed Countries," *Journal of Economic Dynamics and Control*, 7, 1984, pp. 153-169.

_____ and _____, "Military Expenditure, Aid and Economic Development,": in Proceedings of the World Bank Annual Conference on Development Economies, 1992, pp. 159-189.

_____ and _____, "Military Expenditure and Developing Countries,": : in Keith Hartley and Todd Sandler, ed., *Handbook of Defence Economics*, Elsevier, 1995.

De Gregorio, Jose, "Borrowing Constraints, Human Capital Accumulation, and Growth," *Journal of Monetary Economics*, 37, 1996.

Dixon, William J. and B. Moon, "The Military Burden and Basic Human Needs," *Journal of Conflict Resolution*, Vol. 30, No. 4, 1986.

Don Mard, Michael and A. Mintz, "Dynamic of Military Spending in Israel," *Journal of Conflict Resolution*, Vol. 31, No. 1, 1987, pp. 86-105.

Dunne, P., "The Political Economy of Military Expenditure: An Introduction," *Cambridge Journal of Economics*, 14, 1990, pp. 395-404.

Easterly, Willian, "How Much Do Distortions Affect Growth?" *Journal of Monetary Economics*, 32, 1993.

_____ and S. Rebelo, "Fiscal policy and economic growth," *Journal of Monetary Economics*, 32, 1993, pp. 417-458.

_____, M. Kremer, L. Pritchett, and L. Summers, "Good Policy or Good Luck?" *Journal of Monetary Economics*, 32, 1993, pp. 459-483.

Edelstein, Michael, "What Price Cold War? Military Spending and Private Investment in the US, 1946-1979," *Cambridge Journal of Economics*, 14, 1990, pp. 421-437.

Faini, R., P. Annez and L. Taylor, "Defence Spending, Economic Structure, and Growth: Evidence Among Countries and Over Time," *Economic Development and Cultural Change*, 32, 1984, pp. 487-498.

Feder, Gershon, "On Exports and Economic Growth," *Journal of Development Economics*, 12, 1982, pp. 59-73.

Fisher, Stanley, "The Role of Macroeconomic Factors in Growth," *Journal of Monetary Economics*, 32, 1993, pp. 485-512.

Frederiksen, P.C. and R. Looney, "Defence Expenditures and Economic Growth in Developing Countries," *Armed Forces and Society*, Vol. 9, No. 4, 1983, pp. 633-645.

Garfinkel, Michelle R., "Arming as a Strategic Investment in a Cooperative Equilibrium," *The American Economic Review*, Vol. 80, No. 1.

_____, "The Role of the Military Draft in Optimal Fiscal Policy," *Southern Economic Journal*, Jan. 1990, pp. 718-31.

Grobar, Lisa M., R. Porter, "Defence Spending and Economic Growth in LDC's," J*ournal of Conflict Resolution*, Vol. 33, No. 2, June 1989, pp. 318-345.

Harris, Geoffrey, "The Determinants of Defence Expenditure in the ASEAN Region," *Journal of Peace Research*, Vol. 23, No. 1, 1986.

_____, M. Kelly, and Pranowo, "Trade-offs Between Defence and Education/Health Expenditures in Developing Countries," *Journal of Peace Research*, Vol. 25, No. 2, 1988.

Hasterly, E. & S. Rebelo, "Policy Distortion, Size of Government, and Growth," NBER Working Paper Series 3214, 1989.

Herrera, Remy, *Statistics on Military Expenditure in Developing Countries: Concepts, Methodological Problems and Sources*, OECD, 1994.

Hess, Peter, "The Military Burden, Economic Growth, and the Human Suffering Index : evidence from the LDC's," C*ambridge Journal of Economics*, 13, 1989, pp. 497-515.

Hewitt, D., "What Determines Military Expenditures?" *Finance and Development*, 28, 1991, pp. 22-25.

Hsiao, Cheng, *Analysis of Panel Data*, Cambridge University Press, 1986.

Huang, C., and A. Mintz, "Ridge Regression Analysis of the Defence-Growth Tradeoff in the United States," *Defence Economics*, 2, 1990, pp. 29-37.

_____ and _____, "Defence Expenditures and Economic Growth: The Externality Effect," *Defence Economics*, 3, 1991, pp. 35-40.

IMF, *Government Finance Statistics Yearbook*, International Monetary Fund, 1995.

Intriligator, Michael D, "Strategic Considerations in the Richardson Model of Arms Races," *Journal of Political Economy*, Vol. 83, No. 2, 1975.

Joerding, W., 1986, "Economic Growth and Defence Spending: Granger causality," *Journal of Development Economics*, 21, pp. 35-40.

Jones, R. Philip, "Defence Alliances and International Trade," *Journal of Conflict Resolution*, Vol 32, No. 1, 1988.

Judd, K., "Debt and Distortionary Taxation in a Simple Perfect Foresight Model," *Journal of Monetary Economics*, 20, 1987a, pp. 51-72.

_____, "Short-run Analysis of Fiscal Policy in a Simple Perfect Foresight Model," *Journal of Political Economy*, 93, 1987b, pp. 298-319.

Kaldor, Mary, "The Military in Development," *World Development*, Vol. 4, 1976, pp. 459-82.

Kennedy, Gavin, *Defence Economics*, London: St Martin's Press, 1983.

____, "The Military in the Third World," London, 1974.

Kiker, B. F. and J. Birkeli, "Human Capital Losses Resulting from U.S. Casualties of the War," *Journal of Political Economy*, Sep./Oct. 1972, pp. 1023-1030.

Knapp, Charles B., "A Human Capital Approach to the Burden of the Military Draft," unpublished Ph. D. dissertation, University of Wisconsin, 1972.

Knight, Malcolm, Norman Loayza, and Delano Villanueva, "The Peace Divided: Military Spending Cuts and Economic Growth," *IMF staff paper*, Vol. 43, No. 1, 1996.

LaCivita, Charles J. and P. Frederiksen, "Defence Spending and Economic Growth," *Jounal of Development Economies*, Vol. 35, 1991.

Landau, Daniel, "Government and Economic Growth in the Less Developed Countries: An Empirical Study for 1960-1980," *Economic Development and Cultural Change*, 35, 1986, pp. 35-75.

_____, "The Economic Impact of Military Expenditures," Policy Research Working Paper WPS 1138, World Bank, 1993.

Lebovic, James H. and A. Ishaq, "Military Burden, Security Needs, and Economic Growth in the Middle East," *Journal of Conflict Resolution*, Vol. 31, No. 1, Mar. 1987, pp. 106-138.

Lee, Jee-Soon, "Government Spending and Economic Growth,": in J. Kwon, ed., *Korean Economic Development*, 1990.

Lee, Jong-Wha "International Trade, Distortions, and Long-Run Economic Growth," *International Monetary Fund*, Vol. 40, No. 2, June 1993.

_____, "Human Development and Economic Growth: Theory and Evidence," Korea University and *NBER*, Sept. 1995.

Leidy, Michael P. and R. Staiger, "Economic Issues and Methology in Arms Race Analysis," *Journal of Conflict Resolution*, Vol. 29, No. 3, Sept. 1985, pp. 503-530.

Lens, S., The Military-Industrial Complex, United Church Press, 1970

Lim, David, "Another Look at Growth and Defence in Less Developed Countries," *Economic Development and Cultural Change*, 1983, pp. 377-384.

Lindauer, David L. and Ann D. Velenchik, "Government Spending in Developing Countries: Trends, Causes, and Consequences," *The World Bank Research Observer*, Vol. 7, No. 1, 1992.

Looney, Robert E., "The Economic Impact of Rent Seeking and Military Expenditures: A Comparison of Third World Military and Civilian

Regimes," *American Journal of Economics and Sociology*, Vol. 48, No. 1, 1989b.

_____ and P. Frederiksen, "Economic Determinations of Latin American Defence Expenditures," *Armed Forces and Society*, Vol. 14, No. 3, 1988, pp. 459-471.

_____ and _____, "Arms Imports and Third World Growth in the 1980s,": in James E. Payne and Anandi P. Sahu, ed., *Defence Spending and Economic Growth*, Westview Press, 1993.

Lucas, Robert E., Jr, "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22, 1988.

_____, "The Industrial Revolution: Past and Future," The University of Chicago, Sept. 1996.

_____ and Nancy L. Stokey, "Optimal Fiscal and Monetary Policy in an Economy Without Capital," *Journal of Monetary Economics*, 12, 1983.

Lyttkens, Carl H. and C. Vedovato, "Opportunity Costs of Defence : A Comment on Dabelko and McCormick," *Journal of Peace Research*, Vol. 21, No. 4, 1984, .

Macnair, E.S., J.C. Murdoch, C.R. Pi and T. Sandler, "Growth and Defence: Pooled Estimates for the NATO Alliance, 1951-88," *Southern Economic Journal*, 61, 1988, pp. 846-860.

Maddala, G.S., *Introduction to Econometrics*, 2d ed., Mcmillan Publishing Company, 1992.

Maizels, Alfred and M. Nissanke, "The Determinants of Military Expenditures in Developing Countries," *World Development*, vol. 14, no. 9, 1986, pp. 1125-1140.

McNamara, Robert S., "The Post-Cold War World: Implications for Military Expenditure in the Developing Countries,": in *Proceedings of the World Bank Annual Conference on Developing Economics*, 1992, pp. 95-125.

Miller III, James C. and Robert D. Tollison, "The Implicit Tax on Reluctant Military Recruits," *Social Science Quarterly*, Mar. 1971, pp. 924-931.

Mintz, Alex, "The Military-Industrial Complex, *Journal of Conflict Resolution*," Vol. 29, No. 4, Dec. 1985, pp. 623-639.

_____ and C. Huang, "Defence Expenditures, Economic Growth and the 'Peace Dividend'," *American Political Science Review*, 84, 1990, pp. 1283-1293.

_____ and _____, "Defence Expenditures, Economic Growth and the 'Peace Dividend', A Longitudinal Analysis of 103 Countries," *Journal of Conflict Resolution*, 39, 1995, pp. 283-305.

_____ and Stevenson, "Defence Expenditures, Economic Growth and the 'Peace Dividend': A Longitudinal Analysis of 103 Countries."

Mosley, Hugh G., *The Arms Race: Economic and Social Consequences*, Lexington Books, 1985.

Mueller, Michael J., and H.Sonmez Atesoglu, "Defence Spending, Technological Change, and Economic Growth in the United States," *Defence Economics*, 4, 1993, pp. 259-269.

_____ and _____, "A Theory of Defence Spending and Economic Growth,": in James E. Payne and Anandi P. Sahu, ed., *Defence Spending and Economic Growth*, Westview Press, 1993.

Murdoch, James C. and Todd Sandler, "Complementarity, Free Riding and the Military Expenditures of NATO Allies," *Journal of Public Economics*, Nov.1984, pp. 83-101.

Nabe, Oumar, "Military Expenditures and Industrialization in Africa," *Journal of Economics Issues*, vol. 17, June 1983.

Neu, C. R., "Defence-Related Industries and Trade Relations," RAND.

Olson, Mancur, Jr. and Richard Zeckha-user, "An Economic Model of Alliances," *Review of Economics and Statistics*, Aug. 1966, pp. 266-79.

Pivetty, Massimo, "Military Spending as a Burden on Growth: an 'Underconsumptionist' Critique," *Cambridge Journal of Economics*, 16, 1992, pp. 373-384.

_____, "Effective Demand, 'Marxo-marginalism' and the Economics of Military Spending: a rejoinder," *Cambridge Journal of Economics*, 18, 1994, pp. 523-527.

Ram, R., "Government Size and Economic Growth: A New Framework and Some Evidence from Cross Section and Time Series Data," *American Economic Review*, Vol. 76, pp. 191-203.

_____, "Government Size and Economic Growth: A New Framework and Some Evidence from Cross-Section and Time-Series Data: Reply," *American Economic Review*, 79, 1989, pp. 281-284.

_____, "Conceptual Linkages Between Defence Spending and Economic Growth and Development: A Selective Review,": in James E. Payne and Anandi P. Sahu, ed., *Defence Spending and Economic Growth*, Westview Press, 1993.

_____, "Defence Expenditure and Economic Growth,": in Keith Hartley and Todd Sandler, ed., *Handbook of Defence Economics*, Elsevier, 1995.

Rasler, K. and W. R. Thompson, "Defence Burdens, Capital Formation, and Economic Growth," *Journal of Conflict Resolution*, Vol. 32, No. 1, 1988.

Rebelo, Sergio, "Growth in Opon Economies," *NBER*, Reprint no. 1772.

_____, "Long Run Policy Analysis and Long Run Groth," *NBER*, Working Paper No. 3325.

_____, "Long-Run Policy Analysis and Long-Run Growth," *Journal of Political Economy*, Vol. 99, No. 3, 1991.

Riddel, Tom, "Marxism and Military Spending," *Journal of Post-Keynesian Economics*, Vol. 8, No. 4, 1986.

Russett, Bruce M., *What Price Vigilance?: The Burdens of National Defence*, New Haven, CT: Yale University Press, 1970.

Saaty, T., *Mathematical Models of Arms Control and Disarmament*, Wiley: NewYork, NY, 1968.

Scheetz, T., "The Macroeconomic Impact of Defence Expenditures: Some Econometric Evidence for Argentina, Chile, Paraguay and Peru," Defence Economics, 3, 1991, pp. 65-81.

Seiglie, Carlos, "International Conflict and Military Expenditures," *Joural of Conflict Resolution*, Vol. 32, 1988 .

Shantayanan, Devarajan, V. Swaroop, and H. Zou, "The Composition of Public Expenditure and Economic Growth," *Journal of Monetary Economics*, 37, 1996.

Shepherd, William, "Self Interest and National Security," *American Econonic Review Papers and Proceedings*, May 1988, pp. 50-54.

Smith, Ron, "Military Expenditure and Capitalism: A Reply," *Cambridge Journal of Economics*, 2, 1978, pp. 299-304.

_____ and P. Dunne, "Is Military Spending a Burden? A 'Marxo-Marginalist' Response to Pivetti," *Cambridge Journal of Economics*, 18, 1994, pp. 515-521.

Smith, Ronald. P., "Military Expenditure and Capitalism," *Cambridge Journal of Economics*, 1, 1977, pp. 61-76.

_____, "Military Expenditure and Investment in OECD Countries, 1954-1973," *Journal of Comparative Economics*, 4, 1980a, pp. 19-32.

_____, "The Demand for Military Expenditure," *The Economic Journal*, Dec. 1980b, pp. 811-820.

_____, "Alternative Models of Military Expenditure," Birbeck College Discussion Paper in Economics, No. 8-17, 1987.

Smith, Theresa Clair, "The Insurance Factor? An Assessment of War Costs," Journal of Peace Research, Vol. 22, No. 2, 1985.

Solow, Robert M., "A Contribution to the Theory of Economic Growth," *Quartery Journal of Economics*.

Stewart, Douglas B., "Economic Growth and the Defence Burden in Africa and Latin America: Simulations from a Dynamic Model," The University of Chicago, 1991.

Summers, Robert and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," *The Quarterly Journal of Economics*, May 1991.

_____ and _____, "Summer & Heston Data Set 5.6a," 1.15 version, 1995.

Terhal, Peter, "Foreign Exchange Costs of the Indian Military 1950-1972," *Journal of Peace Research*, Vol. 19, No. 3, 1982.

Tollison, Robert D., "The Political Economy of the Military Draft,": in Javes M. Buchanan and Robert D. Tollison, ed., *Theory of Public Choice*, University of Michigan Press, 1972.

United Nations, "Economic and Social Consequences of the Arms Race," 1977.

van der Ploeg, F. and A. de Zeeuw, "Perfect Equilibrium in a Model of Competitive Arms Accumulation," *International Economic Review*, 31, pp. 131-146.

_____ and _____, "Conflict Over Arms Accumulation in the Market and Command Economies," mimeo., 1986a.

_____ and _____, "Perfect Equilibrium in a Model of Competitive Arms Accumulation," mimeo., 1986b.

Vincent, Jack E., "Analyzing Shifts in International Conflict from Quality of Life Indicators," *International Social Science Journal*.

Wagner, Richard. "Conscription, Voluntary Service and Democratic Fiscal Choice,": in *Theory of Public Choice*, James Buchanan and Robert Tollison, ed., Ann Harbor: University of Michigan Press, 1972, pp. 136-52.

Ward, M.D., D.R. Davis, "Sizing up the Peace Dividend: Economic Growth and Military Spending in the United States, 1948-1996," *American Political Science Review*, 86, 1992, pp. 748-755.

_____, _____, M. Penubarti, S. Rajmaira and M. Cochran, "Military Spending in India - Country Survey 1," *Defence Economics*, 1991.

Ward, Michael D., "Dynamics of Military Spending in Israel," *Journal of Conflict Resolution*, Vol. 31, No. 1, March 1987.

Wiberg, Hakan, "The Security of Small Nations: Challanges and Defences."

Yager, Loren and C.R. Neu, "Defence Spending and the Trade Performance of U.S. Industries," RAND.

Zuk, Gary and N. Woodbury, "U.S. Defence Spending, Electoral Cycles, and Soviet-American Relations," *Journal of Conflict Resolution*, Vol. 30, No. 3, Sept. 1986, pp. 445-468.

APPENDIX

1. LIST OF SAMPLE COUNTRIES

Group	Entries
Developed (high income)	Austria, Australia, Belgium, Canada, Denmark, Finland, France, Greece, Germany, Ireland, Japan, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, U.K., U.S.A
Developing (middle and low income)	Algeria, Argentina, Bolivia, Brazil, Cameroon, Chile, Colombia, Dominican Rep, Ecuador, El Salvador, Ghana, Guatemala, Guyana, Honduras, India, Indonesia, Iran, Israel, Rep. of Korea, Malawi, Malaysia, Mali, Mexico, Nicaragua, Pakistan, Panama, Paraguay, Peru, Philippines, Senegal, Sierra Leone, South Africa, Sri Lanka, Thailand, Vietnam, Togo, Trinidad T., Tunisia, Turkey, Uruguay, Venezuela, Vietnam

2. LIST OF NEIBHORING COUNTRIES

Country	Neighboring Countries	
Algeria	Mauritania, Niger, Morocco, Tunisia, Mali, West Sahara, Libya	7
Argentina	Brazil, Bolivia, Paraguay, Chile, Uruguay	5
Australia	Indonesia, Papua New Guinea, New Zealand	3
Austria	Germany, Italy, Hungary, Czechoslovakia, Switzerland, Yugoslavia	6
Belgium	France, Luxembourg, Germany, Netherlands, U.K	5
Bolivia	Peru, Brazil, Paraguay, Chile, Argentina	5
Brazil	Colombia, Venezuela, Guyana, Peru, Bolivia, Paraguay, Argentina, Uruguay, Suriname, French Guyana	10
Cameroon	Nigeria, Gabon, Cent. Af Rep, Congo, Equatorial Guinea Chad	5
Canada	U.S.A	1
Chile	Peru, Bolivia, Argentina	3
Colombia	Panama, Venezuela, Ecuador, Peru, Equatorial Guinea Chad	5
Denmark	Haiti, Jamaica, Trinidad Tobago, Cuba, Rep Bahamas, Antigua, Grenada, Barbados, Martinique	3
Dominican R.	Haiti, Jamaica, Trinidad Tobago, Cuba, Bahamas, Antigua, Grenada, Barbados, Martinique,	9
Ecuador	Colombia, Peru	2
El Salvador	Guatemala, Honduras, Nicaragua	3
Finland	Soviet Union, Sweden	2
France	Spain, U.K. Belgium, Luxembourg, Germany, Switzerland, Italy	7
Germany	Belgium, Netherlands, Denmark, Sweden, Poland, Czechoslovakia, Austria, Switzerland, France, Luxembourg, U.K	11
Ghana	Cote d'Ivoire, Togo, Burkina Faso	3

2. LIST OF NEIBHORING COUNTRIES (Cont.)

Country	Neighboring Countries	
Greece	Albania, Bulgaria, Turkey, Italy, Yugo	5
Guatemala	Mexico, Honduras, El Salvador, British Honduras	4
Guyana	Venezuela, Brazil, Suriname, Peru, Paraguay, Argentina, Uruguay, French Guyana	8
Honduras	Guatemala, El Salvador, Nicaragua	4
India	Malaysia, Singapore, Philippines, Australia, Myanmar	5
Indonesia	Malaysia, Singapore, Philippines, Australia, Papua New Guinea	5
Iran	Turkey, Iraq, Saudi-Arabia, Kuwait, Pakistan, Russia(Soviet Union), Qatar, Bahrain, U.A.E, Oman, Afghanistan	11
Ireland	U.K	1
Israel	Egypt, Syria, Jordan, Saudi-Arabia, Lebanon	5
Japan	Korea, N, Korea, Russia, China	4
Rep. of Korea	N. Korea, Japan, Russia, China	4
Malawi	Tanzania, Zambia, Mozambique	3
Malaysia	Thailand, Singapore, Philippines, Indonesia	4
Mali	Senegal, Mauritania, Niger, Cote d'Ivoire, Algeria, Guinea, Burkina Faso	7
Mexico	U.S.A, Guatemala, Cuba, British Honduras	4
Netherlands	Belgium, Germany, U.K	3
New Zealand	Australia	1
Nicaragua	Honduras, El Salvador, Costa Rica	3
Norway	Sweden, Denmark, U.K. Iceland	4
Pakistan	India, Russia, Afghanistan, China ran	5
Panama	Costa Rica, Colombia	2
Paraguay	Brazil, Bolivia, Argentina	3

2. LIST OF NEIBHORING COUNTRIES (Cont.)

Country	Neighboring Countries	Num.
Peru	Colombia, Ecuador, Brazil, Bolivia, Chile	5
Philippines	Taiwan, Malaysia, Papua New Guinea, China, Indonesia, Hong Kong, Vietnam	7
Portugal	Spain	1
Senegal	Mauritania, Gambia, Cape Verde, Mali, Guinea, Guinea-Bissau	6
Sierra Leone	Liberia, Guinea	2
Singapore	Malaysia, Indonesia	2
South Africa	Zimbabwe, Mozambique, Namibia, Lesotho, Botswana, Swaziland	6
Spain	Portugal, France, Morocco	3
Sri Lanka	India, Maldives, Islands	3
Sweden	Norway, Finland, Russia, Poland, Denmark, Germany	6
Switzerland	France, Germany, Austria, Italy	4
Thailand	Malaysia, Myanmar, Cambodia, Laos	4
Vietnam	China, Cambodia, Laos, Taiwan, Philippines	5
Togo	Benin, Burkina Faso, Ghana	3
Trinidad T.	Dominican Rep, Venezuela, Antigua, Grenada, Barbados, Martinique	6
Tunisia	Algeria, Malta, Libya	3
Turkey	Bulgaria, Greece, Russia, Syria, Iraq, Iran	6
U.K.	Ireland, France, Iceland, Norway, Denmark, Germany, Netherlands, Belgium	8
U.S.A	Canada, Nicaragua, Russia, Cuba	4
Uruguay	Brazil, Argentina	2
Venezuela	Dominican Rep, Trinidad T., Colombia, Guyana, Brazil, Antigua, Grenada, Barbados, Martinique	9
Vietnam	China, Cambodia, Laos, Taiwan, Philippines	5

Biography

Full Name	:	Sung, woo Young (Ph.D)
Date of Birth	:	1 September 1961
Education Background	:	1984 : Korea Military Academy
	:	1993 : Officers Advanced Course (USA)
	:	1997 : Ph.D in Economics at Korea University
	:	1997 : Army College
Military Course Assignments	:	2001 : Battalion Commander, 706 SOF
	:	2003 : Policy Planning Officer, ROK Ministry of National Defense
	:	2006 : Chief of Policy, Military Assistant Office for Minister of National Defense
	:	2007 : Regiment Commander, 65th Infantry Division
	:	2008 : Chief of Policy, Secretary Office of the Chairman, ROK JCS
	:	2009 : Chief of Planning, C5, ROK/US Combined Forces Command
	:	2012 : Deputy Director of Strategic Intelligence, Korea Defense Intelligence Agency
	:	2013 : Defense Attache to Thailand/2016 Senior Researcher, Korean Defense Intelligence Agency, MND of ROK
Military Experience	:	Citation of Minister of National Defense (2012)
	:	Citation of Chairman of Joint Chiefs of Staff (2009)

Summary

Field: Strategy

Title : Enhancing Engine for Economic Growth in Defense Management
Name: Sung, Woo Young

Background

According to Stockholm International Peace Research Institute (SIPRI), the military expenditure of the South East Asia region was increased by 8.8% in 2015, while global military expenditure increased by 1% rate. It is notably high, comparing to global average increasing rate.

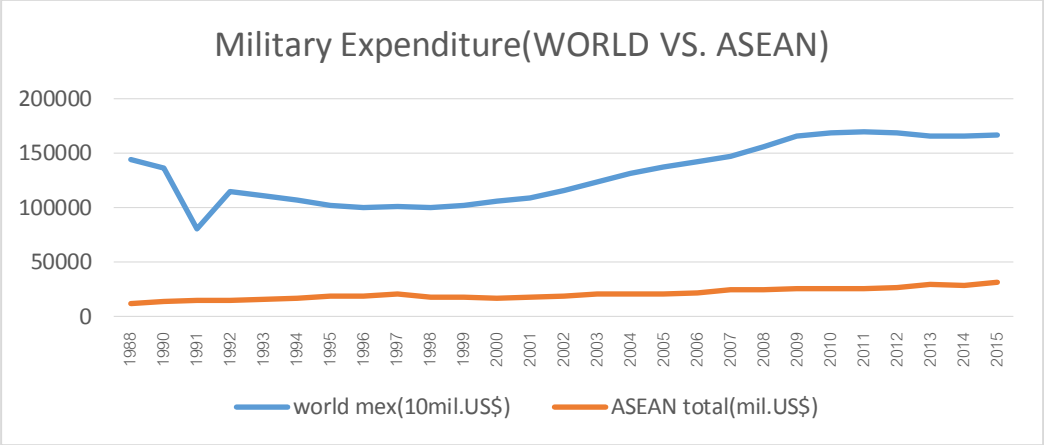


Figure 1-1 Military expenditure (World vs. ASEAN)

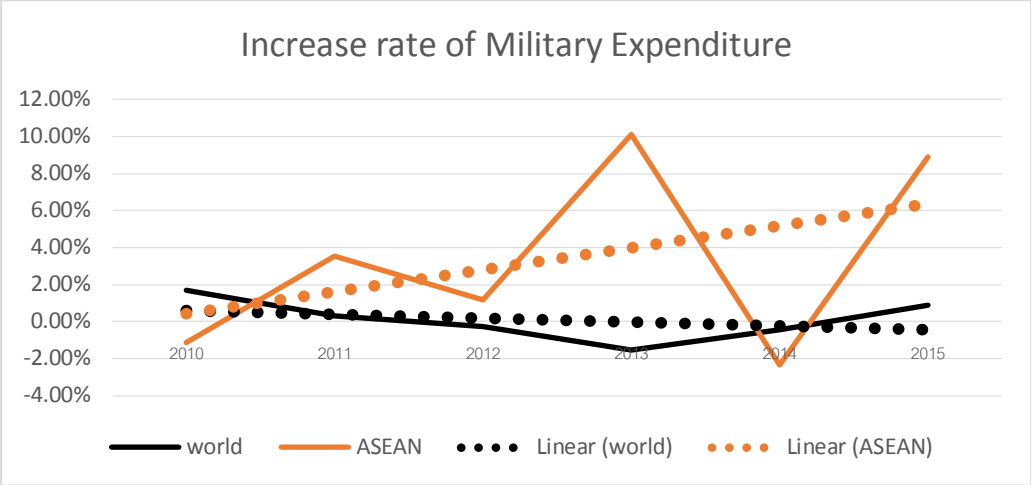


Figure 1-2 Military expenditure increasing rate (World vs. ASEAN)

This trend seems to go further due to ASEAN countries' military modernization programs, and dragged long, as long as the territorial disputes

such as south china sea issue are going on and even can be accelerated, and because especially ASEAN nations capabilities to afford to additional military expenditure seems enough, as military expenditure ratio of GDP, 1.45%, in ASEAN region is lower than world average 2.27% and still decreasing.

On the other hands, developing countries are confronted with the typically two challenges, economic growth and management of regional conflicts. Traditional understanding is that military is a burden to economy and no more than parasite sectors which cannot contribute to production. However, according to numerous economic research, military expenditure has both negative and positive effects on the economy, it is matter of empirical measurement.

As matter of fact, in the end of 1980s, the disintegration of the Soviet bloc and the apparent end of to the cold war had created expectations that lower defense spending will results in a "peace dividend." This expectation is based on the idea that lowering military spending will lead to economic prosperity. However, even global military expenditure decreased dramatically from 1986 to end of 1990's, the evidence of the peace dividend is still ambiguous.

For developing countries seeking their two goals simultaneously, they need to set up their national strategy and defense policy on the basis of more accurate analysis of the linkages between military sector and private sector.

Objectives of Research

The purpose of this paper is to answer for two questions, "is the ASEAN Countries' defense spending desirable for their economic growth?" and "How can their military contribute to their economy more effectively". To answer these question, we need to investigate the relationship between defense spending and economic growth first.

This paper also aims academic contributions. The basic question addressed in most studies is whether a high 'military burden' (usually defined as the share of military expenditure in GDP) tends to lower economic growth in developing countries. Despite so much empirical research effort on this area in 1980s and 90s, they couldn't reach to consistent results with theoretical background at that time. In 1990s, due to emerging of 'Endogenous Economic Growth Theory', there was considerable progress in this area. In previous neoclassical theory, all countries' economic growth rate should converge to certain common rate in the long run. However Endogenous economic growth theory emphasizes that endogenous factors of the economy such as human

capital or government system create sustainable economic growth. This also implies that the long term economic growth rate is determined by these endogenous factors such as policy for innovation, and government's public service also can either accelerate or decelerate economic growth.

Especially 'the Public Model', represented by Barro(1990) provides excellent methodology to analyze the government sector's effect to economic growth with the optimal state in the general equilibrium. More recently, Barro's model was specified and extended to consider defense sector nominally. It allows us to estimate the growth effect of government spending and to assess optimal defense spending for economic growth. In this connection, this paper measures economic growth effects of defense sector. Furthermore, various possible channels in which defense sector affects private sectors will be explored.

Scope and Methodology

Even this study is to draw a meaningful implication for ASEAN country, for more general conclusion, the empirical test covers global 61 countries including 6 ASEAN member group from1970 to 2014.

In chapter 2 and 3, this paper reviews previous theories on the relationship between defense sector and economy focusing on how defense sector affect to accumulation of production factors. Then, Barro's Public Model(1990) is extended as a 3 sector model to introduce defense sector and derives the meaning of externality as a criteria to compose optimal combination of government spending is defined.

Furthermore, in order to measure the externality, Feder's two sectors model(1986) that provides good empirical design to measure the externality and the difference of productivity between heterogeneous economic sectors, will be also revised as a 3 sectors model including private, defense and non-defense-government sector. In chapter 4, using revised 3 sector models, productivity gap and externality of each government spending is measured.

Results

The empirical test with the panel data of 61 countries from 1970 to 2014 found that net effect of defense sector on economic growth is s significantly positive. Even the productivity of defense sector is 25.4% lower than private's sector, positive externality to the economy overwhelms this inefficiency.

The whole sample group divided into 2 groups, 21 developed and 40

developing group. In case of developing countries, results of estimation is consistent with estimation for whole sample, while most estimates of developed group is not significant statistically. In developing countries, 10% increase of defense spending brings 0.86% increase of production in private sector, while 10% increase of nondefense spending causes about 1.47% increase of production.

However, the result of estimation for ASEAN countries was quite different from developing group. Except the term of productivity, other government spending related estimates were not statistically meaningful, and even the value of the coefficients appeared smaller than those of whole sample or developing country group.

It also has been argued in several ways how the national defense gives the externality. Path analysis with various substitute variables such as 'neighbor countries military expenditure ratio of GDP', 'average school year of over 25 years old population', 'arms import ratio of total import, and assassination rate, to examine security effects, human capital spillover effects and arms import effects. Results suggest possibility that the defense sector gives the externality mainly through national security and human capital.

The empirical findings may also interpreted as the followings:

Firstly, there are strong evidences that defense sector spillovers positive effect to economic growth in developing countries. However, some of ASEAN members couldn't exploit these externalities.

Secondly, the optimal level of defense spending to maximize the economic growth is higher than their current spending. It means individual nations have incentive to increase its defense spending. As long as regional conflicts and tension is maintained or increased, developing countries are willing to increase their defense expenditure not only for international politics but also for economic growth.

Thirdly, as path analysis in this paper show us, there are dynamics of international reaction. If the average level of defense spending in global or region arises, optimal ratio of defense expenditure for individual countries rises again. In this connection, efforts for international peace is crucial, rather than increasing national defense spending.

Recommendation

Even the empirical test in this paper couldn't derive much of significant estimates of ASEAN group, still provides some implications for ASEAN

members to enhance their own economic growth engine.

First of all, regarding on the productivity gap between defense sector and private sector, it is highly recommended that each members of ASEAN specialize its defense industry on different specific area, and promote regional exchange and cooperation to exploit the returns of scale in defense industry.

Secondly, as endogenous growth theory implies, intensive innovation to improve the efficiency of defense management is recommended. Producing maximum security with minimum resources, ASEAN nations can concentrate in consolidating the defense posture and executing defense modernization, it will eventually contribute to economic growth.

Thirdly, ASEAN members should make more effort to exploit the externality of defense sector. As the incentives underlying the decisions of management in defense sector are not same as the incentives facing private sector, thus the externality of defense sector was not properly considered in defense policy and its implementation. Defense management should be more focused on cultivating positive side of defense sector considering below,

a. Stimulation of the military project related dual use for developing local and remote area

b. Development of HA/DR capability to relief the government's burden of national reserve for disaster

c. Enlargement of the educational opportunity for military personnel and improvement of military education to cultivate human capital

d. Enhancement of offset trade in arms trading to spill over high technology or to create demand for national industry

e. Mitigation of restrictions to improve economic performance of private sector.

Although this paper provides strong theory of economics and econometrics methodology, plagued limitations are still inherited. Studies on defense spending include various political and social factors. These factors are hard to be quantified and has very complicate and numerous cause-and-effect relationship each other. Nevertheless, this paper used only few substitute variables of them, there are possibility that some important factor is omitted, it could cause misspecification problems. Especially, it is highly recommended to develop the model specifying technical spillover effect for further studies. Moreover, the empirical model in this paper doesn't consider dynamics among nations, and cannot deal with how the externality of defense sector spillover abroad nominally. The game theory or arms race model may provide useful tool

for following study. However this study is one of follow-up study to Barro(1990) and 3 sector model in this study can be extended to other various government spending.