DEFENCE SPENDING, ARMS RACES AND ECONOMIC DEVELOPMENT IN SOUTH KOREA

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To my parents

ABSTRACT

This thesis studies the dynamics of an arms race between South and North Korea, and South Korea's defence-growth relationship.

The thesis begins with a description of the two Koreas' defence economy (Chapter II) and a review of arms race literature(Chapters III). Chapter IV empirically estimates the arms race between South and North Korea using a variant of Richardson's action-reaction model. The arms race during the Cold War and post-Cold War periods is also compared. Chapter V reviews previous studies of defence-growth relationships using supply side, demand side, demand and supply side models, and Granger-causality analysis. Chapter VI empirically estimates South Korea's defence-growth relationship using the Deger-type demand and supply side model. The relationship is investigated using three stage least squares (3SLS) simultaneous equation as well as single equation methods (OLS and 2SLS).

This thesis concludes that an asymmetric arms race[1] led by South Korea exists and the pattern of arms race changes between the Cold War and post-Cold War era. Also, South Korea's defence-growth relationship differs according to the economy's stage of development.

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1 An asymmetric arms race is defined as a state of arms race which a party (or nation) reacts to its opponent's arms expansion, including defence spending, equipment and the number of military personnel, but the other party (or nation) increases its armaments regardless of its opponent's reaction.

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DECLARATION

A version of Chapter II and a part of Chapter IV were jointly published in the *Defence and Peace Economics*, vol.14 (1), 2003.

A version of Chapter IV will be published in the *Defence and Peace Economics* (forthcoming).

A part of Chapter V and a version of Chapter VI are being considered by the *Applied Economics* for possible publication.

A part of Annex has been submitted to the *Defense and Security Analysis* for possible publication.

CHAPTERS

CHAPTER I

INTRODUCTION

1.1. THE AIMS OF THIS THESIS

Defence is one of the most important and controversial factors affecting the national economy in most countries. Resource constraints require the efficient allocation and utilisation of resources in the defence sector. On the one hand, defence involves opportunity costs to maintain peace and national security. Through defence, a nation can attain its political and economic goals through the prevention of any external threat. By keeping peace, a nation might secure stable savings and investment, and induce foreign capital inflows. On the other hand, defence itself could be an important factor affecting economic growth. On the supply side, defence is one of the input factors to increase economic output through the production function. Defence helps the economy through externality effects (e.g. dams, transport, roads, training, etc.) and technological spin-offs to the civilian economy. Defence also creates employment through military personnel and in related industries. By contrast, on the demand side, defence might have a negative effect on the economy by diverting scarce resources from more productive civilian uses to defence. Although defence is a necessary cost for national security, it could also harm the economy by restraining civilian savings and investment and reducing domestic output for civilian uses (crowding-out). Hence, examining the economic effects of defence spending is an important task in defence economics.

South Korea is an extraordinary country which has attained high economic growth whilst maintaining a high level of defence spending. Its geographical location surrounded by major military powers, including Russia, China and Japan, and the political and military tension with North Korea have led South Korea to ceaseless and continuous arms expansion, although there was a decline in defence spending during the latter 1990s. By October, 2001, South Korea's defence spending was the13th largest in the world and accounted for 8.8% of the total East Asian and Australian defence expenditures (IISS, 2001). The Korean Peninsula is one of the world's most tense regions both politically and militarily. As a result, it is important to investigate the defence economy of the two Koreas, their arms races, and the effect of South Korea's defence spending on its economic growth.

1.2. RESEARCH QUESTIONS AND PREDICTIONS

The Korean War (1950-1953) inflicted great damage on both the South and North, and created a deep distrust of each other. The US-South military alliance has effectively deterred the North's threat since the Korean War, but South Korea has suffered a continuing military threat from North Korea. Since the 1960s, South Korea has continually raised its defence spending to deter the North's threat and the North also has expanded its defence to cope with the US-South alliance. Until the 1970s, the US military grant contributed to South Korea's defence and economy, but it was considerably reduced from the late1970s, and South Korea began to share the costs for the presence of US forces from the early 1980s. However, South Korea could achieve rapid economic growth whilst preventing the North's threat due to the presence of US forces and US military aid providing free-riding effects.

South Korea's defence spending is believed to have an effect on its economic growth. In the beginning of economic development, South Korea focussed on a strong "self-reliant" defence policy with a rapid economic development and these were two primary goals under the President Park's regime (1962-1979). Hence, it is believed that defence spending made a contribution to promoting South Korea's economic growth in the beginning of economic development. However, the high level of defence spending might also have prevented higher growth in South Korea in this period. Also, the empirical results of defence-growth relationship might be different according to the time-period, because the effect of defence on growth could differ depending on the economy's stage of development. Thus, the defence-growth relationship in South Korea needs to be estimated in relation to the stage of economic development.

There are three major research questions and predictions for this thesis:

1) ***Does an arms race between the two Koreas really exist and what are the variables affecting any arms race between these two countries?*** An arms race between South and North Korea is predicted to exist, because the North's military threat to the South has not paused and the South's reaction to the North's threat has continued since the Korean War. The variables affecting the arms race between the two countries need to include inter-state conflicts and foreign military aid as well as the two nations' military spending.

2) ***If a South-North arms race exists, has the pattern of any arms race changed between the Cold War and post-Cold War era?*** The pattern of arms race is predicted to change between the Cold War and post-Cold War era, because the

South-North arms race is believed to have been affected by the US-USSR arms race which was more intense in the Cold War era.

3) ***Does South Korea's defence spending promote or inhibit its economic growth? Does the economy's stage of development change the defence-growth relationship in South Korea?*** The answer on the first question cannot be predicted yet, because South Korea's defence spending might have helped its growth by providing externalities and spin-offs, while it might have hampered growth by crowding-out more necessary and productive investment in its development process. However, the defence-growth relationship is predicted to change according to the economy's stage of development. Cross-section studies have found that the effect of defence spending on growth is different according to a country's income level.

Besides these questions, an overview of the defence economy of the two Koreas will be described for an understanding of the circumstances in the Korean Peninsula. To answer these questions, data from the Korean Ministry of National Defense (MND), the Korea National Statistical Office (KNSO), the Stockholm International Peace Research Institute (SIPRI), the International Institute for Strategic Studies (IISS), the International Monetary Fund (IMF)/International Financial Statistics (IFS) and the World Bank will be used with other related sources from previous studies. Also, previous studies on arms races and defence-growth relationship will be critically reviewed for the empirical analysis of any arms race between the two Koreas and the effect of South Korea's defence spending on its growth.

This thesis differs from other comparable studies in that:

1) It describes the defence economy of the two Koreas and also studies the changing military balance between these two countries from the 1960s to the present.

2) It makes a contribution to the arms race literature through an empirical estimation using the Richardson arms race model. Other related variables, such as inter-state conflicts and foreign military aid are also applied for the analysis of an arms race between the South and North Korea. This modified Richardson model has not been used in previous studies of the South-North arms race.

3) It makes a contribution to the defence-growth studies through empirical estimations using a demand and supply side model. The Deger-type demand and supply based model is modified to reflect South Korea's specific circumstances, and this will improve the reliability of the empirical results. It will also show how the economy's stage of development affects the defence-growth relationship in South Korea. This has been shown in the cross-sectional studies, but has not yet been studied in a longitudinal single-country analysis.

1.3. PLAN OF THE THESIS

First, this thesis examines the defence economy of the two Koreas and the military balance of South and North Korea since the 1960s. It also studies the defence industry of South Korea and the future issues for South Korea's defence economy (Chapter II). Second, the dynamics of the arms race between South and North Korea applying the Richardson's action-reaction model are studied for the period 1963-2000. It focusses on detecting the existence of a South-North arms race during this period, because South Korea rapidly

increased its defence spending with its economic development and thus the two nations' arms race is believed to be intensified in this period. Two different sub-periods, 1963-1989 and 1990-2000, representing the Cold War era and post-Cold War era are also estimated to study whether the pattern of arms race changed between the two periods (Chapters III and IV). Third, the effects of South Korea's defence spending on its growth are investigated based on the demand and supply side model for the period 1963-2000. Whether the effects are positive or negative, they have not been deeply studied in South Korea even though it is one of the extraordinary countries achieving high economic growth with a high level of defence spending. This study will also examine how South Korea's defence-growth relationship has been affected by its level of economic development for the two different sub-periods, 1963-1979 and 1980-2000. In South Korea, rapid economic development was attained with strong defences under President Park's regime (1963-1979), and South Korea is regarded as a developing country in this period, although the trend of a high growth and high level of defence spending has been maintained from the early 1960s to the mid-1990s. But, there was a decline in its defence spending during the latter 1990s. Since the 1980s, South Korea became a semi-developed country and reached a developed stage in the 1990s joining the OECD. Hence, South Korea changed from a semi-developed to a developed country for the period 1980-2000. Since the 1980s, South Korea's defence has become more dependent on imports by weakening its "self-reliant" defence policy and US military aid also ended. Thus, South Korea could not enjoy the "free-ride" any more, and this might increase its defence burden in this period and crowd-out the civilian economy (Chapters V and VI). The impact of reductions in South Korea's defence spending and the prospects of a peace dividend are estimated in the Annex.

This thesis mainly contributes to the defence and peace economics literature, but it will

also be helpful for the researchers of strategic studies, political scientists, public sector economists and also development economists. It is of interest to the researchers of strategic studies because this study examines the arms race and military balance between South and North Korea and provides an insight into the regional conflict in the Korean Peninsula. It is of interest to political scientists because the defence-growth relationship is an important issue not only for the economists but also for the political scientists. It is of interest to public sector economists because defence spending is an important subject in public finance and also occupies a substantial proportion of the government budget in most countries. It is of interest to development economists because defence is one of the significant factors affecting the development of countries. In the development process, defence might affect the economy negatively by crowding-out productive investments or positively by providing externalities.

These integrated studies will not only provide a more comprehensive understanding of South Korea's defence economy but will also help research on the defence economies of countries progressing from a less developed country (LDC) to a developed economy[1]. The next chapter will describe the defence economy and military capability of the two Koreas, and also the defence industry of South Korea.

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1 The LDCs and developed countries are characterised by the level of per capita income (or per capita GDP) in this thesis. However, it is difficult questions in the 21st century when interdependence and globalisation pressures are development characteristics of the LDCs and developed countries alike.

CHAPTER II

DEFENCE ECONOMY AND MILITARY FORCES OF THE TWO KOREAS[1]

2.1. INTRODUCTION

This chapter outlines the economic and defence policies of both nations, South Korea's defence industrial base, and studies the military situation between South and North Korea. It provides necessary background to studying the arms race in the Korean Peninsula. Aspects of future defence policies in South Korea are also considered.

During the Cold War the security problems facing the Korean Peninsula depended on the interests of two superpowers, the USA and the former Soviet Union. The Korean War (1950-1953) completely devastated the Korean Peninsula and created deep distrust and antipathy between South and North Korea. Accordingly, the post-war military build-up was one of the most critical and urgent tasks for both Koreas. Korea was divided into two territories, North and South after the liberation from Japan in 1945. The North Korean leader Kim Il-Sung established the Democratic People's Republic of Korea (DPRK), a communist regime supported from the Soviet Union. South Korea constituted an independent and liberal government through separate elections in 1948 and it was named

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1 This chapter was published in *Defence and Peace Economics*, Vol. 14, No.1. See Bae (2003).

the Republic of Korea (ROK). Until the late 1980s, the two Koreas focussed on strengthening their military capabilities to guarantee their security and protect their ideological systems. South Korea, under military regimes from the1960s to the1980s, accomplished high economic growth and military expansion due to US support and its strongly growth-oriented economic policy. By contrast, North Korea continued its military build-up with moderate economic growth pursuing a strong self-reliant defence system (Hamm, 1999). The North concentrated on investing in the heavy and chemical industries while it ignored the light industries to build a strong defence industrial base. In the beginning of the South-North arms race, North Korea's economic development plan was effective and contributed to maintaining the superiority of the North in both its economy and defence. However, North Korea's heavy concentration on the military build-up resulted in "unbalanced" economic development and a deteriorating national economy since the 1970s.

In the post-Cold War era, South Korea's democratic governments changed their unification policy from a hard-line stance into a more moderate attitude and steadily attempted to alleviate the tension and bring peace between the two Koreas. Democratization has exerted intense pressure on the South Korean government to pay greater attention to social welfare and other public services rather than defence (Moon and Hyun, 1992). Investment for social development had been extremely limited and crowded-out under military governments.[2] In contrast, North Korea continues to make great efforts to maintain a strong military power in spite of its severe economic predicament. By 2003, food shortages were

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2 The negative correlation between defence and social welfare, and also other public services is shown in Table 2.16. The crowding-out of civilian investment by defence will be indirectly examined by estimating South Korea's defence-growth relationship in Chapter VI. Defence spending might affect growth negatively by crowding out necessary and probably more productive civilian spending.

the most serious and urgent problem which North Korea needed to solve, but the arms race and confrontation between both nations prevented it disarming. Hence, arms control is necessary not only for the South to escape from the economic burdens of defence spending and attain higher economic growth, but also for the North to reform its economy. The first South-North summit talks since the division of the Korean Peninsula occurred in June, 2000, and were an important first step for peace between the two countries. These summit talks could be the threshold for alleviating the military tension between the South and North. Since the peace talks, the South provided considerable economic aid to the North, but there was still no sign of a reduction in the armed forces and weapons between the two countries. Instead, by 2003, North Korea strengthened its military training and approximately 65% of its armed forces, including up to 80% of its artillery and missile capability were deployed within 60 miles of the southern border. Moreover, North Korea attacked South Korea again in the borderline of the West Sea in June , 2002.

Since the sudden death of Kim Il-Sung (8 July, 1994), North Korea has focussed on its internal cohesion and controlling its people to sustain the Kim Jong-Il regime in spite of international isolation and food shortages. Kim Jong-Il is trying to resolve North Korea's economic difficulties by taking South Korean assistance and improving its relationships with the US and Japan. On the other hand, he uses his nuclear development programme as a leverage for securing this political system against the US-South Korean alliance. North Korea attempts to follow the Chinese model in its economic development by making a special economic territory for openness. However, Kim Jong-Il is opposed to the complete openness of North Korea in order to maintain his dictatorship. This contradictory situation limits North Korea's efforts to reform and develop its economy. North Korean policy toward the West, including Japan appears to be changing, but by 2003, it is difficult to

judge whether it is completely altering its fundamental strategy toward South Korea. In other words, peaceful gestures toward the South may be tactics to improve its relationship with the Western countries supporting the South Korean government. By doing so, North Korea is trying to move out of diplomatic isolation and economic sanctions from the Western countries, including the USA. As a result, most EU countries are attempting to restore or have already formed diplomatic relations with North Korea with the agreement of South Korea. Nevertheless, as long as North Korea does not relinquish its primary goal to communise the South, the military tension cannot easily be removed between these two countries and the North will remain a major security threat to the South in spite of peace talks.

In summary, by 2003, the security environment surrounding the Korean Peninsula was very delicate, because unstable peace and military tension have coexisted since the Korean War. In this potential conflict situation, the high investment in the defence sector of both the South (compared with other developed nations) and the North has not only distorted their economic policy-making but also deprived both nations of the opportunities for a peace dividend. In this context, studying defence and the economies of the two countries, and the military situation between the South and North provides the necessary background for this research.

2.2. OVERVIEW OF ECONOMIC AND DEFENCE POLICIES

2.2.1. The Economy of South Korea

Since the early 1960s, the South Korean economy has recorded consistently high growth rates except for 1980 and the late 1990s caused by domestic political instability and economic crises, respectively. Table 2.1 shows the structural change of the South Korean economy for the period1962-2001. South Korea's real GNP grew at an average annual rate of 8.5% over the three decades from 1962 to 1995, much higher than the average growth rate of about 4% for the preceding period (1953-1962: Kim and Hong, 1997). During President Park's regime (1962-1979), South Korea accomplished phenomenal economic success, and its per capita GDP (in 1995 constant prices) rose approximately 8.5 times from US$ 1,273 in1962 to $10,823 in1995 (Table 2.1). Its export-oriented industrialization policy helped the rapid growth of the South Korean economy and contributed to changing its industrial structure. The export industries have also changed. In the early 1960s, South Korean exports depended heavily on primary industries, such as mining, fishery and textiles, while the share of manufactures was small in total exports. However, as seen in Table 2.1, manufactured exports which accounted for only 27% of the total exports in 1962 reached up to 96% in 1995, although they slightly decreased in 2001. In the 1990s the main exports included electronics and computers, transport equipment, shipbuilding, textile fabrics and semi-conductors.

Table 2.1. Major Indicators of South Korean Economy

Economic Indicator	1962	1979	1995	2001*
Mid-year population (in millions)	26.5	37.5	45.1	47.3
Per capita GDP (US$) (in 1995 constant prices)	1,273	3,930	10,823	7,853
Annual growth rate of GDP (%)	2.2	7.1	8.9	3.0
Inflation rate (%)	-	19.5	7.2	1.3
Unemployment rate (%)	8.1	3.8	2.0	3.7
GNP by industrial origin (% share in current prices)				
Primary industry	44.0	20.3	6.9	4.5
Manufacturing	12.4	27.5	26.9	30.0
Other industries and services	43.6	52.2	66.2	65.5
Expenditures as share of GNP (% share in current prices)				
Private consumption	82.8	62.7	53.4	59.5
Government consumption	14.0	10.1	10.4	10.4
Gross investment	12.8	36.4	37.4	26.8
Exports of goods and services	5.0	28.3	33.5	42.9
Imports of goods and services	16.6	35.1	34.5	40.5
Net factor income from abroad	0.9	-1.6	-0.9	-
Statistical discrepancy	1.1	-0.9	0.6	-
Exports and imports (in 1995 constant prices)				
Commodity exports (f.o.b. in US$ billion)	0.4	27.9	125.1	137.7
Share of commodity exports in GNP (%)	2.0	22.9	27.7	27.6
Share of manufactures in total exports (%)	27.0	90.1	96.1	91.6
Commodity imports (c.i.f. in US$ billion)	1.8	37.6	135.1	129.2
Share of commodity imports in GNP (%)	14.3	29.8	29.9	25.9

Note: 1. South Korea experienced serious reduction of GDP(in $US) in 1997-1998 induced by the fluctuation of exchange rate to US dollar.

2. The numbers in 2001 are estimated based on GDP.

Sources: Bank of Korea, *National Income Accounts,*1984; *National Accounts,* 1994; Korea National Statistical Office, *Korea Statistical Yearbook*, 2002; World Bank, *World Development Indicators*, 2000.

The economic crisis of 1997-1998 in Asian countries was a serious blow to the South Korean economy and decelerated its speedy economic growth. From 1997 to 1999, South Korea struggled with high unemployment rates (6-7%), currency risks, and restructuring

the faltering economy, although it rapidly recovered attaining a high economic growth (an average annual growth rate of 7.7% from 1999 to 2001) due to its export competitiveness partly caused by a weak exchange rate. Nevertheless, by 2003, the prospects for the South Korean economy were still unclear because of the delayed economic restructuring, high government debt and the associated fiscal deficit. Moreover, a worsening global economy is affecting the rapid reform of the South Korean economy. The recent economic change in South Korea is expected to affect not only its civil investment but also its military spending. However, peace talks between the South and North may alleviate the military tension between these two nations and lead to arms reductions in the long term. Although North Korea's nuclear development programme is escalating military tension in the Korean Peninsula, current (2003) peaceful state between the South and North is necessary and important for South Korea to galvanize its economy by focussing on an increase in civil investment and the revitalization of its civilian economy.

2.2.2. The Economy of North Korea

North Korea's centrally-planned economic policy has restrained the opportunities to introduce the capital and technology necessary for economic growth. The North Korean economy has been based on a closed self-supporting system and strong nationalism. Since the 1990s, it has attempted to invite foreign capital to resolve its chronic economic difficulties, but US sanctions caused by the North Korean support for terrorism, arms sales and the development of strategic weapons are affecting its open-door policy. Although the North Korean economy enjoyed an average 8% of real GNP growth from 1960 to 1975, it began to be sluggish after the late 1970s and started to record a negative growth rate from the early 1990s. However, the financial exchange rate of North Korea is measured by two

different methods, namely official and commercial (or trade) rates, and the official rate is much overvalued compared with its real value. Hence, it is believed that the official economic statistics of North Korea are overvalued, and North Korea's economy is worse than its official figures. Furthermore, the collapse of communist countries, including the former Soviet Union and Eastern Europe, accelerated North Korea's economic failure. Its economic failure has also entailed a serious decrease of production. North Korea experienced about a 25% reduction of real GNP between 1989 and 1995 (Chun and Kim, 1997). The industrial productivity of North Korea has decreased every year in most industries, especially in mining and heavy industry. Since the1990s, although the service industry has grown slightly, a continuing shortage of energy and raw materials and ageing industrial equipment have also contributed to the declining growth rate. As shown in Table 2.2, North Korea recorded a serious reduction in its growth rate between the late 1970s and 1997. It even had negative growth in the 1990s. A small trade volume also shows its economic isolation. In the case of agriculture, North Korea is introducing partial private-ownership, but it is still far from complete privatisation and this structurally inefficient agricultural system has resulted in a continuous reduction of agricultural production and serious food shortages. Consequently, the structural weakness of the North Korean economy has been reinforced by its closed economic policy, the irrationality of its political and social system, and the failure of international relations. Thus, subsequent economic failure compelled the North to adopt open-door policies and peaceful gestures toward the South and Western countries.

Table 2.2. Economic Statistics of North Korea 1965-2000

(US$ million in 1987 constant prices)

Year	GNP	GNP per capita	Growth rate (%)	Imports	Exports
1965	9,782	788	8.5	(272)	(210)
1975	19,721	1,197	5.4	(1,273)	(825)
1980	23,263	1,293	3.8	(1,824)	(1,627)
1985	23,337	1,190	2.7	(1,785)	(1,221)
1990	21,302	995	-3.7	(2,760)	(1,960)
1992	16,829	760	-7.6	(1,640)	(1,030)
1994	13,735	599	-1.7	(1,270)	(840)
1996	11,284	484	-3.7	(1,250)	(730)
1998	(12,600)	(573)	-1.1	(880)	(560)
1999	(14,700)	(600)	6.2	(960)	(510)
2000	(16,800)	(757)	1.3	(1,410)	(560)

Notes: 1. Figures in parentheses are current prices. 2. GNP per capita is in 1987 constant US dollars.

Sources: Korea Statistical Office, *Comparison of economic and social indices between South and North*, 2001; International Institute for Strategic Studies, *The Military Balance*, various years.

2.2.3. The Defence of South Korea

Since the outbreak of the Korean War, the defence of South Korea has relied considerably on US military aid. Its defence capability was not strong enough to deter a North Korean attack until the 1970s, even though defence was one of the first priorities under military governments. Under President Park's regime (1962-1979), South Korea sought a self-reliant defence policy in spite of the presence of US troops. Following rapid economic growth, the arms build-up of South Korea was achieved rather easily under successive military governments compared to that of North Korea which experienced serious economic stagnation in the 1980s. During the 1980s, the rapid arms expansion of the South with US co-operation greatly pressed the North Korean government. For example, the introduction of the US AirLand Battle doctrine in 1983, including pre-emptive strikes across the DMZ

(Demilitarized Zone) and counter-offensive operation which might possibly use tactical nuclear weapons, was a significant potential threat to the North. However, North Korea could not properly respond to the threat from the US-South alliance due to its chronic economic problems (Hamm, 1999). During the 1990s, South Korea has looked beyond immediate security concerns over the North and has planned a more self-reliant programme to defend a future unified Korea without US aid. The neighbouring countries such as China and Japan are emerging as a new future threat to South Korea. For example, China's defence budget has increased 10 times (in current price) for the past 15 years reaching 15% annual growth (SIPRI *Yearbook*). Accordingly, South Korea is now more concerned about Japan's and China's military capability. To implement its self-reliant programme, South Korea has focussed on enhancing naval and air forces and communications technology, including improved command, control, communications and computer processing (C4) and integrated logistic support throughout the armed forces (Huxley and Willett, 1999). These new capabilities helped the South to cope with the North's overwhelmingly large armed forces and superiority in weapons numbers. Some of the main projects planned by the Ministry of National Defense (MND) include building the core foundation for C4I systems, improving counter-surveillance and electronic warfare capabilities, upgrading tank capabilities, procuring attack helicopters, mass production of Korean-style Aegis-class destroyers (KDX-II/III) and next generation fighters (MND, *Defense White Paper*, 2000). In 2001-2002, South Korea planned to procure US$ 8-9 billion of new generation combat aircraft to strengthen its command of the air (e.g. an improved model of F-16 was selected as the new generation combat aircraft).

South Korea's defence capabilities have grown rapidly with its economic success between the 1970s and 1980s and its number of armed forces personnel peaked in the early 1990s

(Table 2.3). However, South Korea has focussed more on the modernization and strength of its military equipment rather than increasing its numbers of military personnel. For example, the number of aircraft doubled between 1975 and 1985. South Korea's defence spending began to exceed North Korea's from the early 1980s. Since the 1980s South Korea's defence spending has completely overtaken North Korea's, although its armed forces and equipment are still numerically inferior to North. Hence, it is concluded that the North's numerical superiority in armed forces personnel and conventional weapons is being countered by the South adopting capital and technology-intensive forces. As shown in Table 2.4, South Korea's proportion of defence spending to its military personnel has increased since the 1970s, while North Korea depended more on its number of armed forces personnel due to reduced defence spending since the 1980s. This shows that South Korea has a capital-intensive defence structure, while North Korea has a more labour-intensive defence structure. According to Table 2.4, South Korea's defence spending per soldier increased from US$ 1,704 in 1970 to US$ 15,136 in 2000 in an annual flow ratio, while that of North Korea decreased from US$ 6,080 to US$ 1,733 for the same period (in 1995 constant prices).Therefore, North Korea's reduced defence spending and financial difficulties in purchasing more advanced conventional weapons seem to be one of the major reasons why the North has attempted the development of strategic weapons, such as nuclear and biochemical weapons, and long-distance missiles since the 1990s.

Table 2.3. South Korean Defence Forces

Year	1975	1985	1990	1995	2000
Number of military personnel					
Army	560,000	520,000	650,000	520,000	560,000
Navy	40,000	45,000	60,000	60,000	60,000
Air Force	25,000	33,000	40,000	53,000	63,000
Total	625,000	598,000	750,000	633,000	683,000
Reserves	3095000	4800000	4500000	4500000	4500000
Numbers of army equipment					
Tanks	1,000	1,200	1,550	2,050	2,330
Armoured vehicles	-	700	2,080	2,460	2,540
Artillery	-	3,000	4,100	4,500	4,540
Helicopters	-	250	347	538	410
Numbers of navy equipment					
Combatants	113	120	140	162	138
Support vessels	30	41	24	29	28
Submarines	-	-	3	4	19
Naval air	-	44	59	70	52
Numbers of air force equipment					
Tactical aircraft	216	458	469	461	555
Support aircraft	143	244	195	165	189

Notes: 1. Number of military personnel includes both conscripts and volunteers.
2. Number of support aircraft is the total of transport and training aircraft.

Sources: The International Institute for Strategic Studies (various years) *The Military Balance*; The Ministry of National Defense (various years), *Defense White Paper*, The Republic of Korea.

Table 2.4. Defence Spending per Military Personnel in South and North Korea

(US$ million in 1995 constant prices)

Year	South Korea			North Korea		
	ME	**MP (000's)**	**ME/MP**	**ME**	**MP (000's)**	**ME/MP**
1970	1099	645	1703.9	2511	413	6079.9
1975	2411	625	3857.6	4522	467	9683.1
1980	6689	601	11129.8	5858	700	8368.6
1985	6198	598	10364.5	4647	840	5532.1
1990	11666	750	15554.7	4280	1111	3852.4
1995	14424	633	22786.7	5619	1128	4981.4
2000	10338	683	15136.2	1875	1082	1732.9

Note: ME= Military expenditures; MP= Number of military personnel; ME/MP= Military expenditure per military personnel (US$).

Sources: International Institute for Strategic Studies (various years) *The Military Balance*; Ministry of National Defense (various years), *Defense White Paper*, Republic of Korea.

2.2.4. The Defence of North Korea

North Korea's defence policy has focussed on a self-reliant system since the1960s and emphasized pre-emptive surprise attacks to occupy the entire peninsula. Until the mid-1970s North Korea had built up its military capability by developing conventional weapons and equipment focussing on quantity rather than quality. However, since the1980s it adopted a "blitzkrieg" strategy enhancing the capabilities of simultaneous attack on the front and rear lines, and developing a ballistic missile programme (*Nodong* and

Taepodong).[3] This is a response to the US-South Korean alliance and a source of hard currency earnings from exporting the missile technology to South Asia and the Middle East.[4] The nuclear development programme is also a key tactical leverage for North Korea to obtain more economic aid. North Korea has often threatened to restart its nuclear development programme unless further funding is provided to resolve the hold-up of oil supplies and construction of nuclear power stations under the Korean Peninsula Energy Development Organization (KEDO). By 2003, North Korea re-started its nuclear development programme withdrawing from nuclear Non-proliferation Treaty (NPT) and is increasing military tension in North East Asia.

According to the military expenditure data from SIPRI, IISS, ACDA, and Korean research institutes, the defence spending of North Korea exceeded that of South Korea until the late1970s; but, it started to be overtaken by the South from the early 1980s with the beginning of its economic slowdown. Accordingly, its defence burden grew gradually from the 1970s reaching approximately 15-25% of GNP and peaked in the mid-1990s and then fell to 14-17% of GNP after 1997. There are several reasons for this decline. First, North Korea cannot survive unless it decreases its defence burden and the reduction of defence spending is required to improve its economic performance. Second, North Korea focussed on the nuclear development programme instead of purchasing conventional weapons. This strategy created high military tension between the North and US-South alliance in the mid-

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3 *Nodong* is a modified model of Russian *Scud* missile with ranges of over 1,000 km and is capable of reaching main parts of Japan, including major US bases. North Korea is also developing *Taepodong* with ranges of over 1,500-4,000 km and test launched over Japan in 1998. In December 1998, it was reported that North Korea was building underground *Taepodong* launch sites (Huxley and Willett, ibid. pp.73).

4 In spite of the efforts of MTCR (Missile Technology Control Regime), a number of countries continue with programmes to obtain ballistic and cruise missile inventories. Syria and Iran are believed to have acquired the *Scud-C* missile as a result of trilateral cooperation between themselves and North Korea. Iran, North Korea and Pakistan are also believed to cooperate in the development of a longer-range missile. The Shahab IV in Iran and the Ghauri II in Pakistan are both believed to be derivations of the *Nodong I* developed in North Korea or possibly export versions of this missile (SIPRI Yearbook 2000, p. 670-671).

1990s, but subsequently, the North acquired economic aid from the US-South alliance under the Clinton Administration on the condition that it would stop its nuclear programme. North Korea also obtained financial assistance to construct nuclear power stations and resolve its food problems. Finally, the "peaceful mood" between the South and North could contribute to the reduction of defence spending. South Korea's share of defence spending in GDP has also decreased since 1990.

The number of conventional weapons in North Korea increased rapidly between 1970 and 1990 and the data imply that North Korea stressed its military expansion to dominate the South in spite of its economic decline in this period. However, North Korea's high defence burden also seems to have adversely affected its economy in this period and subsequently contributed to its economic collapse in the 1990s. As shown in Table 2.5, North Korea is still superior to the South in the numbers of military personnel and equipment. Nevertheless, it is doubted that the quality of its weapons is superior to that of the South's, because North Korea's reduced defence spending might indicate its poor maintenance system, aged equipment and the inferior quality of its weapons. In the 1990s, the North's total military personnel was over 1 million and its number of army personnel was 1.7 times larger than that of South Korea. Although modern warfare depends highly on technology and the quality of weapons, North Korea's large numbers of armed forces and conventional weapons is still a great threat to the US-South alliance.[5]

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5 Since the advent of the Bush Administration (2001-), the US-North Korean dialogue has stopped despite South Korea's appeasement policy to the North. The Bush Administration has called upon the North to reduce conventional weapons as well as to relinquish the development of long-distance missiles, and nuclear and bio-chemical weapons for the US-North peace talks. After the terrorist attack on September 11, 2001, the U.S. government has scrutinized the missile development and exports of North Korea to the Middle East.

Table 2.5. North Korean Defence Forces

Year	1975	1985	1990	1995	2000
Number of military personnel					
Army	410,000	750,000	1,000,000	1,000,000	950,000
Navy	17,000	35,000	41,000	46,000	46,000
Air Force	40,000	55,000	70,000	82,000	86,000
Total	467,000	840,000	1,111,000	1,128,000	1,082,000
Reserves	1840000	5000000	5000000	4700000	4700000
Numbers of army equipment					
Tanks	1,130	3,275	4,100	3,940	4,060
Armoured vehicles	200	1,690	4,200	2,200	2,500
Artillery	3,000	4,750	8,100	9,700	10,400
Helicopters	-	170	277	283	320
Numbers of navy equipment					
Combatants	169	340	369	413	336
Support vessels	-	175	150	183	277
Submarines	8	25	22	25	26
Numbers of air force equipment					
Tactical aircraft	588	854	782	589	621
Support aircraft	329	526	490	770	528

Note: Number of support aircraft is the total of transport and training aircraft.

Source: International Institute for Strategic Studies, *The Military Balance*, various years.

2.2.5. The Military Balance of the South and North

South Korea rapidly increased its military power to compete with North Korea since the mid-1970s and was spending approximately 5-6 times more than the North in real terms in the late 1990s (Table 2.6). In other words, the military balance between the South and North has been completely reversed from North's superiority to South's domination since the 1980s. Figure 2.1 shows the dynamics of the arms race between these two countries over the period 1960-2000. The reasons for the reversal are:

1) North Korea could not sustain its defence burden any more due to its economic problems which started from the 1970s and thus, could not catch up with South Korea's defence spending, even though it devoted a considerable share of its GNP to defence.

2) Since the 1990s the gap between the South and North has widened and the North has focussed on developing strategic weapons such as long-distance missiles, and nuclear and bio-chemical weapons to deter the US-South alliance instead of purchasing new and expensive conventional weapons.

3) In the late 1990s, peace talks between the South and North lowered military tension in the Korean Peninsula and contributed to the reduction of defence spending in both countries.

Figure 2.1 describes the military balance between the South and North using both nations' defence spending in real terms. It shows that the military expenditure of South Korea was

approximately 6.8 times more than that of North Korea in 1999, although the gap was slightly narrowed in 2000. The Figure shows that the defence spending of South has rapidly increased since the mid-1970s and the South began to dominate the North from the early 1980s.

The economic recession in South Korea starting in 1997 changed the pattern of military spending in both nations. The two Koreas' defence expenditures were considerably reduced in US dollars and the North's defence cut was more sizable than the South's. South Korea's defence spending was largely reduced in 1998 in real terms, while North Korea had already started to reduce its defence spending in 1997. South Korea's defence reduction was probably caused by the devaluation of the Korean currency (Won) and more needs for social welfare, while North Korea seems to be changing its defence policy because its economy is incapable of sustaining its defence burden. Moreover, North Korea's arms expansion is not conducive to improving the relationship with South Korea and the West. The economic reform programme imposed by the IMF significantly cut South Korea's defence spending. Nevertheless, its defence spending will not be reduced so fast as long as the actual arms reduction in North Korea is not verified. Ultimately, the possibility of disarmament depends on the search for peace between the two Koreas.

In terms of the arms race between the South and North, Table 2.6 and Figure 2.1 imply the possibility of the existence of an arms race between these two countries. It is expected that the arms race between the South and North was led by the North until the late 1970s, but the leadership was changed to the South since the 1980s. North Korea's reaction seems to be submissive since the mid-1980s. The gap in the defence spending between the South and North began to widen from the early 1980s and the South was completely dominating the

North in 2000. In other words, the defence expenditures of the two Koreas had increased, based on a tit-for-tat strategy until the early 1980s, but North Korea's economic failure has limited its defence spending after this time. South Korea's defence spending continually increased, as a whole, between 1960 and 2000, although it had small downswings for this period. Only one exception was 1998 when South Korea experienced a serious economic recession. In 1998 the South's defence spending fell from US$ 12.9 billion to US$ 10.9 billion in real terms. However, its defence spending rose again in 1999. In 2000, South Korea's defence spending decreased in both current and real levels probably owing to the South-North summit talk in June. North Korea's defence spending largely fell in 1997 and has been continually falling after this time. On the other hand, Table 2.7 shows US military aid to South Korea from 1960 to 1998. The US military grant to the South represented a substantial part in the defence spending of the US-South alliance and contributed to reducing South Korea's defence burden until the late 1970s. In fact, South Korea could achieve rapid economic growth owing to the US military assistance in its development process. Hence, it is expected that US military aid might contribute to South Korea's economic growth by providing spill-ins and preventing a crowding-out of civilian investment. In other words, regarding South Korea's defence-growth relationship, US military aid might have contributed to cutting South Korea's defence spending and raise its growth by helping South Korea to divert the resources released from defence to the civilian sectors from the early 1960s to the late 1970s. Even by 2003, US military support, including 36,000 military personnel, 90 combat aircraft, and airborne warning and control system (AWACS) is significant to deter the North Korean threat. Without US military support, South Korea's defence spending would be largely increased. Therefore, even though South Korea has been paying for the presence of US troops since the early 1980s, the presence of US troops is not only symbolically but also strategically important in the security context

of the Korean Peninsula. In the simple correlation analysis, the two Koreas' defence spending is correlated at 0.59 and this indicates possible arms races between the two nations. But, South Korea's defence spending and its growth are not significantly correlated (see Appendices II-1 and II-2). In Figure 2.1, the data from MND are used, because IISS military expenditures data are only available from the 1970s. So, the military balance between the two Koreas will be mainly analysed using MND data.

Table 2.6. Military Expenditures of the South and North Korea, 1960-2000

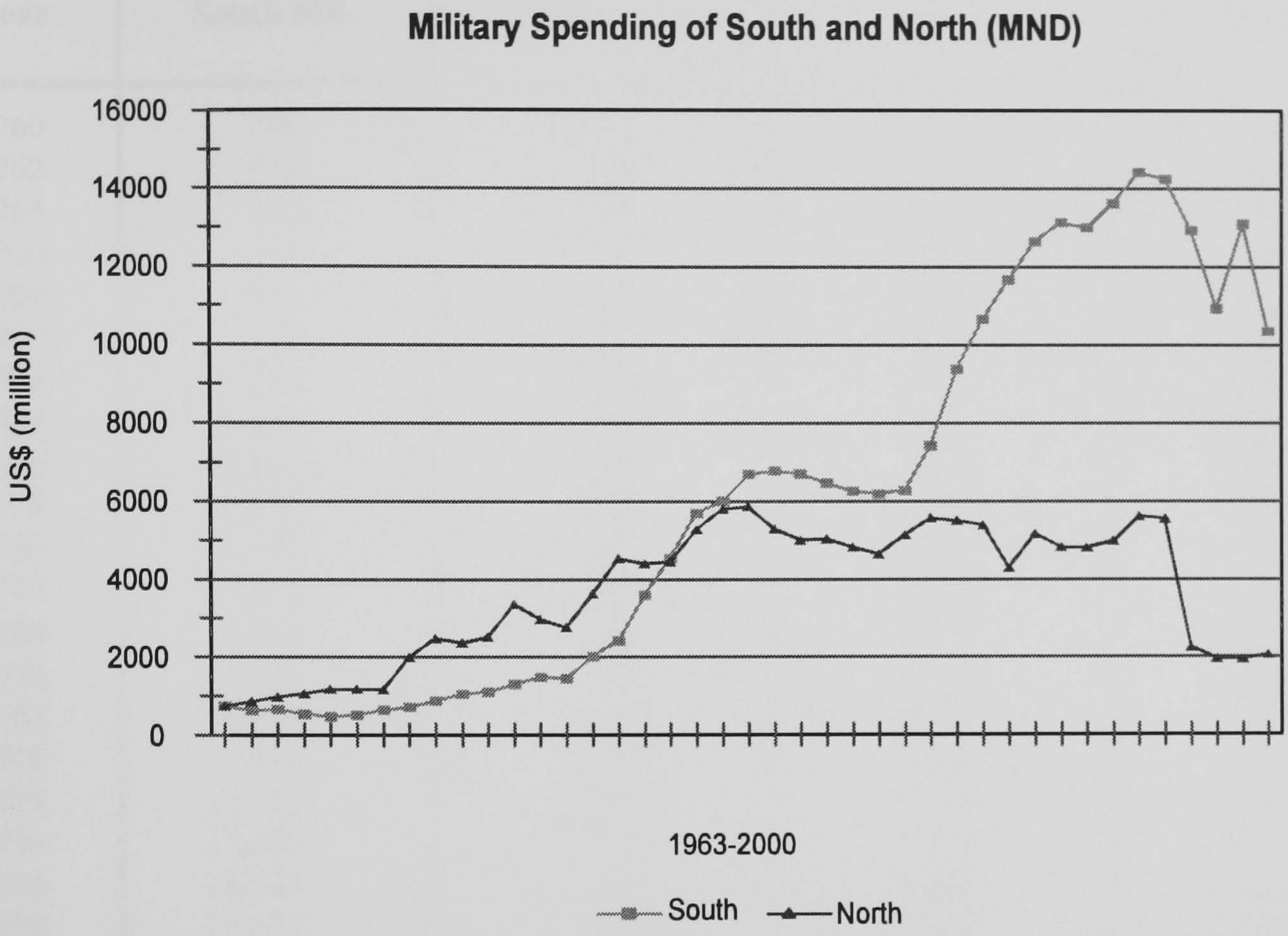
(US$ million in 1995 constant prices)

Nations	South Korea			North Korea		
Year	IISS	MND	Share of GNP(%)	IISS	MND	Share of GNP(%)
1960	-	736	7.0	-	742	7.8
1965	-	508	3.7	-	1,170	8.6
1970	636	1,099	3.7	978	2,511	16.2
1975	1,373	2,411	4.4	918	4,522	14.4
1980	6,609	6,689	6.1	1,350	5,858	15.5
1985	8,592	6,198	5.1	5,675	4,647	17.4
1990	12,677	11,666	3.7	5,434	4,280	23.8
1991	12,146	12,638	3.5	5,328	5,166	24.4
1992	13,731	13,130	3.5	5,087	4,819	25.7
1993	11,645	13,002	3.4	5,305	4,804	25.5
1994	12,764	13,625	3.3	5,412	4,990	26.6
1995	14,359	14,424	3.2	5,232	5,619	(25.2)
1996	16,172	14,245	3.0	(5,559)	(5,559)	(27.2)
1997	14,732	12,930	3.0	(2,238)	(2,238)	(16.8)
1998	10,461	10,923	2.4	(1,952)	(1,952)	(15.9)
1999	11,331	13,104	3.0	(1,929)	(1,929)	(14.3)
2000	11,453	10,338	2.8	(1,875)	(1,875)	(13.9)

Notes: 1. Figures in parentheses are quoting *The Military Balance*, IISS.
2. North Korean GNPs are commercial or trade exchange rates.
3. South Korean military expenditures are not including the US military aid.

Sources: T. Y. Hamm (1999) "Arming the Two Koreas: State, Capital and Military Power pp.93-96; IISS, *The Military Balance*, various years; Ministry of National Defense, *Defense White Paper*, various years; D.G. Kim (1999) "North Koreanology.", pp.108; Korea National Statistical Office, *Korea Statistical Yearbook* 2000; SIPRI, *SIPRI Yearbook*, various years.

Figure 2.1. Change in Military Spending of the South and North Korea, 1960-2000



Sources: The Korean Ministry of National Defense, *Defense White Paper*, various years; The International Institute for Strategic Studies, *The Military Balance* 1963-2002.

Table 2.7. US Military Aid to South Korea, 1960-1998

(US$ million in 1995 constant prices)

Year	South ME	US military aid	Total	US aid/Total (%)
1960	736	1,059	1,795	59.0
1962	654	905	1,559	58.0
1964	475	825	1,300	63.5
1966	630	771	1,401	55.0
1968	861	938	1,799	52.1
1970	1,099	1,286	2,385	54.0
1972	1,470	1,297	2,767	46.9
1974	2,008	513	2,521	20.3
1976	3,600	698	4,298	16.2
1978	5,693	433	6,126	7.1
1980	6,689	161	6,850	2.3
1982	6,703	63	6,766	0.9
1984	6,261	(-38)	6,261	(-0.6)
1986	6,278	(-98)	6,278	(-1.6)
1988	9,375	(-260)	9,375	(-2.8)
1990	11,666	(-194)	11,666	(-1.7)
1992	13,130	(-299)	13,130	(-2.3)
1994	13,625	(-366)	13,625	(-2.7)
1996	14,245	(-425)	14,245	(-3.0)
1998	10,923	(-312)	10,923	(-2.8)

Notes: 1. US military aid is the pure military grant to South Korea.
2. Figures in parentheses are South Korea's share expenses for the presence of US troops.

Sources: US DSAA, *Military Sales, Foreign Military Construction Sales and Military Assistance Facts*, various years; US AID, *Overseas Loans and Grants and Assistance from International Organizations*, various years; World Bank, *World Development Indicators*, various years; Korea National Statistical Office, *Korea Statistical Yearbook*, various years.

According to the correlation test to detect South Korea's free-riding for the period 1960-1976, it is found that there is no significant relationship between South Korea's defence spending and US military aid, but South Korea's defence spending is negatively correlated to the share of US military aid in the total military spending of US-South alliance. It is significant at the level of 0.01 for both Pearson and Spearman tests and the coefficients are -0.89 (Pearson test) and -0.92 (Spearman test).

2.3. SOUTH KOREA'S DEFENCE INDUSTRIES

South Korea's defence industry has been developed under President Park's "self-defence" policy since the early 1970s to cope with North Korea's arms expansion and the reduction of US military aid. Initially, there was free transfer of military technology from the USA, but South Korea's attempt to develop nuclear technology in the late 1970s made the US government more cautious about technology transfer. Accordingly, the free technology transfer from the USA ended in the 1980s and subsequently the South Korean government has focussed on expanding its defence industry and military R&D to build a more independent defence industrial base. The South Korean government has especially supported the development of high technology industries such as aerospace, electronics, and communication systems. As a result, the military R&D expenditures of South Korea increased steadily between 1986 and 2000 except for 1998, and accounted for approximately 5.2% of total defence spending in 2000. One of the plans of the South Korean government includes increasing the defence R&D by up to 15% of total defence spending until 2015 (Table 2.8).

Most South Korean defence equipments are produced in large corporate groups under government contract. In general, government has the initiative in defence R&D, but often co-operates with private conglomerates such as Samsung, Daewoo and Hyundai. These conglomerates are the main contractors of military production and they sub-contract with smaller suppliers. The Ministry of National Defense (MND) has the initiative using a monopsony position and affects the defence industry, and the procurement agency strictly inspects the defence products. Despite many regulatory conditions, the government also encourages private companies to participate in the defence industries by providing

favourable financial and technological support. In other words, the government provides advanced payments for the contract and also provides support for the essential technology through the government-affiliated military institutes, such as the Agency for Defense Development (ADD) for defence projects carried out by private industry. Thus, military business is very helpful for the cash flow and technological progress of a company which attracts companies into the defence market, although it is not as profitable as civil business. For example, Samsung used profits earned from its non-military division, such as semi-conductor and electronics to develop military aerospace technology such as the KTX-1 training-aircraft project and KTX-2 advanced trainer (Cheng and Chinworth, 1996).

Table 2.8. Government Expenditure on Military R&D in South Korea 1986-2000

(US$ million)

Year	1986	1995	1996	1997	1998	1999	2000
Military R&D (1995 constant prices)	170	440	460	510	342	590	663
Share of military R&D in defence spending (%)	2.7	3.1	3.2	3.4	3.5	5.1	5.2

Sources: SIPRI, SIPRI *Yearbook*, various years; Republic of Korea, MND (The Ministry of National Defense), *Defense White Paper*, Seoul, various years; Republic of Korea, The Ministry of Science and Technology, *Annual Survey Report on R&D Activities*, various years.

Despite the increase of R&D investment, the South Korean defence industry has had difficulties in developing high levels of technology and productivity. For instance, in the aerospace field, there has been a chronic shortage of financial resources notwithstanding government support, a lack of experienced and qualified personnel, and also an absence of an efficient material acquisition system. Namely, South Korea did not have the technological capabilities to produce these materials locally and also the import of core technology was not simple. The other problem is that the South Korean defence industry

depends highly on the import of foreign components, raw materials and technological licences. According to the US government[6], the defence procurement of the South Korean government depends highly on foreign supply, although the Korean Ministry of National Defense (MND) claimed that approximately 80% (Table 2.9) of its purchases are indigenous (Huxley and Willett, 1999). Probably, the gap between the two data implies that South Korea needs the imports of semi-manufactured or semi-assembled goods for defence production from foreign countries, particularly from the US with frontier technologies needed for the local assembly of weapon systems. Thus, it is assumed that many local defence suppliers import these semi-assembled materials and produce finished goods owing to a lack of technology. However, the South Korean government seems to regard these products as locally-produced goods.

Table 2.9. Defence Procurement by Source 1990-1995

(Won billion in 1990 constant prices)

Year	Defence procurement				
	Total	Domestic purchase	Share (%)	Foreign imports	Share (%)
1990	4,252	3,092	73%	1,160	27%
1991	3,215	2,680	83%	535	17%
1992	3,502	2,217	63%	1,285	37%
1993	3,455	2,999	87%	456	13%
1994	3,632	2,975	82%	657	18%
1995	3,446	2,816	82%	630	18%

Sources: Ministry of National Defense (MND), *Defense White Paper* (various years), Republic of Korea; International Monetary Fund (IMF), *International Financial Statistics Yearbook* (various years); Choi, J.C. (1998) "South Korea" in R.P. Singh (ed.) *Arms Procurement Decision Making Volume I: China, India, Israel, Japan, South Korea and Thailand*, Oxford: Oxford University Press.

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6 According to the US Department of Commerce, it is estimated that only 20% of government procurement is supplied locally in the defence sector in South Korea. (US Department of Commerce, Bureau of Export Administration, Office of Strategic Industries and Economic Strategy, *Pacific Rim Diversification and Defense Market Assessment*, Washington DC: DoC, 1994: p.95).

Another problem for the South Korean defence industry is low offset rates on foreign imports, although South Korea is one of the major importers from the US defence market. South Korea's offset rate is low compared with major offset agreements between the USA and other major importers. For example, in 1990, South Korea's offset rate was only 46.2% while other countries, including Britain and Spain achieved over 100% (Choi, 1998). These low offset rates might be caused by the lack of South Korea's negotiation skill and the USA's arms export strategy preventing the transfer of high technology. South Korea's defence policy is to secure military technologies in order to accelerate the rate of indigenisation of defence production, but the USA is reluctant to provide the core technology and a high ratio of offset trade to South Korea. Hence, South Korea needs to diversify defence suppliers from the USA to other countries and choose the best option for its defence procurement, but it is not simple due to the US-South military alliance. But, recently, South Korea's offset rates have been gradually rising. The imminent F-15K fighter programme, for example, carries a large offset obligation amounting to 83%.

South Korea's defence industry is also faced with low productivity. First, regarding the efficiency of the procurement process, contract forms and cost management systems are not developed so as to improve the productivity of defence suppliers and reduce unit costs. Defence contractors do not have incentives to reduce unit costs in the case of fixed-price contracts, because the military deducts the difference between the prime cost on the contract and the real prime cost after production (Choi, 1998). This means that fixed price contracts are re-negotiated. If the real prime cost after production (post-cost) is lower than the prime cost on the contract, government deducts the difference and cuts the price of equipment to reduce government expenses. That is, the profits from cost reduction do not go to the suppliers. Second, the South Korean government has encouraged arms exports to increase

the productivity and profitability of the defence industry, but South Korea's annual arms exports have not only been very small but they also have been declining even compared with North Korea (Table 2.10). North Korea has developed its indigenous missile technology by applying Russian *Scud* and strategically exported these missiles to the Middle East, India and Pakistan, while South Korea's defence industries have depended on imports which entailed technology transfer from the US and Western countries.

Table 2.10. Arms Imports/Exports of South and North Korea, 1986-2000

(US$ million, 1996 in constant prices)

Nation	South Korea			North Korea		
Year	Import	Export	Trade Balance	Import	Export	Trade Balance
1986	849	177	-672	571	340	-231
1988	953	102	-851	1,271	890	-381
1990	1,111	152	-959	234	246	12
1992	1,314	33	-1,281	164	186	22
1994	2,188	42	-2,146	135	63	-72
1996	1,100	20	-1,080	0	50	50
1998	1,002	36	-966	-	-	-
2000	815	7	-808	-	-	-

Note: It is doubted that South Korea's arms exports/imports data for the period 1996-2000 are undervalued. But, both ACDA and Defense White Paper (The Korean Ministry of National Defense) show similar results.

Sources: U.S. Arms Control and Disarmament Agency (ACDA), *World Military Expenditure and Arms Transfers* 1997; The Korean Ministry of National Defense, *Defense White Paper*, various years.

From the late 1990s, with South Korea's economic crisis, the government has pursued downsizing and restructuring of its defence industries and has decided to reduce the number of major contractors and over-investment in the defence industry. For example, three major aerospace firms, Daewoo, Samsung and Hyundai, merged in 1999 to form "Korean Aerospace Industries" (KAI), now the sole aircraft manufacturer in South Korea (Lewis, 1998). KAI started to produce the KT-1, a basic trainer aircraft developed indigenously

after it completed the initial Korea Fighter Program (KFP). KAI is also developing the T-50, an advanced supersonic trainer aircraft and preparing for long-term strategic programs, such as the F-X next generation fighter, a multi-purpose helicopter and marine patrol aircraft. However, South Korea's fighter market depends mostly on imports from foreign countries, mainly the USA. Table 2.11 compares the output, profit and the proportion of military sector to total output between the KAI and other major aerospace companies. According to Table 2.11, KAI is not yet competitive with other major companies in both scale of output and profitability. General Dynamics, a relatively small aerospace company is about 16 times larger than KAI in its total output and KAI did not make a profit by 2000. Thus, it is estimated that KAI is inferior to other major companies in both its economies of scale and associated productivity. Its dependence on the military sector is also higher than other major companies. Hence, KAI needs to penetrate the domestic market first by producing fighters and other aircraft meeting domestic needs, and develop niche markets for export in both the military and civil aerospace sectors.

The South Korean defence industries may also have to face competition with foreign companies through the government's open market policy. The South Korean government has been very energetic in inviting foreign capital since the 1997 economic crisis and they are ready to permit not only the investment of foreign companies in local defence industries but also the ownership of these industries. However, by 2003, there was no case of foreign companies actually acquiring ownership of major South Korean defence industries. It is believed that the investment of foreign companies in local defence industries is not always desirable in terms of the national security. Therefore, it is desirable that the government resolve the problems of defence industry domestically through restructuring and downsizing. In terms of the optimal structure of aerospace industry, it is better to be

monopolistic in South Korea, because South Korea has a relatively small aerospace market and few opportunities to export due to its technological weakness. In so doing, the economy can save resources by avoiding over-investment.

Table. 2.11. Comparison between Korea Aerospace Industries (KAI) and Other Major Producers

(US$ million in 2000 constant prices)

Company	Arms sales	Total output	Profit	Profit/ Sales (%)	Military sector in total output (%)
Korea Aerospace Industries (KAI)	483	568	-88	-15.0%	85%
Lockheed Martin (USA)	18610	25329	-519	-2.0%	73%
Boeing (USA)	16900	51521	2128	4.1%	33%
BAE SYSTEMS (UK)	14400	18473	1440	7.8%	78%
Northrop Grumman (USA)	6660	7618	608	8.0%	87%
General Dynamics (USA)	6520	10356	901	8.7%	63%
EADS (France/Germany/ Spain)	5340	22303	-832	-3.7%	24%
Mitsubishi Heavy Industries (Japan)	2850	28255	-189	-0.7%	10%

Source: SIPRI, *Yearbook* 2002, Oxford: Oxford University Press; Korea Aerospace Industries, KAI Financial Report 2000, Seoul: KAI.

There has been a positive effect of dual technologies on the South Korean economy. From the 1970s to the mid-1990s, South Korea's development of dual technologies contributed to its economy through technological spin-ons and employment. As illustrated in Table 2.12, the production technology of machine tools and fuel injection systems was applied to developing rifles, and technology for manufacturing railcars, trucks, and special engines

for civilian uses was utilised in producing tanks and military vehicles. Also, technology for commercial electronics and communications technology, such as the development of video tape recorders, copy-machine drums, microwave devices, cordless telephones, navigational radar and marine electronics contributed to progressing fire control systems, communications and laser-ranging equipment (Kim, 1993). Under President Park's regime (1962-1979), government made efforts to commercialize military technology and develop dual-use technologies for civilian uses and such efforts were successful in some parts. However, as mentioned earlier, South Korea had a relatively weak base in developing military technology, and civilian firms had no capabilities and incentives to implement these projects (Hwang, 1996). Furthermore, it is doubted that dual-use technologies, especially from the military to the civilian sector, really contributed to the development of civilian technology and the economy. In most cases, it is difficult to apply the technology for military purposes to civilian uses. Thus, it is believed that the technology spin-offs from military to civilian sector were not much efficient in South Korea. Alternatively, as shown in Table 2.12, it must be considered to apply the civilian technology to the military sector to achieve a more economic efficiency. It is claimed that the application of military technology to civilian uses might increase the cost of products to resolve the technological difference between the military and civilian products. Thus, it might be more efficient to invest in the civilian technology directly. To some extent, these dual-use technologies were beneficial at the beginning of South Korea's economic development, because the military technology could be transferred to civilian purposes and bring an import-substitution effect. In the development process of South Korea, dual use technologies might have supplied key technologies to the defence industry and contributed to the development of civilian technology by providing its advanced know-how until the late 1970s. However, the importance of dual-use technologies has gradually ebbed since the 1980s.

Table 2.12. Examples of Spin-on

Area	Military technology	Commercialization examples
Metals; Machining	Small arms manufacture Recoil system for 155 mm gun Parts for howitzers and Vulcans Aluminum welding technology	Production of fuel injection Hydraulic cylinders NC machine tools Welded aluminium structures
Transportation	Armoured vehicle fabrication Tool and die design Military engines	Transmissions
Electronics and Communications	NKH missile-tracking device Fire control system for guns Production of aluminum fuses Fire control calculators	Laser range finders Airborne meteorology equipment Military radio communications Guided missiles and radars Military teletype printers

Source: Hwang, D. J. (1996) "The Role of Defense Industry in Innovation and the Development of Dual-Use Technology", *The Korean Journal of Defense Analysis*, 8(1):153-176.

Since the 1980s, the South Korean defence industry has tended to rely on arms imports and technology transfer from the arms exporting countries, so that its defence industrial policy has seemed to be changed from indigenous technology development to licensed production and offsets (eg. F-16 co-production programme, Hawk, etc.) due to South Korea's technological and manpower limitations. But, the opportunity cost should be estimated whether the foreign imports of defence equipment gave more benefits to the rest of the economy compared with indigenous development. On one hand, the development of indigenous military technology might have a negative effect on the rest of the economy by crowding-out necessary non-military public and private investment. On the other hand, the import of defence equipment has also a negative effect on the balance of trade and subsequently the rest of the economy. Also, depending wholly on the imports might cause the underdevelopment of indigenous technology. Hence, it is important for government to harmonise these two methods in making its defence industrial policy by increasing offset

rates, and nurturing technicians and industrial base.

In terms of employment, the defence industry contributed to the South Korean economy throughout the 1980s. Table 2.13 shows that the South Korean defence industry increased its employment until 1995 (about 10,000 employees every five year), although it has declined with the economic slowdown since 1997.

Table 2.13. Employment in Defence Industry in South Korea, 1985-2001

Year	Total employment (thousand)	Employment in manufacturing industry (thousand)	Employment in defence industry (thousand)	Share of employment in defence industry in total employment (%)
1985	14,970	3,504	40	0.3
1987	16,354	4,416	40	0.2
1989	17,560	4,882	50	0.3
1991	18,677	5,026	50	0.3
1993	19,328	4,677	60	0.3
1995	20,432	4,797	60	0.3
1997	21,106	4,482	55	0.3
1999	20,281	4,006	50	0.2
2001	21,362	4,199	-	-

Sources: Bonn International Center for Conversion, *Conversion Survey: Global Disarmament, Demilitarization and Demobilization* (various years) Baden-Baden: Nomos Verlagsgesellschaft; Korea National Statistical Office, *Major Statistics of Korean Economy* (2002), Seoul: Republic of Korea.

Defence spending has also been a burden to South Korea in spite of its economic success.

As shown in Table 2.14, South Korea has sacrificed its spending on social welfare, including health and housing, and public and private investment for the civilian economy due to the defence burden required for the North Korean threat. According to Table 2.14, government spending on defence has declined over the last 15 years, but is still high. In Table 2.15, compared with other OECD countries, including Australia and France, South

Korea's share of defence in total government spending is extraordinarily high. Although expenditures on social welfare and other public services have steadily increased, the social welfare sector has fallen behind compared with other OECD countries. Table 2.16 shows that government outlay on the defence sector is significantly and negatively correlated with outlays on the social welfare and other public and economic services. The correlation coefficient between defence and social welfare is highly negative at -0.86 and it is also negative at -0.96 for other public and economic services. But, government spending on education is positively correlated with its spending on defence, because both the share of spending on defence and education in government expenditures decreased for the period 1980-2000. Thus, it is noted that the South Korean government has mainly focussed on the increase of social welfare and other public services at the expense of reducing the share of defence spending in government outlays.

Table 2.14. Government Final Consumption Expenditure of South Korea by Function, 1980-2000

Percentage (%)

Function/ Year	1980	1985	1990	1992	1994	1996	1998	2000
Defence	35.6	30.6	25.0	25.9	23.7	22.1	19.3	17.0
Education	17.7	20.1	20.4	19.4	19.3	18.9	16.6	14.3
Social welfare	6.4	6.8	8.9	9.7	9.0	8.6	9.8	11.9
Others	40.3	42.5	45.7	45.0	48.0	50.4	54.3	56.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: 1. Social welfare defines the social security and development such as unemployment benefit and the government subsidy to private social welfare facilities. Social welfare sector also includes health and housing.

2. Others include expenditures on economic development, general public and economic services such as fuel and energy, agriculture, forestry, mining, and transportation and communication etc.

Source: Korea National Statistical Office, *Major Statistics of Korean Economy* 2000, Seoul.

Table 2.15. Government Final Consumption of Major OECD countries by Function, 1995

Percentage of government final consumption (%)

Function / Country	Defence	Education	Health	Welfare	Housing	Others
Australia	10.9	21.2	18.2	5.8	2.1	41.8
Austria	4.7	22.7	27.1	17.5	-	28.0
France	15.8	26.0	17.3	7.5	6.9	26.5
Italy	10.5	26.1	20.7	4.2	3.1	35.4
Japan	9.0	32.7	4.6	6.6	6.8	40.3

Note: Others are general public services and various economic services such as fuel and energy, agriculture, forestry, mining, and transportation and communication etc.

Source: National Accounts Statistics, *Main Aggregates and Detailed Tables 1995*, Department of Economic and Social Affairs Statistics Division, UN: New York.

Table 2.16. Nonparametric Correlations between Defence and Other Sectors in South Korea

Sector	Education	Social welfare	Others
Defence	0.587**	-0.863**	-0.961**

** Correlation is significant at the 1% level (2-tailed).

Notes: 1.Correlations are measured by the share of expenditures on each sector in the total government spending.

2. Nonparametric correlations are examined by Spearman's rho test.

2.4. SUMMARY: FUTURE ISSUES FOR THE TWO KOREA'S DEFENCE ECONOMY

Since the Korean War, both the South and North re-started the arms build-up in spite of their devastated economies. North Korea began to increase its armaments in the early 1960s and spent approximately 20-25% of GNP on military expenditure throughout the 1990s, although it suddenly decreased in 1997 and 1998 (*The Military Balance* 2000/2001, IISS). As a consequence, North Korea's high defence burden has seriously crowded-out civilian investment and caused an economic decline in its closed economy. By contrast, the defence spending of South Korea has escalated with its economic development since the 1960s, heavily depending on US military aid, and has been maintained at about 3-6% of GNP, although it has steadily decreased since the 1990s. The South has spent more on military expenditures than the North since the early 1980s, but it is still inferior to North in the number of armed forces and weapons stock. In spite of this inferiority, the South could deter a potential threat from the North owing to the presence of US troops (with US commitment to aid South Korea in any conflict).

Even though South Korea has spent more on defence for about two decades, North Korea has had a dominating military power over the South in the number of military personnel and equipment. Here, three factors are relevant. First, the North has substantial hidden costs which should be counted as defence expenditure but are not. For example, North Korea retains 189,000 security troops under the Ministry of Public Security and some 3,500,000 Worker/Peasant Red Guard, but there are doubts as to whether the costs of retaining these forces are counted as military expenditure. In fact, the Korean Ministry of National Defense (MND) estimates that North Korea's actual defence spending is about 2-3 times larger than

its official data. Second, North Korea's cheap labour costs might have lowered its defence spending. In 1998 the gap of per capita income between the South and North was over 12 times in current prices. Thus, it is inferred that the North might depend on its cheap labour cost to maintain its defence forces and industries owing to its conscription system and long-term military service. Hence, North Korea could have an advantage over the South, especially in labour-intensive defence industries and military forces. Third, the major conventional weapons of North Korea have low quality and value as they are mostly outdated and aged compared with those of the South which has constantly attempted to improve its quality of weapons and purchased new weapons. For example, South Korea's main combat aircraft, F-16 series, imported from the US was introduced in the late 1980s and the early 1990s while North Korea's major fighters are still the MIG-21 series produced in the former Soviet Union from the late 1950s.

Although the military gap between the South and North is being widened and South Korea's defence budget tends to increase annually, North Korea is still a major threat to South Korea. Thus, South Korea's dilemma is how to attain higher economic growth, maintain a strong military capability with a small defence burden and mitigate the North's threat. As a result, since the late 1980s, there have been many efforts at peace negotiation (*entente cordiale*), including the discussion for arms control between the two Koreas, but mutual trust has hardly improved[7] : hence, the military build-up is still the most secure way to survive in the competition between the two nations. Nevertheless, if peace talks between the two nations are continued, disarmament will be the key issue for both countries. Disarmament is essential to the North for its economic reconstruction while it is also

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7 Two Koreas made the Agreement on Reconciliation, Nonaggression and Exchanges and Co-operation between the South and the North in 1992, but there is no notable progress in disarmament and both nations are continuing their military build-up and regular military training.

significant for the South for better economic prosperity. Since the peace talks, North Korea urgently requested economic aid, including food and energy; however they cannot wholly depend on the South and foreign assistance, and also need to finance themselves through reductions in defence spending.

Another important issue concerns the defence industry of South Korea. It is expected that the South Korean defence industry will decline with the progress of peace talks between the South and North, but nonetheless, the South cannot reduce its arms production immediately due to the schedule of military procurement and its negative economic effects. A sudden shrinkage of military production may damage its defence industrial base and increase costs. Also, at the very beginning of peace talks, both countries need to continue their military build-up, because the disarmament through peace negotiation might fail. Therefore, on the one hand, South Korea needs to avoid the rapid decline of its defence industrial base and prepare for the adverse effects from disarmament, while on the other, South Korea should raise the competitive position of its defence and military R&D in the long-term. In this aspect, military outsourcing might be considered for improving the efficiency of South Korea's defence. The UK Ministry of Defence (MoD) transferred its traditional 'in-house' activities, such as catering, security guarding and maintenance, engineering and supply, and training and instruction to private firms, and saved some 20-30% of cost (Hartley, 2002). However, the military outsourcing might increase the cost in South Korea, because the wage of military personnel is generally much lower than that of civilians owing to its conscription system. Hence, the cost and benefit of military outsourcing needs to be carefully analysed before awarding such contracts. Also, South Korea needs to prepare for the unification of the two Koreas and subsequent economic conversion of North Korea, even though it is unlikely to happen in the near future.

Basically, economic conversion must entail the gradual reduction of major weapons and arms expenditures, but mutual trust between the two nations is needed to attain this goal and this will require more time.

From this chapter, three hypotheses might be suggested. First, the arms race between South and North Korea is expected to exist since the 1960s. Until the late 1970s, the defence spending of North Korea was superior to South Korea's, but since the 1980s, it was reversed. Hence, it is expected that North Korea led the South-North arms race until the 1970s and South Korea led it from the 1980s. Second, US military aid is expected to provide a free-ride to South Korea. As mentioned earlier, South Korea's defence spending was not correlated to the real US military aid, but it was found that it had a significant negative relationship with the share of US military aid in the total military spending of US-South alliance. Third, it is expected that some positive or negative relationship exists between defence and growth in South Korea. At the beginning of South Korea's economic development, its defence might have a positive effect on growth through spin-offs and externalities, such as social infrastructure, human capital and the technology transfer from military to the civilian sector. By contrast, defence might harm growth after South Korea reached a middle-income country by crowding-out more productive non-military investment. In the next chapter, the existence of an arms race in the Korean Peninsula will be examined, beginning with a review of the related literature.

CHAPTER III

A REVIEW OF ARMS RACE MODELS

3.1. INTRODUCTION

The arms race is one of the most important and widely pervaded phenomenon in today's world politics. Even though the Cold War has faded away since the end of the1980s, big and small conflicts between regional rivals still exist in the post-Cold War era and China is rising as a dominant power confronting the US in East Asia (Buzan and Herring, 1998). In this changing environment, arms races between regional rivals are very important to both defence economists and political scientists.

There is no common and widely accepted definition of an arms race, because it is a highly controversial topic and can be approached from many different angles. For example, at one extreme, the arms race between superpowers could be thought as a means to maintain the balance of power and thus secure world peace in the Cold War era. However, at the other extreme, an arms race is regarded not only as a main threat to international peace but also as a serious dilemma to world security. Anderton (1986, p.9) defined an arms race as "a situation where two or more parties change the quantity or quality of their armed forces in response to perceived past, current or anticipated future increases in the quantity or quality of armed forces of the other party(ies)". On the other hand, Albrecht(1990, p.89) asserted that programs for major weapons systems of the leading military powers do not follow an action-reaction pattern, although he did not completely deny the existence of a race. In other

words, he suggested that the accumulation of weapons by both parties is something different from a race whether they are conventional or strategic. However, as generally defined, an arms race is two or more nations (or parties) actively involved in a competition to accumulate military strength against each other.

Although arms races have always existed between conflicting nations throughout history and security has been one of the most important factors which sustains the state system, systematic research on military competition including war, armed conflicts, arms races and defence policy had not been performed deeply before Carl von Clausewitz (1832) wrote "*On war*". The theoretical studies on the arms race were started by L.F. Richardson in the 1930s and "*Arms and Insecurity*"(1960) describing his general theory of the arms race was published posthumously in 1960. Accordingly, the history of arms race studies is relatively short and still has a long way to go. After the Cold War ended in 1989, research on arms races seems to be unnecessary in the age of peace. Nevertheless, many regional conflicts, small wars and terrorism are still continuing, and they are emerging as a new significant threat to international security. To describe these phenomena, some stylized facts are presented in Table 3.1.

Table 3.1. Change of Armaments in Regional Rivalries

Nations	Military expenditures (US$ Million)				% of GDP			
	1970*	1980	1990	2000	1970	1980	1990	2000
US	120655	270262	356994	262380	7.1	5.4	5.3	3.0
Russia	93900	107300	203000	24883	9.7	-	12.3	3.8
S. Korea	662	6689	11666	10338	3.7	6.1	3.7	2.8
N. Korea	956	5858	4280	2049**	16.2	15.5	23.8	13.9
Turkey	1655	3347	5502	9686	4.7	4.3	3.5	5.4
Greece	1044	4425	5059	6738	4.7	5.7	4.7	4.8
Pakistan	874	1494	3111	3259	6.6	5.7	6.2	5.8
India	3201	4408	7660	11838	3.4	3.0	2.9	3.1

Notes: 1. Russian data before 1990 are the data from former Soviet Union.
2. Military expenditure data are 1995 constant prices except for 1970 (1970 data are 1978 constant prices).
3. Military expenditure of North Korea in 2000 is in current prices.

Source: SIPRI Yearbook, various years (SIPRI); The Military Balance, various years (IISS).

The trends in change of armaments in US and Russia, the Cold War superpowers, and three pairs of regional rivalries are shown in Table 3.1. This Table illustrates how the pattern of arms races has changed since the end of the Cold War. After 1990, the military expenditures of the two superpowers, US and Russia, rapidly reduced and those of the two Koreas also decreased. However, the gap of military spending between the two Koreas widened since the 1990s. In contrast, there are some differences in other regions. Turkey, Greece, Pakistan and India increased their military spending even though the Cold War had ended. Hence, these regional rivalries were not affected by the end of the Cold War.

South and North Korea increased their defence spending since the Korean War (1950-1953) until the mid-1990s, but they tended to decrease defence spending since the mid-1990s. In

spite of its economic difficulties, North Korea's share of defence spending in GNP reached up to 25-27% until the mid-1990s and its defence burden was unprecedentedly high in the world. As a result, North Korea's excessive defence burden precipitated its economic collapse. By contrast, South Korea steadily increased its defence spending owing to its economic success and caught up with North Korea in the 1980s. Although the share of North Korea's defence spending in GDP has reduced since the 1990s, it is believed that its actual defence spending was not really reduced, and the number of military personnel and weapons dominated South Korea's by 2003. South Korea's defence spending tended to decrease after its economic crisis in 1997. Consequently, there is no clear evidence that the arms races between these regional rivals disappeared. Among these countries, the military confrontation between South and North Korea is still continuing despite the end of the Cold War. Economic co-operation between the two countries is increasing, but military tension is still high in the Korean Peninsula. Although the arms race between the South and North tended to be alleviated since the 1990s due to the military superiority of the US-South alliance, North Korea is still a great threat to the South. Its development of nuclear and bio-chemical weapons is threatening peace in this region. Hence, it is important to study the arms race between South and North Korea experiencing rapid political change. Although there are many arms race models, only some key elements of those models related to this thesis will be briefly introduced and discussed in this chapter. Many arms race models include demand for military expenditure, because defence spending and an arms race are closely related to each other. Here, the major features of those models will be presented and critically assessed (Isard and Anderton,1988; Sandler and Hartley,1995; Intriligator and Brito, 2000).

This chapter discusses the classical Richardson model and its alternative model considered in the strategic aspects (missile war game) studied by Intriligator (1975) and Intriligator and Brito (1976,1977, 1984). These two models are very important to the study of arms race theory. Richardson provided the first and most basic arms race model and showed that international relations could be explained by mathematical methods. Intriligator(1975) and Intriligator and Brito (1976, 1977, 1984) developed a strategic missile war model strongly influenced by Richardson. This model not only introduced the Cold War arms race interaction, but it also represented strategic analysis concerning arms escalation, mutual deterrence and the outbreak of war. Hence, these two theories are necessary to describe the action-reaction process, one of the main hypotheses in explaining arms race phenomenon. Other necessary arms race models will also be introduced, but this survey will be mostly focussed on the models based on the Richardson's action-reaction process.

3.2. ARMS RACE MODELS

When two or more countries or alliances are involved in an competitive arms acquisition or increase of military manpower, the phenomenon is defined as an arms race. These arms racing countries or alliances usually have conflicting national goals and are often engaged in regional disputes. Most Richardson arms race models are characterized as an action-reaction or tit-for-tat processes in which a nation increases its arms expenditures in response to increases in its potential opponent's. However, it is found that this action-reaction process is not adequate to explain the entire arms race phenomena and often fails to demonstrate them. Consequently, an arms race is not caused by a certain factor, but is induced by a combination of various complex factors. In other words, arms races are caused not by a simple armed conflict but by various internal and external factors including

diplomatic disputes, the change of political, economic and social environment, the military-industrial complex and the revolutionary growth of military technology. For example, the post-Cold War US military expansion has been largely motivated by the development of military technology and political purpose to grasp world hegemony. Whereas the South and North Korean military competition has been induced by historical antipathy and distrust caused by the Korean war (grievance factor) under the Cold War system. Therefore, the arms race in the Korean Peninsula is affected by the combination of external (the Cold War) and internal (national conflict) factors.

3.2.1. The Richardson's Action-Reaction Model and Its Variants

3.2.1.1. The Richardson Model

Lewis F. Richardson's seminal work (Richardson, 1960) which represented the first arms race model made a great contribution to the development of mathematical theories of international relations. Most of the arms race theories have been derived from his model and one of the important works on arms race study was developing a better model fitting the real world. Accordingly, a study on arms race models should start with Richardson's 'action-reaction' model, because it is the most influential model in the arms race studies and a descriptive model of the dynamic processes of interaction in an arms race (Intriligator and Brito, 1990). The classic Richardson model starts from the following two hypotheses (Majeski and Jones, 1981):

> ***Hypothesis* 1.** For any two nations in a mutual arms race, changes in their military expenditures (or armaments) are determined by its opponent's military

expenditures(or armaments), its own military expenditures(or armaments) and a grievance factor.

***Hypothesis* 2.** Two adversary nations will be engaged in a competitive arms race.

The Richardson model for two antagonistic nations, A and B, is shown by the following pair of differential equations:

$$dM_A / dt = kM_B + \alpha M_A + g \qquad (k \succ 0, \alpha \prec 0) \tag{3.1}$$

$$dM_B / dt = lM_A + \beta M_B + h \qquad (l \succ 0, \beta \prec 0) \tag{3.2}$$

where

$M_A =$ military expenditure (or stock)[1] in nation A.

$M_B =$ military expenditure (or stock) in nation B.

$k, l =$ reaction (or threat) coefficients.

$\alpha, \beta =$ fatigue (or burden) coefficients.

$g, h =$ grievance (or enmity) terms.

According to Richardson's equation, threat coefficients k, l should be positive, but fatigue coefficients α, β should be negative. Grievance factors g and h can be positive or negative.

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1 Military stock can be defined as weapons stock, armed forces or any military stock possible to measure and compare with opponent's. For example, number of missile or number of aircraft can be compared between two rivals, although the quality of weapons might be different.

From these two equations, it is found that the change in the military stock or defence spending of one nation is linearly correlated to its adversary's military stock or defence spending and its own stockpile or expenditure. However, a variable (e.g. M_B in equation (3.1)) indicating an adversary's military spending or armament stock gives a positive effect on the change in the military spending of a nation while the other variable (M_A in equation (3.1)) representing a nation's own military spending or armament stock gives a negative effect on it due to the fatigue effect caused by the economic burden from defence. In other words, in equations (3.1) and (3.2), k and l are "reaction (threat) coefficients" indicating an adversary's threat causing a nation's armaments, whereas α and β are "fatigue" or "burden" coefficients reflecting the economic burden or stress caused by a nation's own armaments. Hence, it is noted that reaction coefficients(or threat coefficients) induce both nations' armaments while fatigue coefficients motivate both nations' disarmament and suppress an arms race (Zinnes *et.al*, 1976). In short, the two pairs of coefficients, k,l and α,β have a counterposing and restraining relationship with each other. Also, g and h are generally called "grievance(or hostility) factors" which indicate a nation's historical antipathy against its adversary nation or factors stimulating a nation's military expansion. Alternatively, they can express an amicable relation or alliance between two nations when they have negative signs. For instance, if two nations are historically and seriously hostile to each other, such as Greece-Turkey or India-Pakistan relationship, the grievance factor will be significantly positive. The grievance factor of South and North Korea is also assumed to be positive. In contrast, the grievance factor can be zero or even negative when two nations have a normal relationship or are allied politically, economically and militarily. The US-Canada relationship is a good example.

Wolfson (1968) introduced a variant of the Richardson model in which one nation contends with its adversary's armaments stock or expenditures. The model is represented by the following equation:

$$dM_A / dt = k(M_B - M_A) - \alpha M_A + g \qquad (3.3)$$

$$dM_B / dt = l(M_A - M_B) - \beta M_B + h \qquad (3.4)$$

In the above equations, the only difference from the Richardson model is that the change in one nation's military stock (or expenditures) is dependent on the difference between its own stock (or expenditures) and that of its opponent. The fatigue and grievance factors are the same as the Richardson equation. Another similar variant of the Richardson equation is the submissiveness model (Zinnes *et.al*, 1976; Hollist and Guetzkow, 1978; Isard and Anderton, 1988; Sandler and Hartley, 1995):

$$dM_A / dt = k\left[1 - \phi(M_B - M_A)\right]M_B - \alpha M_A + g \qquad (3.5)$$

The larger nation B's military stock (or expenditures) is than nation A's, the greater the negative effect on the change in nation A's military stock (or expenditures). An equation for nation B will also be analogous. In case of $\boldsymbol{M_A = M_B}$ the equation returns to the Richardson model. Also, if $M_A < M_B$, ϕ will give a negative effect on the change in A's military armaments, but if $M_A > M_B$, ϕ will give a positive effect on it. These models are a simple technical change of Richardson and are ultimately based on the action-reaction mechanism:

hence, they should be regarded as variants of the Richardson model.

In Table 3.2, Richardson (1960) examined the European arms race of 1909-13 between the two alliances, France and Russia, on one side, and Germany and Austria-Hungary, on the other side. According to the Table, the defence expenditures of these nations increased 1.45 times between 1909 and 1913, while the trade volume of these nations only increased 1.33 times. In the arms race between these two alliances he regarded the trade volume as an index of their friendliness while he thought defence expenditures indicate their hostility against each other. Assuming that the trade is constant, he set the following differential equations:

$$d(U+V)/dt = (k-\alpha)\left[U+V-\left\{U_0+V_0-(g+h)/(k-a)\ \right\}\right] \qquad (3.6)$$

The above equation can be rearranged as follows:

$$d(U+V)/dt = k\left[(U+V)-(U_0+V_0)\right]-\alpha\left[(U+V)-(U_0+V_0)\right]+(g+h) \qquad (3.7)$$

where:

U = alliance A's military expenditure

U_0 = alliance A's trade volume with its opponent

V = alliance B's military expenditure

V_0 = alliance B's trade volume with its opponent

and k, α, g and h were denoted in Equations (3.1) and (3.2).

Table 3.2. Defence Budgets and Trade Volume of Arms Racing Nations 1909-13

(Current Million Pound)

Nation/Year	1909		1910		1911		1912		1913	
	Defence	Trade	Defence	Trade	Defence	Trade	Defence	Trade	Defence	Trade
France	48.6	56.8	50.9	67.2	57.1	72.7	63.2	75.8	74.7	79.8
Russia	66.7	116	68.5	126	70.7	144	81.8	144	92	149.7
Germany	63.1	155	62	174	62.5	196	68.2	197.7	95.4	208.6
Austria-Hungary	20.8	17.3	23.4	18.9	24.6	20.5	25.5	22.2	26.9	20.9
Total	199.2	345.1	204.8	386.1	214.9	433.2	238.7	439.7	289.0	459.0

Source: Richardson, L.F. (1960) "Arms and Insecurity", London: Stevens & Sons; Rappoport. A (1957) "Lewis F. Richardson's Mathematical Theory of War", *Journal of Conflict Resolution*, 1:249-304.

In his empirical estimation, Richardson did not test for U and V separately. Instead, he examined the trend of the change of the sum $(U+V)$ in the 1909-13 arms races. Here, he found that the rate of increase of total military expenditures had a positive linear relationship with the defence expenditures of the two nations(or alliances) in this period. Hence, he asserts that the arms race between two alliances cannot be avoided as long as their defence spending overwhelms the trade volume between them, because the effect of arms build-up which symbolizes hostility between two alliances is stronger even though they have some trade relationship. As the result of data analysis, he estimated the slope of the line in the Equation (3.6) at 0.73. However, even in this simplistic approach serious inconsistencies could be found. As Rapoport (1957) pointed out, the trade volume indicating the friendliness between these potential adversaries did not remain constant, but it steadily increased after 1909. Hence, the slope of the line, that is, the change of military expenditures should have decreased, although the grievance terms might be able to explain this discrepancy.

Richardson extended his model to more than two nations and focussed on deriving the stability conditions resulting from various values of constant parameters. Although he tried to develop various arms race models, empirical tests of the models were not supported in many cases. On the other hand, the debates on whether a nation responds to the opponent's current defence budget or to the opponent's accumulated expenditure (or weapons stock), and what really determines a nation's defence budget (internal vs external) have not been concluded yet. First, according to Richardson's classical equations, the rate of increase of military expenditure in a nation responds to the current military expenditure of an opponent. However, it is actually impossible to know the exact amount of an opponent's current expenditure as Majeski (1985) pointed out. The estimation of opponent's current

expenditure should be simply depended on expectations, but cannot be sure that it will be the same as actual expenditure. Hence, it will be more persuasive that the change of defence spending of a nation responds to the lagged value (whether it is one year or more) of defence spending of an opponent. Also, it was still not clear whether the arms race between nations was affected by their current defence expenditures or historical, that is, accumulated expenditures. Second, the defence budget of a nation can be affected by an opponent's defence budget based on the Richardson's action-reaction model to deter an enemy's attack, but it can also be determined by internal budgetary decisions. In other words, the defence budgetary process reflects both external (e.g. coping with enemy attack) and internal factors (e.g. resource allocation plan in defence versus other civilian sector), but it was not concluded which factor is more influential on defence expenditure. Nevertheless, Richardson regarded the current defence budget of an opponent as the only important factor which determines the increase of defence expenditure of a nation.

Richardson's classical arms race model was explained and conceptualized by Rappoport (1957) and Abelson (1963). Also, Lambelet (1971, 1973), Wagner, Perkins and Taagepera (1975) tried to detect arms races using various approaches, such as non-linear models and reformulation of the Richardson model, but their tests did not escape from Richardson's classical model. Wagner, Perkins and Taagepera (1975) simply extended and rearranged the Richardson model to show the incompleteness of the Richardson test. That is, Richardson detected how the higher rate of total defence spending was affected by the defence spending of both alliances while they changed the variables into the increased rate of difference of military spending in both alliances and the difference of defence spending between two alliances. As a result, they could find a series of positive relationships between these two variables, namely, the increased rate of difference of military spending and the difference

of military spending between two alliances.

The Lambelet model (1971, 1973) resembles the models of McGuire (1965, 1977), Brito (1972) and Gillespie *et.al* (1977). Lambelet attempted to test the strategic and conventional arms race between the two superpowers, the USA and Soviet Union, and also considered the social resource constraints by taking both security and civilian economic production as explanatory variables. For example, he regarded both opponent's military strength and own GNP as important factors influencing the arms race. In other words, he considered opponent's military strength as a "demand factor" consisting of the external stimuli to arms acquisition and expansion, while own GNP as a "supply constraint" reflecting limited resources which a nation can allocate to defence spending.

3.2.1.2. Richardson: A Critique

Richardson's empirical test is valuable, because it was the first attempt to prove his own arms race model. It provided an academic base for further empirical researches, although it has been criticised by many following scholars in terms of its simplicity and incompleteness. As mentioned earlier, it will be more reasonable to change the explanatory variable from current military expenditure to the lagged values of military expenditure, because it is difficult to observe the current military spending of an opponent. Also, although his empirical test perfectly supports his theory, the observable data were only a few years, namely,1909 to 1913 which are insufficient to prove his model. If his model is tested with more data, it might provide a different result. Finally, Richardson regarded trade volume as a measure of friendliness between two nations, but it is possible to have a larger trade volume between more hostile nations than between friendly nations. For example, the

trade volume between USA and China is much larger than between USA and South Korea, however China has been emerging as a new threat to the USA since the collapse of the Soviet Union. Trade definitely contributes to peace between two nations, but it cannot be used as a measure of friendliness in an arms race. Due to these weaknesses, Richardson's empirical analysis needs to be re-tested and complemented in spite of his successful test result. In his test, $\Delta(U+V)/\Delta t$ representing the increased rate of total defence expenditures between two alliances was rapidly escalated before World War I from 5.6 in 1909-1910 to 50.3 in 1912-1913. The rates of increase were 10.1 for 1910-1911 and 23.8 for 1911-1912. Hence, he showed the existence of an arms race between these two alliances using his action-reaction model.

In conclusion, the Richardson's arms race model is criticised for the following weaknesses:

1) Signs of coefficients (except for grievance factor) are predeterministic. There is no rationale why the reaction coefficient is positive while the fatigue coefficient should be negative. For example, in case one nation disarms regardless of its opponent's armaments because of economic shrinkage or change of government policy, the reaction coefficient can be negative. Moreover, in most cases the pattern of military spending does not necessarily follow an action-reaction process but is determined by a nation's defence policy related to long and short term military R&D plan, demand and supply of military manpower, political and security environment and economic capacity. Also, if one nation has a dominant defensive capability, it will not need to react to the other nation's armaments. NATO-WTO and US-Russia dyads will be the case since the end of the Cold War. On the other hand, if defence

spending stimulates the economic development of a nation, the fatigue coefficient can be positive and hence escalate the change in its armaments. This seems to be very usual in the developing countries, because the defence sector provides various spin-offs (e.g. technology, infrastructure etc.) to the civilian economy (Sandler and Hartley, 1995). Accordingly, the signs of threat and fatigue coefficients should not be predetermined as they are dependent on a nation's defence and economic policies, and its stage of economic development.

2) It is also doubted what exactly determines the grievance factor. According to Richardson (1960) one of the important barometers is trade volume. He regarded absent or insignificant trade between countries as an indication of hostility whereas a large trade volume was a symbol of friendliness. However, these hypotheses are so simplistic that they do not exactly illustrate what really determines the grievance factor. Theoretically, if there is neither hostility nor friendliness between two nations, the grievance factor should be zero but he assumes that a grievance factor is only positive or negative.

3) According to the Richardson model, the change of one nation's armaments is simply determined by how much its opponent and itself spent on defence in the previous period. In other words, the Richardson model is based not on a "stock" concept but on a "flow" concept. However, some critics suggest that the effectiveness of defence spending does not appear in the short term and hence it should be considered on a long-term basis. That is, the change of military expenditure of a nation is not simply determined by the previous year's military spending of its opponent and own military spending but is accumulated since the

start of an arms build-up at some point of time (i.e. a stock rather than flow concept).

4) The Richardson model is missing some important exogenous variables (e.g. foreign aid, sanction, etc.) and endogenous variables (e.g. internal political and social factors) which can explain an arms race between two nations. Arms races can be affected by regional alliances, and internal political and economic circumstances. The arms race in the Middle East and the Korean Peninsula exemplifies this case. These variables need to be considered to make a more realistic model. Ferejohn (1976) and Gillespie *et.al* (1975) examined the effect of foreign military assistance on arms races. The domestic political and economic environment is also an important factor to increase (or decrease) arms expenditures in the bureaucratic-organizational politics model. Hence, it is necessary to include some complementary variables to analyse the complex arms racing mechanism in international relations.

3.2.1.3. Neo-Richardson Models

McGuire (1965, 1977) analysed historical data to detect the arms race in strategic weapons between the USA and USSR. In his test, he focussed on how the interaction process between two countries influences the data, and deriving the stability conditions in their mutual competition. He analysed the US-Soviet missile race with the data from 1960 to1973 in the Richardson framework. In his empirical test, McGuire found the two lines, the US line of equilibrium and the Soviet line of equilibrium intersect where the USA retained 2,560 missiles and the Soviet Union had 8,270 missiles. Hence, he asserted that the US-Soviet arms race could attain a stable equilibrium and the two nations could mutually deter

at this point. However, he did not expect the rapid technological changes and increasing returns to scale in arms production identified by Brito and Intriligator (1999).[2] Strategic weapons production has more possibilities to be affected by these increasing returns to scale due to the rapid change of military technology. On the other hand, Brito (1972) and Gillespie *et.al* (1977, 1978) introduced an optimal control and geometric lag model in analysing arms races. Brito provided a theoretical basis for an arms race using optimal control theory while Gillespie *et.al* attempted an empirical estimation with a geometric lag model. They estimated the US-USSR, NATO-WTO and Israel-Arab rivalries in the post-World War II era with distributed lag analyses. As a result, the threat coefficients are generally positive except for USA and the fatigue coefficients are negative except for Israel.[3] Hence, they showed that their empirical results generally support the Richardson model by applying lags. Hamblin *et.al* (1977) recognized the asymmetric and non-linear aspects of the arms competition and focussed on the psychological factors causing an arms race.

International tension is another important variable in an arms race model. Choucri and North (1975), Ashley (1980) and Zinnes *et.al* (1978) introduced the concept of "tension", the circumstances which can induce diplomatic or armed conflicts in an arms race between adversary countries. Choucri and North (1975) studied the pre-World War I (1871-1914) arms races for six countries divided into two alliances (Britain, France and Russia vs Germany, Italy and Austria-Hungary) using a simultaneous equation model. In the model, they asserted that a nation's military expenditure is determined by its previous year's

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2 According to Brito and Intriligator (1999), increasing returns technology in an arms production, caused by the progress of information, electronics, computers and software, could change the dynamics of arms race. Increasing returns technology does not necessarily have a unique equilibrium. Rather it can have multiple stable equilibria with the possibility of a choice between them.

3 The threat coefficients are -0.35 (US), 0.04 (USSR), 0.05(NATO), 0.06(WTO), 0.29(Israel) and 0.34(Arabs). The fatigue coefficients are 0.20(US), 0.13(USSR), 0.40(NATO), 0.13(WTO), 0(Israel) and 0.12 (Arabs).

expenditure, military expenditures of an opponent alliance, intensity of interactions[4], the colonial area of the nation, and its population and national income. They analysed the direct and indirect influence of world violence on arms races in the international framework. However, first, their explanatory variables have multi-collinear problems. For example, colonial area might reflect war between nations and needs for more military bases, and these are related to military expenditures. Also, the military expenditure is not only an explanatory variable determining a nation's intensity of interactions but it also depends on it. According to Zuk (1985) these interrelations understated the effects of these variables and subsequently Choucri and North's empirical results failed to support their model. Second, although most time-series analyses require an adequate number of observations to ensure reliable parameter estimates, they often violated this requirement, using comparisons and inferences from fifteen year time periods. As a result, their empirical analysis was seriously questioned by Zuk (1985) and other scholars due to the statistical unreliability.

Ferejohn (1976) also studied arms races in the international framework by focussing on the influence of foreign aid which can strongly affect the competition between rivals. Ferejohn analysed US aid to India and Parkistan using graphical methods and a utility maximization model, and reached the following findings. First, aid to nations in an arms race has the effect of imposing a burden on the domestic economies of the nations not receiving aid. Second, the effects of aid are continued for a while even though the aid policy is no longer implemented. Third, military aid programs can distort the budgetary process of arms racing nations with respect to the increase of defence spending.

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4 According to Choucri and North (1975) a nation's intensity of interactions is determined by the colonial area of own and opponents, own military expenditure and the violence behaviour (e.g. number of attacks or battles) toward others.

In conclusion, there have been various types of neo-Richardson models to amend and complement the classical Richardson model, but as shown above, most scholars established new models by simply changing equations from linear into non-linear or by adding plausible explanatory variables to the classical equation. In addition, they failed to suggest a clear answer for overcoming the weaknesses and limitations of the Richardson model, because their ideas were based on the Richardson framework. That is, these models cannot escape from the Richardson territory and can be categorized as a ramification of the Richardson model. However, their findings are meaningful because the Richardson model could be further developed by various ideas. Although serious weaknesses were often found in some of these models, they contributed to improving arms race models and studying existing arms race phenomena.

3.2.2. The Intriligator-Brito Model

The Intriligator-Brito model shows some strategic considerations which are associated with the Richardson arms race model. This model developed by Intriligator (1967, 1975), and Brito and Intriligator (1976, 1977, 1984, 1987) shows that the mutual deterrence ability, that is, the balance of armaments stock , the preparedness of attack and weapons, and strategic decisions regarding targeting and rate of fire, especially the intentions of the leader (strong nation) are determinant factors in an arms race between two nations. The model is based on Intriligator's (1964, 1967) hypothetical missile war model that could be used by military authorities to calculate deterrence and attack potentials in a computer simulation. The simulated missile war is described by the time paths for missiles and casualties for two countries, *A* and *B* as in the following equations (Intriligator, 1975):

$$\dot{M}_A = -\alpha M_A - \beta' \beta M_B f_B \tag{3.8}$$

$$\dot{M}_B = -\beta M_B - \alpha' \alpha M_A f_A \tag{3.9}$$

$$\dot{C}_A = (1-\beta')\beta M_B \upsilon_B \tag{3.10}$$

$$\dot{C}_B = (1-\alpha')\alpha M_A \upsilon_A \tag{3.11}$$

where

$M_i(t)$ = stock of missiles at time t in nation i, $i = A, B$.

$\dot{M}_i(t) = \dfrac{dM_i}{dt}$ = change in stock of missiles at time t in nation i.

$C_i(t)$ = civilian casualties at time t in nation i.

$\dot{C}_i(t) = \dfrac{dC_i}{dt}$ = change in civilian casualties at time t in nation i.

$\alpha(t), \beta(t)$ = rates at which A and B fire their missiles at time t.

$\alpha'(t), \beta'(t)$ = proportion of missiles targeted counterforce by A and B.

f_A = the number of B's missiles destroyed by one of A's missiles.

f_B = the number of A's missiles destroyed by one of B's missiles.

υ_A = the number of B's casualties caused by one of A's missiles.

υ_B = the number of A's casualties caused by one of B's missiles.

In equation (3.8), $-\alpha M_A$ indicates A's reduction in the stock of missiles caused by A's firing decision. Missiles might be aimed at not only enemy missiles (counterforce) (of nation A) but also enemy cities (countervalue) and hence α' implies A's counterforce

proportion and $(1-\alpha')$ indicates A's countervalue proportion. Hence, $\alpha'\alpha M_A$ implies A's missiles targeted at B's missiles while $\left(1-\alpha'\right)\alpha M_A$ means A's missiles targeted at B's population. Subsequently, $\alpha'\alpha M_A f_A$ indicates the loss of B's missiles caused by A's counterforce attack. Similarly, $\beta'\beta M_B f_B$ indicates the destruction of A's missiles caused by B's counterforce attack. On the other hand, $\left(1-\alpha'\right)\alpha M_A \upsilon_A$ implies civilian casualties in B caused by A's countervalue attack. An analogous interpretation holds for the change in B's stock of missiles.

At the stage of war initiation, if it is assumed that A starts the war, A will choose its maximum level of fire, $\alpha = \overline{\alpha}$, entirely aiming at B's missiles (counterforce attack) and hence $\alpha' = 1$. Also, it is assumed that time span is indicated as $0 \le t \le \tau_A$, where τ_A is the time interval for decision-making, and $\beta = 0$ because A attacks without a response from B. By these assumptions, the following equations are derived:

$$M_A(\tau_A) = M_A(0)\exp(-\overline{\alpha}\tau_A) \tag{3.12}$$

$$M_B(\tau_B) = M_B(0) - f_A\left[1-\exp(-\overline{\alpha}\tau_A)\right]M_A(0) \tag{3.13}$$

In above equations, it is noted that the missile stock of A is $M_A(0)\exp(-\overline{\alpha}\tau_A)$ at the stage of war initiation and it consumes $M_A(0)\left[1-\exp(\overline{\alpha}\tau_A)\right]$ to destroy $f_A\left[1-\exp(-\overline{\alpha}\tau_A)\right]M_A(0)$ of B's missiles.

In its tit-for-tat, B will choose its maximum rate of countervalue attack targeting at A's population, denoted as $\beta = \overline{\beta}$ and $\beta' = 0$. Also, the time interval for retaliatory attack will be $\tau_A \le t \le \tau_A + \psi_B$, where ψ_B is the time interval for B's decision-making and $\alpha = 0$ because B attacks without A's response. Hence, under these assumptions the number of A's civilian casualties at the end of B's retaliatory attack is as follows:

$$C_A(\tau_A + \psi_B) = \nu_B \left\{ M_B(0) - f_A \left[1 - \exp(-\overline{\alpha}\tau_A) \right] M_A(0) \right\} \left[1 - \exp(-\overline{\beta}\psi_B) \right] \quad (3.14)$$

In equation (3.14), it is noted that B chooses its maximum level of fire with the rest of its missiles to retaliate for A's attack. The right-hand side of the equation means the product of the rest of B's missiles after A's attack and $\left[1 - \exp(-\overline{\beta}\psi_B) \right]$ representing the maximum level of B's fire and A's casualties.

On the other hand, Intriligator and Brito derived the deterrence conditions for A and B, based on equations (3.8)-(3.11):

$$M_A = \omega_B M_B + \overline{C}_B / \xi_A \quad (3.15)$$

$$M_B = \omega_A M_A + \overline{C}_A / \xi_B \quad (3.16)$$

where:

$$\omega_A \equiv f_A \left[1 - \exp(-\overline{\alpha}\tau_A) \right] \qquad \xi_A \equiv \upsilon_A \left[1 - \exp(-\overline{\alpha}\psi_A) \right]$$
$$\omega_B \equiv f_B \left[1 - \exp(-\overline{\beta}\tau_B) \right] \qquad \xi_B \equiv \upsilon_B \left[1 - \exp(-\overline{\beta}\psi_B) \right]$$

$\overline{\alpha}(t), \overline{\beta}(t)$ = maximum rates at which A and B fire their missiles at time t.

$\overline{C}_A(t)$ = B's recognition of the minimum unacceptable civilian damage in nation A.

$\overline{C}_B(t)$ = A's recognition of the minimum unacceptable civilian damage in nation B.

τ_A, τ_B = time interval of A's and B's first strikes.

ψ_A, ψ_B = time interval of A's and B's second strikes.

If it is assumed that both A and B deter, each side must have enough missiles to inflict unacceptable damage on the other. If B thinks the minimum unacceptable damage to A is $\overline{C}_A$ casualties, it must have enough missiles to inflict this number of casualties in a second strike. Equation (3.16) shows the number of B's missiles needed to deter A as a function of the number of A's missiles.

As shown above, equations (3.15) and (3.16) are, in fact, the Richardson-type reaction functions. ω_A and ω_B are the normalized defence coefficients, and $\overline{C}_A / \xi_B$ and $\overline{C}_B / \xi_A$ are the grievance factors of both nations. Since the grievance terms are positive, a condition for the existence of a stable equilibrium is $\omega_A \omega_B < 1$. But, according to Inriligator (1975), the "hardness" condition that more than one missile should destroy an enemy missile is a sufficient but not a necessary condition for stability. Also, the stability condition is independent of $\overline{C}_A, \overline{C}_B, \upsilon_A, \upsilon_B$. In the case of two adversary nations, the equilibrium is always stable when $\omega_A \omega_B < 1$ is satisfied. If it is assumed that a stable equilibrium exists, the equilibrium point will be:

$$M_A^e = \frac{\omega_B \bar{C}_A / \upsilon_B \xi_B + \bar{C}_B / \upsilon_A \xi_A}{1 - \omega_A \omega_B} \tag{3.17}$$

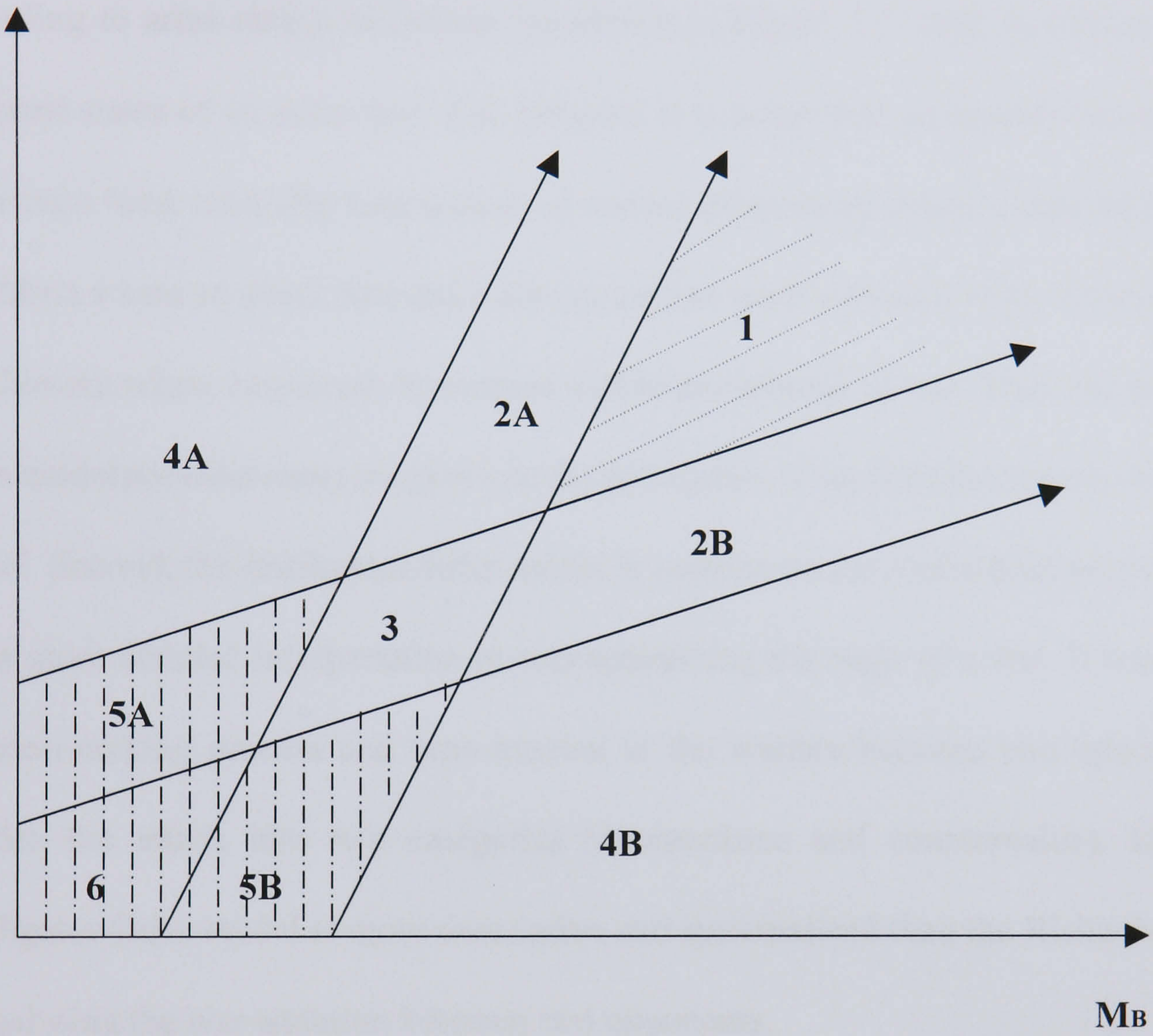
$$M_B^e = \frac{\omega_A \bar{C}_B / \upsilon_A \xi_A + \bar{C}_A / \upsilon_B \xi_B}{1 - \omega_A \omega_B} \tag{3.18}$$

Figure 3.1 shows the equations (3.15)-(3.16) graphically. In region 1, each nation retains enough missiles to deter its opponent. Both nations can reduce their level of armaments and stay within the cone of mutual deterrence. Such selective disarmament does not cause instability as long as they stay in this region. Regions 2A, 2B, and 3 can be interpreted as the cone of mutual attack avoidance (Anderton, 1992), where one nation cannot stage a pre-emptive attack against its opponent, because each nation holds enough missiles to repel the attack. Regions 4A and 4B represent an overwhelming military power of one nation. This imbalance of military strength may induce the outbreak of war, but if a dominant (or leading) nation pursues economic growth through disarmament and an inferior (or following) nation focuses on the military build-up, it may reduce an outbreak of war. Regions 5A, 5B, and 6 represent war initiation. In region 5A, nation *A* will not avoid pre-emption as *A* has enough missiles to attack *B* with impunity, however, simultaneously, neither has enough missiles to deter the other. *A* will be forced to attack or *B* will be forced to pre-empt, in either case leading to war. Region 5B is the obverse case. In region 6, each nation can attack the other, neither can avoid pre-emption nor can deter the other. These regions (5A, 5B, 6) start from the totally disarmed state and as a result of an arms race, both nations should move to a highly unstable situation. Subsequently, this unstable situation can induce an outbreak of war. In other words, at the initial stage of arms races, two rivalries have a high possibility of war, particularly when their arms level is very low. This does not

imply that disarmament can increase the possibility of war. As seen in Figure 3.1, balanced disarmament between two nations (inward movement of mutual deterrence lines) enlarges the cone of mutual deterrence and mutual attack avoidance (Region 1, 2A,B and 3), and thus reduces the possibility of war. Through the Figure, Intriligator and Brito (1976, 1977, 1984, 1987) represented that the possibility of war is high at the beginning of an arms race, especially between the two nations retaining a low level of armaments. This is a theoretically persuasive hypothesis. Heavily armed countries will not easily decide to go to war and will try to seek a diplomatic solution, because the outbreak of war between these countries inflicts a greater damage against each other than the war between those having a low level of weapons. The Cuban Crisis in the 1960s between the USA and Soviet Union is a good example. That is, heavily armed countries attempt to avoid the outbreak of war and secure the superiority of military power against their opponents. Today, numerous small wars and battles occur in various regions. However, most of them are between the countries having a low level of weapons and most localized warfare is caused by internal conflicts and civil war.

The Richardson model suggests that an arms race between two nations is simply affected by the action-reaction process of a military build-up and the economic capability of each nation, but does not clarify the state of stability condition, while the Intriligator-Brito model has a unique prediction about the stage of an arms race between two nations and elucidates the stability conditions graphically. According to the stage of arms race, stability conditions are different as shown in Figure 3.1.

Figure 3.1. The Mutual Deterrence for Arms Race



In some aspects, the Inriligator-Brito model provides a better explanation than the Richardson model. First, the Intriligator-Brito model gives a more specific description in terms of the equilibrium situation. The Richardson model does not explain whether the equilibrium is a state of peace or an outbreak of war. In this aspect, the Intriligator-Brito model provides more understandable interpretation. This model has various equilibria according to arms racing situations. As shown in Figure 3.1, each equilibrium reflects different states of an arms race. For instance, it is noted that an equilibrium where two deterrence lines meet (the intersection of mutual deterrence) means a state of peace, two equilibria where an attack line and a deterrence line meet indicate a state of tension and an equilibrium where two attack lines cross will be an outbreak of war. Thus, the Intriligator-Brito model provides more insights into the description of equilibrium than the Richardson model. Second, the Intriligator-Brito model is superior to the Richardson model in that it gives more detailed interpretation in conceptualizing the stage of a war. It considers the decision-making process and time interval in the warfare between two opponents and divides the attack into two categories (counterforce and countervalue). Hence, the Intriligator-Brito model is more descriptive and systematized than the Richardson model in analysing the war situation between two opponents.

Nevertheless, the Intriligator-Brito model is regarded as a ramification of Richardson and has its own limitations. First, the Intrilgator-Brito model has the same structure as the Richardson's equation. Changes of one nation's military stock (e.g. missiles) are determined by the missiles used for its attack against an enemy and the missiles destroyed by the enemy's counterforce attack (retaliation). Casualty equations are also determined in a similar fashion. Especially, because it was created to interpret the dynamics of warfare, the explanatory variables are very limited, and it shows strong similarities with the Richardson

model. Hence, the Inriligator-Brito equations are the simple composition of action-reaction parameters and are not basically different from Richardson's equation. Second, according to the Intriligator-Brito model, there is more possibility to be engaged in an arms race and result in an outbreak of war when two enemy countries have a lower level of weapons. In contrast, when both countries maintain higher levels of weapons, they can avoid an outbreak of war, deter each other and bring peace. However, their theory has not been supported by an empirical analysis in spite of its well-organized mathematical introduction. Third, Intriligator and Brito analysed warfare by target. In other words, an attack against opponent's missiles is counterforce attack and an attack against opponent's cities (or population) is countervalue attack. However, it is difficult to discriminate between targets in modern warfare, although military technology is becoming more advanced. For example, even though one nation attacks only its opponent's missiles (or military base), it can also inflict civilian damage if the missile control system is not precise or the enemy camouflages its missile bases in a civilian area. Fourth, according to the simulated outbreak of war (Intriligator, 1975), one nation's pre-emptive attack should start from counterforce attack and the enemy nation's retaliatory strike should aim at its opponent's population (countervalue attack). But there is no theoretical basis on why the target should be predetermined. For example, if nation *A*'s first strike against nation *B*'s missile bases fails in spite of its maximum rate of fire, *B*'s decision maker might target *A*'s missiles instead of *A*'s population.

The Intriligator-Brito model represented the arms race appearances between two adversary nations during the state of warfare and especially considered civilian damage as a part of influencing an arms race. Hence, this model contributed to a description of a dynamic interaction of warfare and an arms race of two antagonists during the state of warfare. It

also illustrated the stability conditions of an arms race. Anderton and Fogarty (1990), Anderton (1992) and Wolfson (1992) analysed an arms race applying the Intriligator-Brito model. Wolfson (1992) applied this model to his *n*-nation arms race analysis and examined the conditions for a stable cone in an *n*-nation arms competition. Anderton (1992) pointed out that the Intriligator-Brito model might need additional constraints such as the balance of weapons quantities, the qualitative state of weapons and the intentions of the dominant party (or nation) having a higher arms level and arms race initiative when identifying the zone of war initiation, and created an alternative Intriligator-Brito model which represents an optimistic state of an arms race.[5] The Inriligator-Brito model is an adequate theory in a war time arms race because the decrease of an arms stock caused by warfare gives rise to an arms acquisition for both countries and subsequently will induce an unstable arms competition. Conversely, if both countries have enough arms stock to deter its counterpart, they will be reluctant to attack each other and this will bring a stable equilibrium of weapons level.

Nevertheless, the Intriligator-Brito model is different from other arms race models such as McGuire's (1965). In peace time, the high level of weapons has more possibility to threaten the security of both nations and induce an accidental war. Critics might argue that there has been no war between major military powers since World War II, but there have been many proxy wars such as the Korea, Vietnam and Afghanistan involving the superpowers. Also, the advent of nuclear weapons alleviated the possibility of war, and the quality of weapons

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5 As explained earlier, in the Intriligator-Brito model, the level of weapons quantities decides the probability of war. That is, a high level of weapons quantities reduce the probability of an outbreak of war while a low level of weapons quantities increases it. However, in the "optimistic" Intriligator-Brito model the attack lines of two opponents does not cross each other. In other words, a more optimistic view of a nation and its opponent's unwillingness to attack can shift both attack lines out so far that regions 5A and 5B disappear in Figure 3.1. Hence, the probability of war is relatively low, even at small weapons level as long as the weapons build-up is roughly balanced. In the optimistic model, it is an imbalance in weapons quantities, not high or low weapons quantities, that makes the probability of war high.

and military technology is more important than the quantity of weapons today. Hence, experience that an arms race between nations becomes stable when they attain a higher level of weapons might be inadequate in the modern arms race. Furthermore, the Intriligator-Brito model has still not been proved by empirics as mentioned earlier. Therefore, it will be necessary to employ different variables to analyse the arms race phenomena in the Korean Peninsula.

3.2.3. Bureaucratic and Organizational Politics Models

The organizational politics model explains that defence decision-making is largely influenced by organizations and interest groups which affect the defence budgetary process (Crecine, 1969). Similarly, in the bureaucratic politics model, defence expenditure is largely dependent on the need and interests of the bureaucrats and politicians, including the government officials and members of parliament making defence policy decisions. The two models have some differences in the decision-making process, but ultimately they view defence expenditures as the result of political consensus among interest groups, namely politicians, bureaucrats and the arms industry. In this light, they can be regarded as the public choice model or the military-political-industrial complex model studied by Thee (1978,1986).

3.2.3.1. Rattinger Model

Davis, Dempster and Wildavsky (1966) studied the US federal budgetary process (although it was not exactly the defence budgetary process) and developed the interactive decision equations between agencies, the Budget Bureau and the US Congress. On the other hand,

Rattinger (1975) developed a model which described the relationship between bureaucratic action and defence expenditures. According to the theory the request for an excessive budgetary increase compared with the previous year's defence budget might bring a massive reduction rather than increase by budgetary decision-makers, because they think the defence budget is overstated and try to reduce it. In contrast, the request for too small increase can motivate an overtightened budget because the decision-makers think the increase of defence budget is not necessary and try to maintain the status quo. Hence, some medium range which decision makers can approve- neither too large nor too small of the budgetary growth rates- should be settled to secure stable budgetary goals (Wildavsky, 1964; Rattinger, 1975). By these considerations, Rattinger suggested the following equation:

$$E_t^X = k_1 A_{t-1}^X \tag{3.19}$$

where E_t^X denotes the expected defence budget of nation X at time t and A_{t-1}^X stands for the actual defence expenditures of nation X at time t-1. Also k_1 indicates an approximately fixed rate of the budget increase. However, this equation simply specifies the budgetary mark-up process of a nation and does not describe an arms race between two adversary nations. Hence, he proposed an alternative equation as follows:

$$A_t^X - E_t^X = k_2(A_{t-i}^Y - E_{t-i}^Y) + g^X \tag{3.20}$$

where

A_t^X = actual defence expenditure in nation X at time t.

A_t^Y = actual defence expenditure in nation Y at time t.

E_t^X = expected defence budget in nation X at time t.

E_t^Y = expected defence budget in nation Y at time t.

$\boldsymbol{k_2}$ = a defence coefficient

g^X = a grievance factor in nation X.

and $E_{t-i}^Y = k_3 A_{t-i-1}^Y$.

In equation (3.20), the difference between a nation's actual defence spending and its expected budget is linearly correlated to the difference between its opponent's actual and expected defence budget in some previous period. The same expression can be applied to nation Y and g^X is a grievance factor in nation X. In his empirical analysis, Rattinger (1975) considered the international tension factor in the Richardson framework. His major findings were that the regular annual growth of defence expenditures predicted by the bureaucratic model was well explained by the data for the individual countries of European NATO and the Warsaw Pact, whereas the Richardson-type action-reaction and international tension were relatively low influential factors in determining the increase of arms expenditures. Also, he asserted that comparisons between the two blocs (NATO and the Warsaw Pact) should be based on the analysis of their individual nations rather than their aggregate spending because there is no high-level coordination of overall NATO defence expenditures linking them to aggregate spending of the Warsaw Pact and vice versa. Some major issues found in his empirical test were that the values of $\boldsymbol{R^2}$ are unusually low in most member

states of NATO in action-reaction model while it is relatively high in some states, such as France and Britain. Probably, it is believed that these two countries reacted to the threat from the WTO countries more sensitively than any other NATO member states in the Cold War system (i.e. these countries follow the pact leader). According to Rattinger (1975), France was more independent from the Western alliance in the post-World War II and this induced a higher reaction of defence spending to protect the country from external threat, while Britain's defence spending in the post-World War II period was more determined by reaction processes than by bureaucratic momentum. There is no clear reason explaining Britain's strong reaction to the WTO countries, but its major military role in the Western alliance could lead Britain to the higher responsiveness to the communist countries in the Cold War era (UK ranked as number 2 in NATO). Rattinger (1975) concluded that the defence expenditures of most NATO member states are determined by bureaucratic momentum rather than the Richardson's action-reaction mechanism besides these two countries. He also found that most WTO countries followed the action-reaction pattern, but they were also significantly affected by bureaucratic momentum.

Nevertheless, there are some pitfalls in the Rattinger model. First, the statistical results cannot directly be compared from one nation to another, because they were derived from different time lags. In his empirical test, Rattinger applied various time lags from 1 to 4 years to increase the overall significance (R^2), although he failed to show the high significance of some countries in his model. Subsequently, his test lacks some objective comparability. Second, the R^2 s are generally higher for the WTO countries than for the NATO members, but dealing with the data of centrally planned economies should be cautious. They are often highly artificial and inaccurate reflecting the lack of data for some

of these countries. Third, it is necessary to consider the problem of autocorrelation. According to Kmenta (1971) the classical Durbin-Watson test is not applicable to regression equations in which the place of the explanatory variable is taken by the lagged value of the dependent variable or in which there is no constant term, although Rattinger (1975) showed the Durbin-Watson ratios are not significant for any nation or alliance in his analysis. The GLS (Generalized Least Squares) method could be used to obtain more unbiased estimators, but he only used OLS estimates.

3.2.3.2. Ostrom Model

Ostrom (1978) tried to combine the elements of three competing models: arms race, organizational processes and bureaucratic politics through a "Reactive-Linkage Model." This model views the initial policy-making rule as a reaction to the changing conditions[6] in the international and domestic environments which is then filtered through the organizations such as President, Congress and Department of Defense (DoD) to determine the magnitude, scale and timing of the reaction (Moll and Luebbert, 1980). According to Ostrom the policy-making rules are expressed by the following equation:

$$D_{it} = b_{i1}H_{it} + \sum_{i=1}^{n}\sum_{j=2}^{k} b_{ij}E_{jt} + u_{it} \qquad (3.21)$$

where

6 Policy-making decision of US defence spending depends on the changing international and domestic conditions, such as increasing military conflict in the Middle East, increase of defence spending in the Soviet Union and domestic opinion for defence reductions.

D_{it} = the i-th organization's (the Department of Defense) decision on defence expenditure

H_{it} = i's historical base (previous decision-making of DoD)

b_{ij} = policy-making parameters (rules of thumb)

E_{jt} = the exogenous environmental factors (domestic and/or international factors affecting the decision)

u_{it} = random disturbance terms

Ostrom's model includes three factors which influence the military budget of the United States: the military services (e.g. Department of Defense), the President and the Congress. Interest groups such as the arms industry are excluded in his equation, because he thought that the US defence expenditures are determined by the interaction between these three groups. Based on equation (3.21), the services' request for a military budget can be derived as follows:

$$y_{1t} = b_{11}x_{1t-1} + b_{12}x_{2t-1} + b_{13}x_{3t-1} + u_{1t} \qquad (3.22)$$

where x_{1t-1} represents Soviet military expenditures in the previous year, x_{2t-1} is the number of US battle deaths in the previous year, and x_{3t-1} indicates the rate at which Congressional appropriations have increased (or decreased) over the two previous years. In his model, US defence spending is determined by the adversary's defence spending (external threat), the number of US battle deaths (grievance) and the increased rate of Congressional appropriation (economic constraint). Therefore, it is found that basically his model has the

identical structure with the Richardson model. Thus, Ostrom's "Reactive-Linkage Model" can be regarded as a variant of the Richardson model, but it attempted to combine international and internal political-bureaucratic factors into one set of integrated equations. However, even though there were not many warfare and battle deaths of US soldiers for the sample period (1955-1973) except for the Vietnam War, US defence spending steadily increased in this period. Hence, the correlation between the US battle deaths and US defence spending is doubtful. Thus, his model has a problem in the choice of variables. Also, Ostrom's model not only shows a poor result in empirical tests but also does not demonstrate much superiority to the naive model representing the correlation between the defence spending of this year and that of previous year, even though it has seven independent variables in the reduced form. In his analysis of the US defence expenditure policy-making from 1955 to 1973, the Reactive-Linkage Model is only successful for the period 1955, 1957 and 1962-1968 with a single exception (1964) while the naive model shows more successful results for the period 1956-1961 and 1969-1973. For example, in the naive model, US defence spending was predicted to change from US$77,373 million in 1969 to US$ 75,084 million in 1973, whilst actual US defence spending changed from US$ 77,872 million to US$ 76,435 million in the same period. But, Ostrom's model is less accurate than the naive model. His model predicted that US defence spending would change from US$ 85,244 million to US$ 82,420 in this period. In his empirical analysis, the Reactive-Linkage Model is well-fitted in a war situation, because the empirical results show the increasing requirements of defence expenditures caused by the Vietnam War for the period 1966-1968.

3.2.3.3. Lucier Model

Lucier (1979) proposed the organizational process model which deduced two propositions about the occasions for changes in the value of the parameter.

$$X_t = qX_{t-1} \tag{3.23}$$

where X_t is the defence expenditures at time t and q is the parameter representing policy-making rule which determines defence expenditures. First, he proposed that the value of parameter usually changes in the year following a revision of the armament Standard Operating Procedure (SOP). The organizational politics model (Tanter 1974; Lucier 1977) describes the state as a set of bureaucracies which decision-makers control. Decision-makers are surrounded by so many demands that they often prescribe standard operating procedures indicating a set of decision rules for government's policy goal, and delegate the responsibility for implementing the rules to the bureaucracies. Decision-makers prescribe varied decision rules, that is, standard operating procedures to execute various policies. Lucier (1979) asserted that the defence expenditures of a state are proportional to its previous defence expenditures by the implementation of these SOPs, and a change in parameter value generally occurs when decision-makers reconsider policy and revise the armament SOP. Second, he also suggested that the value of parameter changes in the year following a deadline whether it increases or decreases. Here, the deadline indicates a turning point where the SOP is changed. Namely, SOP could be changed due to the end of an arms agreement with a potential enemy, the termination of an existing SOP, a domestic or international event affecting defence plans and the replacement of decision makers.

Hence, Lucier's contribution was conceptualising the value of parameter by introducing SOP. In contrast, Rattinger's model is ambiguous in deciding the value of the parameter. He confirmed that SOP definitely affects the change of the value of parameter in his analysis of naval expenditures of Britain, Japan, and USA for the period 1919-1939. In the tests for three countries, the R^2 s are high at 0.990 for USA, 0.998 for Japan and 0.987 for Britain and the parameters are significant at 5% level. However, according to Dennis (1974), the domestic or international circumstances, replacement of leadership and other major changes do not always result in policy changes. He found no evidence that the value of the US parameters had changed from 1950 to 1970 in spite of numerous changes of domestic and international environments in this period. Therefore, the value of parameters which decides the increase (or decrease) of arms expenditures cannot simply be defined by the bureaucratic organization model. Although Rattinger (1975), Ostrom (1977, 1978), Lucier (1979) and Dennis (1974) all made efforts to find the parameter affecting arms expenditures, the decision-making process still seems to be a "black-box" as Moll and Luebbert (1980) mentioned.

Majeski (1983) also studied the decision-making process of US military expenditures in the Ostrom framework. However, he asserted that the decision-making process is not characterized by a monolithic and unitary rational factor. He assumed that annual defence expenditures are the product of a series of decisions made by autonomous but interacting policy-making groups, namely, the Department of Defense (DoD), President and Congress pursuing different goals. The DoD will attempt to increase its defence budget, the President might focus on the next election and depend on opinion polls for decision-making, and Congressmen might focus on their electorate. Hence, the decision-making of defence

expenditures might reflect a consensus among these groups having different interests and objectives.

3.2.3.4. Cusack and Ward Model

Cusack and Ward (1981) examined the military expenditures of the United States, the Soviet Union, and the People's Republic of China by modifying the classical Richardson arms race formulation and assuming that the military budget is used by decision makers, in part, to respond to the domestic political and economic environment. In this aspect, they investigated the relationship between the military spending of each nation and the political and economic circumstances through an empirical analysis. The linear based functional form for US military spending is as follows:

$$\begin{aligned} Y = \beta_0 &+ \beta_1 \text{(Electoral Cycle)} \\ &+ \beta_2 \text{(Change in Aggregate Demand)} \\ &+ \beta_3 \text{(Prior Change in US Military Spending)} \\ &+ \beta_4 \text{(War Mobilization)} \end{aligned} \tag{3.24}$$

where β_0 through β_4 are regression coefficients and Y is change in US military spending.

According to their model, US defence spending is affected by the electoral cycle, aggregate demand, the previous year's defence spending and war mobilization. The defence spending of the Soviet Union is determined by leadership tenure, economic performance, the economic planning cycle, and the previous year's defence spending. China's defence spending is determined by domestic violence, economic performance, the economic

planning cycle and the previous year's defence spending. They ignored the external threat from opponents and focussed instead on the domestic environment in their model. This is a basic difference from the Richardson and neo-Richardson models. In their empirical estimation of US defence spending from 1949 to 1978, all explanatory variables are significant and the overall explanation is also high at 0.81. Aggregate demand, previous year's defence spending and war mobilization are necessary variables to determine the demand for defence expenditure. The electoral cycle is also an adequate variable in that US defence budget is affected by the change of political power. Traditionally, the Republican party pursues a strong defence while the Democratic party attempts to reduce defence spending and increase the social welfare budget. In the estimation of Soviet Union (1951-1976), they showed the significance of leadership tenure, but evaluated only Khrushchev and Brezhnev regimes, although Stalin's regime could be an important variable in this period. In the empirical test of China for the period 1960-1974, domestic violence (e.g. the Cultural Revolution: 1966-1971) is regarded as a major determinant affecting its defence spending, but the significance is different according to the data. In the SIPRI data, domestic violence is a significant determinant of China's defence spending, but it is not significant using other data such as Rubin (1978). Economic performance and the planning cycle are significant variables in the Soviet Union, however they are positive with some data while negative using other data. In China, economic performance has a significant and positive effect on its defence spending in the SIPRI data, but the planning cycle has a negative effect on it. According to Cusack and Ward (1981), the performance of the domestic political economy model is somewhat erratic from one country to another. It seems to be most useful for the USA, and the empirical results of the Soviet Union and China are different according to the source of data. Especially, the results from China are not generally consistent with the proposed model.

The domestic political economy model is not universal but somewhat inconsistent from one nation to another due to the difference of the domestic political and economic situations. Also, it excluded the Stalin regime from the Soviet empirical test and did not explain which domestic violence is included in the test of China. It is doubted that the Soviet and Chinese military spending are reliable in the Cold War era and whether the data from different sources could be compared with each other. For example, US national defense expenditures (NDEXP) are from US *Defense Budget for Fiscal Year 1979* whereas the Soviet military expenditure data series are from SIPRI *Yearbook* and the Military Balance (IISS). Also, the overall explanatory power of the equations is relatively low in the cases of Soviet Union (0.47-0.66) and China (0.27-0.61).

3.2.3.5. Hartley and Russett Model

Hartley and Russett (1992) studied the effect of public opinion on US defence spending for the period 1965-1990. They added public opinion on US defence spending as an explanatory variable to the traditional threat (Soviet defence spending) and fatigue (government deficit) factors in the Richardson framework. In their model, the explanatory variables determining changes in US military spending are changes in Soviet military spending, changes in the difference between US and Soviet military spending, changes in the US federal budget deficit, and public responses to US military spending. In their empirical tests, they discovered that the increase (or decrease) of US military expenditures is strongly affected by public support. They found that if the percentage of public opinion favouring increases in military spending rises, then the level of military spending increases, while if the percentage opposing increases in military spending rises, then actual spending tends to decrease. Their model does not depend on public voting but instead uses survey

data as an indicator of aggregate public opinion on military expenditure. Using the survey data they found that changes in public opinion consistently exert an effect on changes in military spending.[7] Public opinion changes according to the political and social circumstances. For example, since the 9.11 terrorist attack occurred in 2001, the increase of US military spending has been broadly supported by American public. As the results of empirical tests, they obtained a high R^2 at 0.77 and all independent variables are significant at 0.05 and 0.10 level except for the difference between Soviet and US military spending.

The bureaucratic and organizational politics model has contributed to examining the internal factors determining the military expenditures of countries. These models, including the organizational politics model, domestic political economy model, and pubic opinion approach have shown that internal factors, such as interaction between interest groups, electoral cycle and economic performance could also be significant in explaining the decision process of military expenditures. The Richardson models often failed to prove the significance of the threat coefficient and provided poor empirical results. In this aspect, the organizational/bureaucratic politics model focussed on the internal factor stimulating defence spending and contributed to studies on defence expenditures and arms races. Most organizational/bureaucratic politics model attempt to combine some explanatory variables stimulating defence spending- whether they are a budgetary process or internal political events- with the Richardson's action-reaction process. Thus, the organizational/bureaucratic politics model could be regarded as another variant of the Richardson model. As a result, the basic equations of these models are not greatly different from the Richardson's classical

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7 All of the public opinion data used in their analysis can be found in "U.S. Public Opinion Data on Military Spending, 1937-1990." (Graham and Hartley, 1990). The survey data sources are as follows: Gallup, American Institute of Public Opinion, Gallup/Newsweek, Gallup/Times Mirror, The Roper Organization, National Opinion Research Center, General Electric/Trendex, CBS, CBS/New York Times, New York Times, Yankelovich, Skelly, and White/Times, and Yankelovich, Clancey, Shulman/Time

equation. However, they were not categorized as the neo-Richardson model, because the internal determinant for defence spending is more stressed than the external threat factor.

But, the organizational/bureaucratic politics model has some pitfalls. Most budgetary processes are veiled, the decision-makers are affected by public opinion and interest groups and the organizational actions are not easy to quantify and measure. The parameter deciding the increase (or decrease) of arms expenditures, such as SOP is ambiguous and indeterminate in both Rattinger (1975) and Lucier (1979). Also, Ostrom's (1978) "Reactive-Linkage Model" did not show any superiority to the naive model even though it has seven independent variables. The empirical analyses often showed unsatisfactory results and fail to prove the overall significance of the variables. Also, the domestic political economy model proposed by Cusack and Ward (1981) regarded economic performance as an important variable explaining the military spending of the Soviet Union and China, but they had both positive and negative effects on their defence spending and thus obtained two different results according to data. Thus, it is doubted that economic performance is really a necessary variable for determining the defence spending of these countries. In the organizational/bureaucratic politics model, it is difficult to estimate how defence expenditures are really determined. The decision-making of defence expenditures is difficult to be quantified, and the process is often vague and veiled. For example, SOP (Standard Operating Procedure) does not provide any clear standard for deciding the defence budget. Hence, they often present different results in the empirical tests according to the data and sample. Consequently, the organizational/bureaucratic politics models often reveal their weaknesses in the selection of variables and empirical results, and also have limitations in that they have the same action-reaction framework with the Richardson model. Table 3.3 summarises the major arms race models.

Table 3.3. Review of Arms Race Models

Authors	Model	Arms race mechanism	Conclusion
Richardson (1960)	Richardson model	An action-reaction basis	Arms races depend on adversary's and own military spending (or weapons stock) and grievance factor.
McGuire (1965)	Duopoly model	Utility maximization in defence	National utility is determined by own and adversary's arms level and wealth for defence. Utility is maximized at the intersection of two nations' reaction curves.
Brito (1972)	Utility optimization model	National utility maximization	National utility is determined by the trade-off between civilian economy and security.
Intriligator and Brito (1976)	Intriligator-Brito model	Strategic warfare model based on the Richardson's action-reaction process	At the initial stage of an arms race, the possibility of war increases, but once both nations retain high level of arms stock and deter each other, it decreases.
McGuire (1977)	US-Soviet missile race	An action-reaction basis	The equilibrium of the number of missiles in two nations meets at some point.
Ostrom (1978)	Reactive-Linkage model	US decision-making process of arms expenditure	US defence spending is affected by Soviet defence spending and internal political process.
Lucier (1979)	Budgetary process model	Internal effect on US defence spending	US defence budget is mainly affected by SOP (Standard Operating Procedure).

Authors	Model	Arms race mechanism	Conclusion
Koistinen (1980)	Military-industrial complex model	Self-stimulative process	A main cause of arms build-up is internal military-industrial relations rather than external threat.
Cusack and Ward (1981)	Domestic political economy model	Self-stimulative process	Arms race is stimulated by internal political and economy
Thee (1986)	Military R&D-industrial-bureaucratic complex model	Self-stimulative motivation and a tit-for-tat process	Military technology plays a key role in contemporary arms races and technology race raises military spending.
Hartley and Russet (1992)	Public opinion model	Self-stimulative motivation and a tit-for-tat process	Defence spending is affected by public opinion.

3.3. SUMMARY

Studies on arms races and the determinants of defence spending will be a major part in this thesis. The arms race models shown in Table 3.3 have theoretical and empirical gaps as presented earlier, but most of them are based on the Richardson framework. In other words, most arms race models employ external threat and internal factors stimulating a nation's armament, although their expression methods are different from each other. The arms race between South and North Korea has rarely been studied and the literatures are also very few. The arms race model in this thesis will be based on the Richardson's action-reaction model, but it will include other variables, such as inter-state conflict and foreign aid factors reflecting the specific situation of the two Koreas. Since the Korean War (1950-1953), the two Koreas have had big and small political and armed conflicts, and the USA has militarily supported South Korea through the US-South military alliance. These two factors must be included to estimate the arms race in the Korean Peninsula. Including these factors

will also avoid the oversimplification of the Richardson model. The arms race model in this thesis will differ from previous models by estimating not only the defence spending of South and North Korea but also their number of military personnel and defence equipment. It is believed that these various approaches to modelling will provide more insights into the arms race between these two nations. The studies on arms races are also important for my further research on the defence-growth relationship, because defining the demand for defence expenditures is necessary to study the effect of defence spending on economic growth. Accordingly, the studies on the arms race between South and North Korea are closely related to the research on the defence-growth relationship. Therefore, arms race studies are an integral part of the research on the relationship between defence and economic development.

Since the end of the Cold War, many theorists have asserted that the arms race between the superpowers was finished. However, this conclusion should be approached with caution. The US-Russian relationship seems to be in a mood of co-operation and the world is changing into an uni-polar system dominated by the USA. Nevertheless, regional conflicts have increased globally in the Balkans, Africa, the Middle East and various parts of Asia, even though the arms race between the two superpowers has ended. Also, the increasing economic and military power of China may induce a future arms race in East Asia. Accordingly, it will be important to study arms races between regional rivals and analyse how the pattern of their races has changed. Especially, the study of an arms race in the Korean Peninsula, the last symbolic zone of the Cold War, is relatively unexplored and researched by few scholars considering its military and strategical importance. The next chapter examines the existence of South-North arms race using various data for the period 1963-2000.

CHAPTER IV

EMPIRICAL ANALYSIS OF THE SOUTH-NORTH ARMS RACE 1963-2000

4.1. INTRODUCTION

The military tension between South and North Korea lasting since the Korean War (1950-1953) has always been a serious threat to peace in the Korean Peninsula. South Korea has prepared for North Korea's surprise preemptive attack since the cease-fire in 1953, and the North has had to cope with the military alliance between South Korea and the USA. Hence, a distinctive feature is that this arms race has been a long-term one. During the Cold War, the military competition between the two superpowers, the USA and former Soviet Union might have intensified the South-North arms race. The arms expansion of the two Koreas was directly and indirectly supported by the two superpowers. The USA has supported South Korea through the ROK (Republic of Korea)-US Mutual Defence Agreement and military aid since the Korean War. The presence of US troops has contributed to deterring North Korea's potential threat. The former Soviet Union and China also had a great influence on North Korea in the Cold War era and it is believed that they provided military aid as well as political support until the 1980s.

After the end of the Cold War, the South and North Korean governments have attempted to improve the relationship between the two countries and made considerable economic and political progress through the South-North peace talks (e.g. the enlargement of economic

cooperation, the reunion of separated families). However, they have never agreed on arms reduction in spite of the non-aggression agreement between the South and North. South Korea has continually increased its real level of defence spending until the mid-1990s, although both the real defence spending and its share in GDP have tended to reduce since the economic recession in1997. North Korea also maintained a high share of defence spending in GNP (20-25%) until the mid-1990s in spite of its economic collapse.

This chapter answers two major research questions mentioned in Chapter I. One is whether an arms race between the two Koreas really exists and what are the variables affecting any arms race between these countries. The other is whether the pattern of any arms race has changed between the Cold War and post-Cold War era. First, the possible existence of an arms race between the two Koreas will be tested using defence spending, the number of military personnel and equipment (tactical aircraft) of both countries. South Korea has focussed more on increasing its defence spending and acquiring high technology weapons than North Korea. By contrast, North Korea has larger numbers of weapons and military personnel than South Korea, although its official defence spending is much lower than the South. Hence, as mentioned in Chapter II, it is believed that the quality of North Korea's conventional weapons is lower than that of South Korea's and the North is also hiding many parts of its defence spending. In the 1990s, North Korea started to develop nuclear and bio-chemical weapons, and long-distance missiles to close the military gap with US-South alliance and strengthen its military deterrent capability. Second, the mechanism of the South-North arms race will be also examined. This is important because the arms competition between the two countries is believed to increase their defence spending and the increase of defence spending affects their economies. Thus, the investigation of an arms race between the two Koreas needs to be analysed before studies on the economic effects

of defence spending. US military aid to South Korea, the US-South alliance and inter-state conflict between the South and North are also considered in the South-North arms race.

4.2. THE SOUTH-NORTH ARMS RACE MODEL

Although various alternative arms race models have been developed since the introduction of the Richardson model, they are mostly derived from Richardson's classical action-reaction equation. The Richardson's classical equation is based on a two-person zero-sum game. Hence, it is criticised since the Richardson model is difficult to apply to the South-North arms race since the 1990s, because the major superpowers, including the USA, Russia, China and Japan are actively involved in the South-North relationship. Considering their active role, some scholars propose that the nature of South-North arms race is more likely to be a 6-players non-zero-sum game since the 1990s. Nevertheless, the Richardson's equation has represented the most basic form of South-North arms race model during the 1960s to 1980s, and the military confrontation between the two Koreas has not diminished in the 1990s. These major powers surrounding the Korean Peninsula do not influence the two Koreas militarily but they do politically except for the USA. The Richardson's action-reaction paradigm has not been applied to the arms race in the Korean Peninsula, although it may have been one of the most relevant models to represent the military conflict in this region. Hence, a revised Richardson model will be applied to the South-North arms race studies.

Assuming that the arms race between the South and North follows Richardson's action-reaction process, other variables reflecting Korea's special circumstances need to be added to his original equations. The armament of the two Koreas has been influenced not only by

the threat against each other, their economic capabilities and historical antipathy but also by inter-state tension, such as the political and armed conflicts between the South and North. Since the end of the Korean War, there have been frequent inter-state political and armed conflicts between the two countries, and the North has shown its hostile behaviour by intruding into South Korean territory. There have been many small battles between the South Korean army and the guerillas from North Korea. Furthermore, South Korea's first lady was assassinated by a North Korean terrorist in 1974. These events need to be reflected in the South-North arms race model as a dummy variable separately from the threat factor, because they might have affected the change of defence spending in both countries in a specific year.

Besides the inter-state conflict factor, one of the important factors affecting the South-North arms race is US assistance to the South. Unlike the arms races in other regions, the South-North military confrontation has been strongly affected by the major powers surrounding the Korean Peninsula as mentioned earlier. Among those powers the USA has formed very strong ties with South Korea not only politically and economically but also militarily since the Korean War. US military grants were over 50% of the total defence budget of the US-South alliance until 1970, but they were under 5% in the late 1970s, and South Korea began to pay for the presence of US forces from 1983. Although US military aid to the South has rapidly diminished every year since the mid-1970s, the firm alliance between two nations is still sufficient to deter the North Korean threat. Therefore, US military assistance will be considered as a key variable in the analysis of the South-North arms race. As a result, the alternative Richardson model describing the South-North arms races includes the demand factors for military expenditures, such as threat, spill-in (US military aid), income and

prices.[1] Income and prices are reflected indirectly in the fatigue factor, because it is believed that a nation's income has a positive correlation with its own defence spending (Sandler and Hartley, 1995). Hence, the model for the South-North arms races can be presented:

$$dM_t^S = a_1 M_{t-1}^N + a_2 M_{t-1}^S + a_3 IC_{t-1} + a_4 US_t + g \qquad (4.1)$$

$$dM_t^N = b_1(M_{t-1}^S + US_{t-1}) + b_2 M_{t-1}^N + b_3 IC_{t-1} + h \qquad (4.2)$$

where

$dM_t^S =$ the change of real defence spending (armed forces, equipment) in the South.

$dM_t^N =$ the change of real defence spending (armed forces, equipment) in the North.

M_t^S = real defence spending (armed force, equipment) in the South at time t.

M_t^N = real defence spending (armed forces, equipment) in the North at time t.

g = grievance factor of South (constant term)[2].

h = grievance factor of North (constant term).

$IC_t =$ inter-state conflict dummies between the South and North (See Table 4.1).

$\begin{cases} IC_t = 1: \text{inter-state conflict between the South and North at time } t; \\ IC_t = 0: \text{no inter-state conflict between the South and North at time } t. \end{cases}$

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1 Prices can be dropped from the equation of demand for military expenditures without biasing results provided that price of military activities has inflated at the same general rate as that of non-military activities (Sandler and Hartley, 1995). But, Solomon (2003) suggested that whether the unique defence market structure causes relatively higher price levels as opposed to high inflation is not confirmed. He found some evidence from selected defence capital projects in Canada which shows a persistent high inflation during the life of acquisition process unlike the rate observed in the overall economy.

2 If g, known as a grievance term, is positively and significantly correlated to the dependent variable, it represents that a nation may augment its armament even though the other nation poses no threat. Grievance may be caused by a past defeat or else from territorial or religious disputes (Sandler and Hartley, 1995).

US_t = real level of US military grant to the South at time t.

(Other variables were defined in Equations (4.1) and (4.2)).

Equations (4.1) and (4.2) reflect not just the impact of the previous year's defence spending on the change of defence spending in both nations but also the importance of inter-state conflicts. In general, the defence spending of both nations is considered as the barometer of the arms race between the two nations, but it is not the only variable affecting the arms race. As shown in Table 4.1, since the 1960s, there have been several momentous incidents stimulating military expansion which might have led to increased defence spending between the two nations. They were mainly South Korea's domestic political changes or North Korea's provocative acts, including terrorism and guerilla attacks against South Korea's civilians and government officials. These incidents, namely, inter-state conflicts are basically different from the threat factor in that South Korea's defence spending (the number of armed forces and defence equipment) is not only affected by North Korea's, but also it might be affected by specific events whether political or military between the two countries. Thus, inter-state conflicts should be considered as another factor affecting the change of the level of defence spending in both nations. These equations also describe the South-North arms race more precisely than the original Richardson model by including the effect of US military aid (grant) to the South. Another feature of this model is using the lagged value of the new explanatory variables. The lagged values are also applied to the inter-state conflict factor, because incidents in the present year are expected to have an effect on next year's level of defence spending. In the case of the US military grant, both the lagged and present values are applied to the equations. The change of South Korea's defence spending is expected to be affected by the present US grant rather than the previous one. If present US military aid is large, South Korea's defence spending will be possibly

reduced, while if it is small, South Korea will spend more on defence. In other words, as mentioned earlier, it is expected that South Korea could enjoy a "free-ride" on US aid until the late 1970s. In contrast, North Korea will react to the previous year's military spending of the US-South alliance.

Table 4.1. Major Conflicts between the South and North, 1963-2000

Year	Domestic events and Military tension between South and North
1968-1969	US naval vessel *Pueblo* is kidnapped by North Korean warships.✓
1974-1975	South Korean first lady is killed by North Korean assassin.✓
1975-1976	Tunnels (for surprise attack) built by North Korea are found in the DMZ.✓
1976-1977	Armed conflicts between the US Army and North Korean soldiers in the DMZ.✓
1979-1980	South Korean President is assassinated by his staff.* Declaration of the martial law.✓
1980-1981	Military coup and pro-democracy movement in South Korea.* Increasing military alert against North.✓
1983-1984	A number of South Korean cabinet members are killed in Burma by North Korean bomb terror.✓
1987-1988	Korean Airline is exploded by North Korean terror.✓
1988-1989	Olympic game is held in Seoul and military alert is increased.✓
1994-1995	North Korean leader Kim Il-Sung dies and his son Kim Jong-Il succeeds his regime.† Nuclear crisis between the US and North Korea.✓
1999-2000	Warfare between the South and North in the West Sea.✓

Note: * Domestic events in South Korea.
† Domestic events in North Korea.
✓ Military conflict between South and North.

Source: Institute of International Studies *Korean Defense Yearbook* 1998-1999.

In this model, the threat coefficients a_1 and b_1 will be positive by the tit-for-tat arms racing process and the fatigue coefficients, a_2 and b_2 will be negative because of the economic burden induced by military spending if two countries have been involved in a long-term

arms race. Also, the coefficients of inter-state conflict will be positively correlated to the defence spending of both nations. It is expected that South Korea is more sensitive to inter-state conflicts, because it has suffered from North Korea's hostile acts since the Korean War. On the other hand, US military aid will give different effects on the South and North. South Korea would not need to spend on its defence when US support, including grant, weapons and troops was large, as in the 1960s, but it had to increase its defence burden with its rapid economic growth. However, the US contribution started to decrease fast with South Korea's economic and military growth. Accordingly, it is predicted that the coefficient of US military aid will be negatively correlated to the defence spending of South Korea (free-riding hypothesis). In contrast, the defence spending of North Korea will be positively correlated to that of the US-South alliance according to the Richardson's action-reaction mechanism. Therefore, the main hypotheses are summarised as follows:

i) the threat coefficients: $a_1 > 0$, $b_1 > 0$

ii) the fatigue coefficients: $a_2 < 0$, $b_2 < 0$

iii) the coefficients of inter-state conflict dummies: $a_3 > 0$, $b_3 > 0$

iv) the coefficient of US military aid to South Korea: $a_4 < 0$

v) the coefficients of the grievance factor (constant): $g > 0$, $h > 0$

4.3. DATA ANALYSIS

4.3.1. Data

There are some data problems for the empirical studies of the South-North arms race. First, many parts of military activities between South and North Korea are veiled due to the specific security environment in the Korean Peninsula and the official defence data of both countries are believed to be unreliable. Although South Korea's military data are becoming more reliable, North Korea's real defence budget is still concealed and has hidden expenses. Hence, the actual defence spending of the North is unknown and most military research institutions use their own estimations by combining various data. Second, there are consistency problems. Although military data are provided by several institutions, such as SIPRI (Stockholm International Peace Research Institute), IISS (International Institute for Strategic Studies) and ACDA (US Arms Control and Disarmament Agency, Department of State) on an annual basis, their estimations are different from each other and there are missing observations. In the empirical analysis of South-North arms races, the official data published by the Korean Ministry of National Defense (MND), SIPRI and IISS will be used and compared, and the data generated by North Korean specialists will also be studied. The real level of defence spending from these institutions are shown in Figures 4.1 and 4.2. However, the data on the numbers of military personnel and tactical aircraft are based on the *Military Balance* (IISS), because there is little difference between institutions (e.g. MND).[3] SIPRI does not provide data on North Korea's number of armed forces and defence equipment: hence, the IISS data will be used to examine the arms races of military

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3 SIPRI (Stockholm International Peace Research Institute) does not provide the data on the number of military personnel and defence equipment, and ACDA (US Arms Control and Disarmament Agency) only provides the data on the number of military personnel.

personnel and defence equipment (tactical aircraft) between the two countries for data consistency and comparability. Third, unfortunately, the historical data on the number of US armed forces and equipment in South Korea are unavailable. Only recent data (since the mid-1990s) are available, but they are not enough to cover the arms race between the South and North over the period 1963-2000. Accordingly, the effect of US aid to South Korea is ignored in the test of arms races in the number of military personnel and tactical aircraft.[4] Based on these conditions, the South-North arms races will be tested for the period 1963-2000, and also for two different sub-periods based on before and after the end of the Cold War in 1990.

4.3.2. Data Analysis of Defence Spending

As shown in Figure 4.1, South Korea's real defence spending has steadily increased, although it has some downswings for the period 1963-2000. There are some discrepancies between institutions, but they unexceptionally show that South Korea's real defence spending tends to continually increase for the sample period. According to these three institutions South Korea's defence spending peaked in the mid-1990s, but since the late 1990s, it considerably reduced (Bae, 2003). But, it started to increase again from 2000 according to SIPRI and IISS. From these data, it is found that South Korea's defence spending rapidly increased from the late 1970s to the early 1980s, and also from the early 1990s to the mid-1990s. South Korea's defence spending measured in US dollars fluctuated depending on its exchange rate. That is, the devaluation of local currency to US

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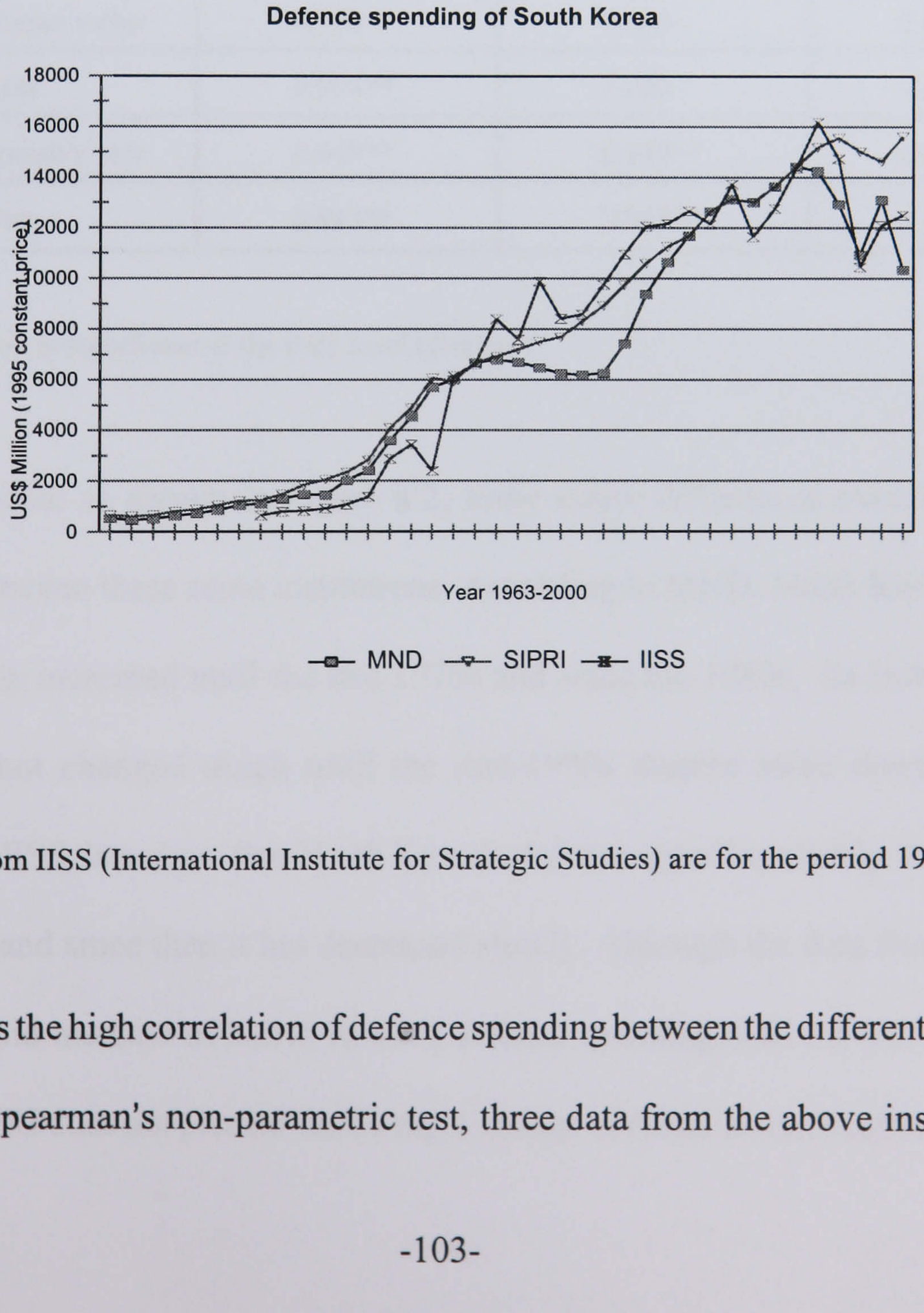
4 In this case, the South-North arms race equations will omit the US variable:

$$dM_t^S = a_1 M_{t-1}^N + a_2 M_{t-1}^S + a_3 IC_{t-1} + g$$
$$dM_t^N = b_1 M_{t-1}^S + b_2 M_{t-1}^N + b_3 IC_{t-1} + h$$

dollar could decrease its real level of defence spending. Sen (1995) argued that using a US constant-dollar value does not exactly reflect the actual value of defence spending because of the inadequate comparability of exchange rates. Thus, he argued that using constant value of local currency is adequate to accurately measure a nation's defence spending. Nevertheless, the value of constant US dollar is used in the South-North arms race, because South Korea is a major importer in the world defence market depending heavily on foreign imports for its weapons and South Korea's military strength changes according to its purchasing power in the international arms market.

Figure 4.1. Comparison of Real Defence Spending in South Korea



Note: The data from IISS (International Institute for Strategic Studies) are for the period 1970-2000.

Table 4.2 shows the high correlation of defence spending between the different institutions. According to Spearman's non-parametric test, three data from the above institutions are

correlated with each other between 0.94 and 0.96 at the 1% level of significance. MND (Ministry of National Defence) and SIPRI data are highly correlated at 0.96 and other data also show relatively high correlations. The Pearson test also shows high correlations between the data from these institutions. According to the Pearson test, the correlations are between 0.94 and 0.98 among institutions. Therefore, it is concluded that South Korea's defence spending data are relatively consistent and accurate between the above institutions.

Table 4.2. Correlation of South Korea's Defence Spending Between Institutions

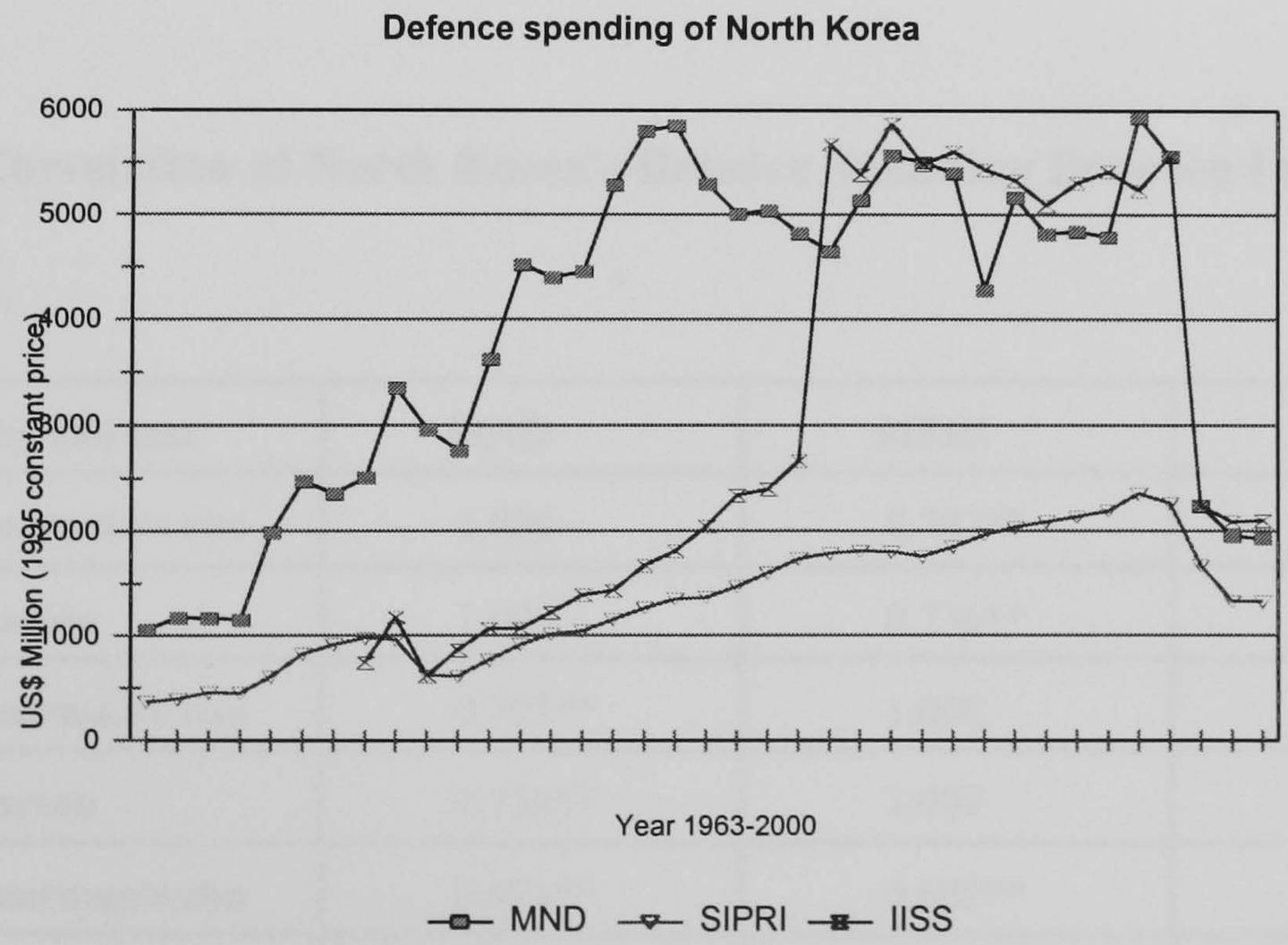
Institutions and test		MND	SIPRI	IISS
MND	**Spearman's rho**	1.000	0.960**	0.949**
	Pearson	1.000	0.976**	0.943**
SIPRI	**Spearman's rho**	0.960**	1.000	0.944**
	Pearson	0.976**	1.000	0.948**
IISS	**Spearman's rho**	0.949**	0.944**	1.000
	Pearson	0.943**	0.948**	1.000

Note: ** correlation is significant at the 0.01 level (2-tailed).

On the other hand, as shown in Figure 4.2, some major differences exist in the North Korean data between these same institutions. According to MND, North Korea's defence spending rapidly increased until the late 1970s and since the 1980s, its level of defence spending had not changed much until the mid-1990s despite some downswings and upswings. But, IISS data show that North Korea's defence spending rapidly increased until the mid-1980s and since then it has decreased slowly. Although the data from MND and IISS show a rapid increase of North Korea's defence spending until the late 1970s or the mid-1980s, SIPRI does not present such a rapid change of North Korea's defence spending.

According to SIPRI, its level of defence spending slowly increased without such a big change until the mid-1990s and since then it started to decrease. Moreover, SIPRI data show quite large differences from those of MND and IISS in the real level of defence spending. These differences might be due to two reasons. First, the North Korean government does not reveal its military expenditures and thus these institutions might depend on their own estimations and extrapolation. Although each institution might have its own information sources on North Korea's defence data, they can be inaccurate and unreliable. Second, North Korea's exchange rates are divided into official and commercial rates. In general, its official rates are much overvalued compared with its commercial rates and hence, the estimation of North Korea's defence spending might differ according to whether official or commercial rates are applied. Due to these reasons, its actual defence spending is veiled and institutions might not guarantee the accuracy of North Korean data.

Figure 4.2. Comparison of Defence Spending in North Korea



Note: The data from IISS (International Institute for Strategic Studies) are for the period 1970-2000.

In Table 4.3, North Korean data have lower correlations of defence spending between institutions than those of South Korea's. According to Spearman's non-parametric test, three data are correlated with each other between 0.49 and 0.89 at the 1% level of significance. The SIPRI and IISS data are highly correlated at 0.89, but MND and IISS data show a low correlation at 0.49.The MND and SIPRI data have also quite a high correlation at 0.71. The Pearson test shows higher correlations than Spearman's test resulting in the correlations between 0.51 and 0.90. Therefore, the correlations between institutions are much lower compared with those of South Korea's defence spending. The MND and IISS data do not show a meaningful relationship with each other, although IISS data represent only the period 1970-2000. However, these three institutions commonly show that North Korea's defence spending has decreased since the mid-1990s. Although it is noted that North Korea's defence spending data are less correlated and inconsistent between these institutions, MND data are believed to be more reliable because SIPRI data are too low compared with other data and IISS data have missing variables. In this thesis, all three data sources will be used and compared with each other.

Table 4.3. Correlation of North Korea's Defence Spending Between Institutions

Institutions and test		MND	SIPRI	IISS
MND	**Spearman's rho**	1.000	0.707**	0.491**
	Pearson	1.000	0.736**	0.508**
SIPRI	**Spearman's rho**	0.707**	1.000	0.889**
	Pearson	0.736**	1.000	0.903**
IISS	**Spearman's rho**	0.491**	0.889**	1.000
	Pearson	0.508**	0.903**	1.000

Note: ** correlation is significant at the 0.01 level (2-tailed).

4.3.3. Data Analysis of Military Personnel and Tactical Aircraft

The arms race might have occurred between the South and North not only in their defence spending but also in their number of military personnel and defence equipment. Investigating the change of the number of military personnel and defence equipment in terms of the South-North arms race is necessary to study the defence structure of these two countries. As mentioned in Chapter II, South Korea's defence has focussed more on the increase of defence spending and quality of weapons. Whereas, North Korea has focussed on dominating the South in its number of military personnel and conventional weapons to cope with the capital and technology-based defence policy of the US-South alliance. As shown in Figure 4.3, the number of South Korea's military personnel peaked in the early 1990s, but it could be a temporary oversupply caused by its conscription system. With the exception of these periods, its number of military personnel has been maintained at approximately between 600,000 and 700,000 since the early 1960s. Hence, the number of South Korea's armed forces might not be an important factor causing the arms race between the South and North. However, it had been much larger than that of North Korea's until the late 1970s, and this might stimulate North Korea to increase its number of military personnel. The gap between the South and North narrowed until the late 1970s and North Korea started to catch up with South Korea from the 1980s. Since the 1980s, the number of North Korea's military personnel steadily increased and the gap between the South and North has widened every year subsequently. According to Figure 4.3, by 2000, North Korea had almost twice the number of military personnel than South Korea. Therefore, Figure 4.3 indicates that North Korea has focussed relatively on the increase in the number of military personnel in the arms race with South Korea and has a more labour-intensive military force structure than the South.

Figure 4.4 compares the number of tactical aircraft, including fighters, reconnaissance aircraft and unmanned aerial vehicles between the South and North. For the sample period, North Korea's tactical aircraft has outnumbered South Korea's, although the quality of aircraft is questioned.[5] It is noted that North Korea's tactical aircraft numbers rapidly increased from the mid-1960s to the late 1980s, but since the 1990s, they tend to decrease in spite of a few upswings between the early 1990s and the mid-1990s. On the other hand, South Korea's tactical aircraft numbers also increased for the sample period, but it was not as fast as North Korea's. The gap was widest in the late 1980s and from the early 1990s to the mid-1990s, but since the mid-1990s, South Korea's tactical aircraft numbers have increased rapidly, while North Korea's have declined. Considering South Korea's capital and technology-intensive defence policy, it is believed that South Korea is more advanced than North Korea in the quality of weapons and this will explain the gap shown in Figure 4.4. Its growth in the number of tactical aircraft is also higher than that of the North's since the mid-1990s. In Figure 4.4, it is found that the number of tactical aircraft is highly correlated between the South and North for the period 1963-2000 unlike the number of military personnel. Table 4.4 illustrates the correlation of the number of tactical aircraft between the South and North. According to the Spearman's test, the number of tactical aircraft between the South and North is correlated to each other at 0.89 and the Pearson test at 0.95 shows the higher correlation between these two countries.

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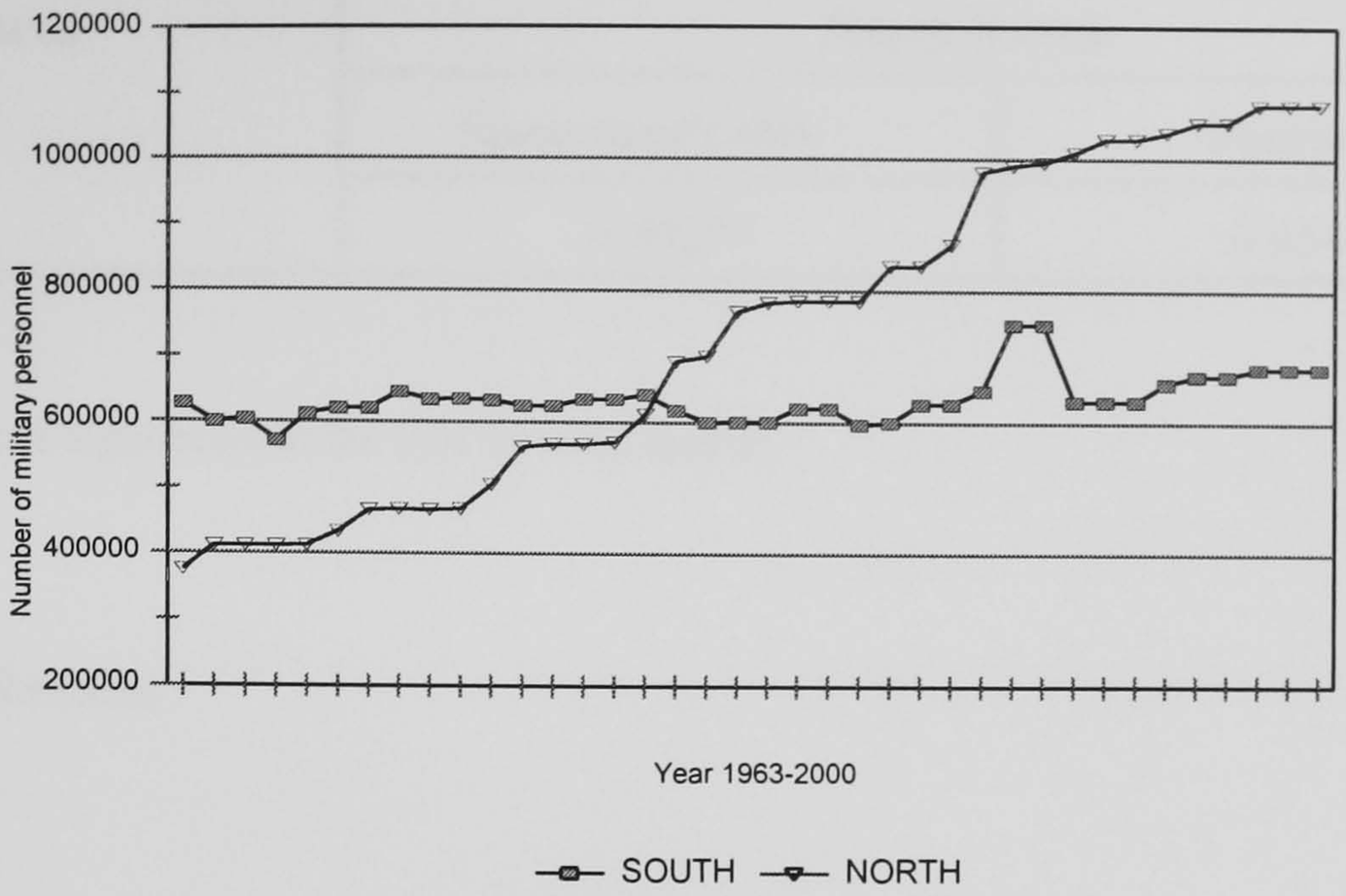
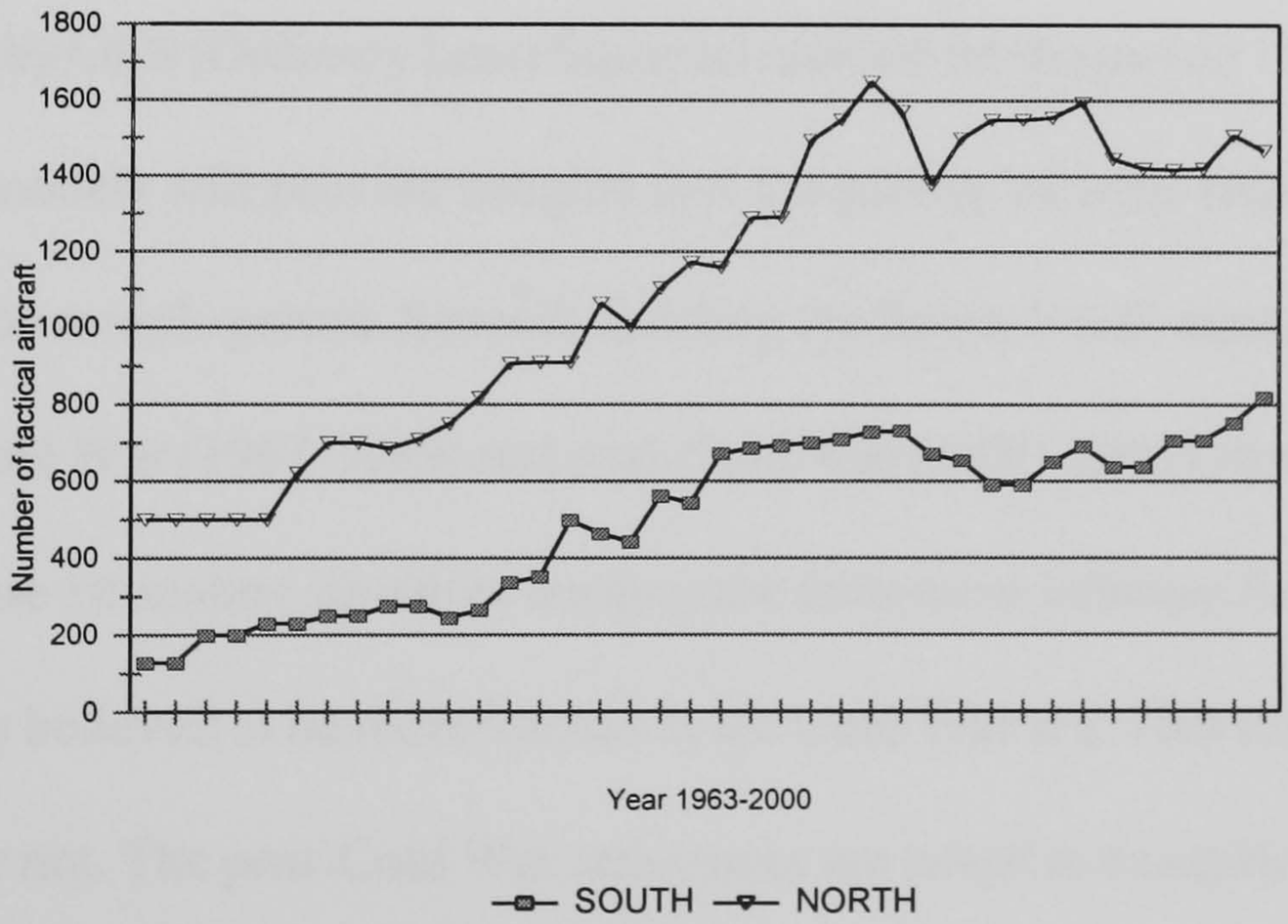
5 By 2002, South Korea's main fighters are F-16C/D, F-5E/F and F-4D/E. Their maximum bombing powers are about 940-1,290 kt and maximum speeds are 1,082-1,485 mph. The operation ranges are 595-2,415 mile. By contrast, North Korea's main fighters are MiG-17, 19 and 21. Their maximum bombing powers and speeds are 617-1,203 kt/711-1,385 mph. The operation ranges are 426-1,230 mile. Hence, South Korea's fighters are slightly superior to the North's in the maximum speed and destructive power, but in general, they are much better in the operation range than the North's.

Figure 4.3. Military Personnel of South and North Korea



Source: International Institute for Strategic Studies (IISS), *The Military Balance*, various years, Oxford: Oxford University Press.

Figure 4.4. Tactical Aircraft of South and North Korea



Source: International Institute for Strategic Studies (IISS), *The Military Balance*, various years, Oxford: Oxford University Press.

Table 4.4. Correlation of the Number of Tactical Aircraft

South Korea	North Korea	
	Spearman's rho	Pearson
	0.892**	0.954**

Note: ** correlation is significant at the 0.01 level (2-tailed).

4.4. Empirical Results

4.4.1. Arms Races in Defence Spending

In the empirical tests of arms races in defence spending between the South and North, the data from MND (The Ministry of National Defense), SIPRI and IISS will be used and their results will be compared. First, the South-North arms races using the original Richardson model in Equation (3.1) and (3.2), and the alternative model presented in Equation (4.1) and (4.2) are estimated by OLS (Ordinary Least Squares) method for the period 1963-2000. The results from both models will provide insights into the pattern of arms races between the two countries for the sample period. Second, dividing the South-North arms races into two sub-periods, the Cold War (1963-1989) and post-Cold War (1990-2000) arms races will be tested using the same estimating equation, because the arms races between South and North Korea are generally believed to be more intense in the Cold War era. This test will uncover whether it is true or not. The post-Cold War arms races are tested to examine the change of arms racing mechanism since the collapse of communist countries. The end of arms races between the two superpowers, USA and USSR might alleviate the South-North arms races, but it also might not be true, because the defence spending of the Asia region increased

about 27% in the post-Cold War era (UNIDIR; Willett, 2002). Also, the increased tension in the Korean Peninsula caused by North Korea's nuclear development programme might intensify South Korea's reaction since the 1990s. Hence, it is difficult to hypothesise the pattern of post-Cold War arms races between the South and North. Even the pattern of South-North arms races might not be changed between the Cold-War and post-Cold War era.

Table 4.5 shows the empirical results of the South-North arms races for the period 1963-2000 using the original Richardson model. In the Table, the change of South Korea's defence spending shows an R^2 of 0.24-0.36, while the change of North Korea's defence spending has very low R^2 of 0.07-0.17. In other words, the original Richardson model explains 24%-36% of the variation in South Korea's defence spending, but the explanatory value for North Korea is causally low at 7%-17%. The R^2 s might be raised by using additional explanatory variables, but these results show that the classical Richardson model has its limitations to explain the South-North arms races. Also, F-values are significant at 1%-5% level for South Korea for all data, but it is only significant at 5% level for North Korea in the MND data. The F-values of SIPRI and IISS data show no significance for North Korea. From the statistical results in Table 4.5, it is found that South Korea follows the original Richardson's action-reaction process in spite of relatively low R^2 s , but the defence spending of North Korea does not follow the Richardson model. According to the MND data, it follows another variant of the Richardson model considering a submissiveness effect. Namely, the larger South Korea's defence spending is relative to North Korea's defence spending; the greater the negative effect on the defence spending of North Korea, *ceteris paribus* (Richardson, 1960; Smoker, 1964). This is quite a surprising result, because

it was assumed that North Korea's reaction must be more intense than South Korea's considering its provocative acts for the sample period. The results of SIPRI and IISS data only show that South Korea follows the classical Richardson process. Both the reaction and fatigue coefficients of North Korea are insignificant, and therefore, it is found that North Korea does not follow the classical Richardson model. As a result, Table 4.5 represents an asymmetric arms race led by South Korea.[6]

6 Tests of log-linear model such as log SM_t=log NM_{t-1}+ log SM_{t-1}+ C ,where SM is South Korea's military spending, NM is North Korea's military spending and C is other variables including interstate conflicts and US military aid provide high R^2 s compared with linear regressions. But, they do not meet the hypotheses of the alternative Richardson model presented earlier. For example, the test of South Korea's defence spending for the period 1963-2000 results in a high R^2 at 0.99, but the signs of coefficients are different from our expectations. Not only the threat but also the economic burden coefficient is positive and the coefficient of inter-state conflicts has a negative sign. Hence, only threat coefficient meets our expectation and other coefficients have completely different signs from the hypotheses provided earlier (see Appendix IV-1).

Table 4.5. Empirical Results of the Classical Richardson Model 1963-2000

Dependent	Coefficients of independent variables			Statistical values		
Dependent variable	Threat	Fatigue	Grievance	R^2	F-value	DW
(1) MND						
South	0.35 (3.31)***	-0.11 (-2.75)***	-364.14 (-1.36)	0.25	5.72***	1.68
North	-0.07 (-2.02)**	0.01 (0.15)	290.43 (1.31)	0.17	3.45**	2.55
(2) SIPRI						
South	0.98 (4.28)***	-0.10 (-3.61)***	-244.35 (-1.52)	0.36	9.46***	1.42
North	-0.01 (-1.24)	0.05 (0.46)	66.68 (0.94)	0.11	2.17	1.18
(3) IISS						
South	0.59 (2.59)**	-0.27 (-2.93)***	622.31 (1.31)	0.24	4.34**	2.26
North	-0.02 (-0.30)	-0.08 (-0.53)	417.70 (1.38)	0.07	1.05	2.09

Notes: 1.Threat factor in North is the coefficient of the total defence spending of the US-South Korea alliance.
2. Figures in parentheses in the coefficients of independent variables are t -statistics.
3. IISS data represent the period 1970-2000.

***.01 level of significance; **.05 level of significance; *.10 level of significance

Table 4.6 shows the South-North arms races using the alternative Richardson model represented in Equations (4.1) and (4.2). The overall R^2s are increased to 0.40-0.46 compared with the original Richardson model in Table 4.5. As shown in Table 4.6, South Korea leads the South-North arms races by the Richardson's action-reaction process, but this is not the only factor affecting the arms race between the two countries.

Inter-state conflict is found to be a significant factor affecting the changes in South Korea's defence spending in MND and SIPRI data. The political and military conflicts between the two countries are expected to be a necessary factor to explain the South-North arms races. Since the end of the Korean War (1953), North Korea has attacked South Korea persistently and irregularly. It is assumed that chronic political conflicts, terrors, and sending guerillas into the South has led South Korea to increase its defence spending. For example, North Korean guerillas have frequently infiltrated the South Korean territory since the cease-fire in 1953 until the late 1990s, and have sought to weaken the military forces of South Korea. However, according to the empirical results in Table 4.6, it is found that North Korea's defence spending has not been affected by the inter-state conflicts. All the data from MND, SIPRI and IISS show no evidence that North Korea's defence spending was affected by inter-state conflicts with South Korea.

The fatigue factor has a significant and negative effect on South Korea's defence spending, while it has an insignificant effect on North Korea's. This is different from our expectation, because the economic burden caused by previous defence spending is supposed to have a negative effect on present defence spending. The grievance factor measured by a constant term has different results according to the data. In the MND data, grievance is a significant factor explaining North Korea's defence spending at the 10% level, while it explains South

Korea's at 1% level of significance in the IISS data. The Durbin-Watson *d* statistics are 1.65-2.14 for South Korea and 1.32-2.52 for North Korea and hence there is no evidence of autocorrelation, although some statistics are in the inconclusive zone.

On the other hand, the test results show that US support to South Korea has no significant effect on the change of South Korea's defence spending except for the IISS data. That is, South Korea's defence spending steadily increased in spite of US military aid.[7] Nevertheless, it is believed that US military aid alleviated South Korea's defence burden and provided a free-ride to the South until the late 1970s. As a result, it is found that inter-state conflicts can be added as a variable explaining South Korea's defence spending besides the defence spending of South and North Korea. By adding the dummy variables for inter-state conflicts and US military aid, the alternative model shows quite a satisfactory result for describing the mechanism of South Korea's defence spending compared with the original Richardson model. The R^2 indicating the overall significance of equations were increased from 0.24-0.36 to 0.40-0.47 for South Korea, and hence it is better for explaining South Korea's defence spending. Nevertheless, the empirical test of the alternative model shows disappointing results for North Korea's defence spending and does not improve the overall significance of the equations. Therefore, it is doubtful whether Richardson's action-reaction process is adequate to explain the mechanism of North Korea's defence spending.

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7 From the late 1970s South Korea's contribution exceeded 90 percent of the total defence burden of US-South alliance, owing to the Force Improvement Plan (Yulgok project). The US military assistance programme ended in 1976 in spite of some deliveries of the past programme and some transfers of equipment from the US forces in Korea. Also, the foreign military sales (FMS) credit ended in 1986, but South Korea became fully responsible for its defence burden in 1983, as the repayment of the credit exceeded the new FMS credit as early as 1980 (Hamm, 1999; p.147).

Table 4.6. Empirical Results of the Alternative Model 1963-2000

Dependent	Coefficients of independent variables					Statistical values		
Dependent variable	Threat	Fatigue	Conflict	US Aid	Grievance	R^2	F-value	DW
(1) MND								
South	0.27 (2.50)**	-0.15 (-2.21)**	541.20 (2.57)**	-0.49 (-0.48)	2.27 (0.004)	0.40	5.28***	1.84
North	-0.07 (-2.04)**	-0.01 (-0.17)	106.44 (0.55)		364.19 (1.71)*	0.18	2.47*	2.52
(2) SIPRI								
South	0.92 (4.20)***	-0.13 (-3.86)***	226.26 (1.93)*	-0.47 (-1.38)	80.73 (0.26)	0.47	7.00***	1.65
North	-0.02 (-1.55)	0.06 (0.62)	78.54 (1.49)		59.01 (0.92)	0.18	2.49*	1.32
(3) IISS								
South	0.53 (2.64)**	-0.56 (-4.58)***	-271.38 (-0.56)	-4.51 (-3.17)***	3512.21 (3.40)***	0.46	5.39***	2.14
North	-0.02 (-0.39)	-0.06 (-0.44)	37.52 (0.11)		428.83 (1.27)	0.07	0.70	2.13

Notes: 1.Threat factor in North is the coefficient of the total defence spending of the US-South Korea alliance.

2. Figures in parentheses in the coefficients of independent variables are *t* -statistics.

3. IISS data represent the period 1970-2000.

***.01 level of significance; **.05 level of significance; *.10 level of significance

4.4.1.1. Sub-Period : 1963-1989

Table 4.7 shows the Cold War (1963-1989) arms race between the South and North. According to the empirical results, South Korea's arms race pattern follows the Richardson's action-reaction process in the MND data, but other data show different results from Tables 4.5 and 4.6. Hence, the empirical results are sensitive to choice of data. In the Cold War era, the South-North arms races do not follow the Richardson's action-reaction mechanism using the SIPRI and IISS data. This is a surprising result because the South-North arms race is believed to be more intense in the Cold War era. It seems that both countries seek to expand their defence expenditures according to their economic capability and self-defence policy in this period. South Korea's defence spending is affected by the economic burden (MND, IISS), conflict (MND, SIPRI),US aid (IISS) and grievance (IISS) rather than threat (MND). Hence, it is found that the arms race led by South Korea are insignificant in the Cold War era in the SIPRI and IISS data, but it is still significant using the MND data. The reaction coefficient is significant at the 5% level and slightly larger than the reaction coefficient for the period 1963-2000. North Korea's defence spending is still different from the Richardson's action-reaction process, but IISS data show that North Korea reacts to the threat from the US-South alliance at the 10% level of significance. However, the empirical results for North Korea have a very low R^2 at 0.18 and thus it is difficult to conclude that North Korea actually followed the Richardson's action-reaction process in this period. According to Table 4.7, North Korea's defence spending is rather affected by the grievance factor in the Cold War era.

Table 4.7. Empirical Results of the Alternative Model 1963-1989

Dependent	Coefficients of independent variables					Statistical values		
Dependent variable	Threat	Fatigue	Conflict	US Aid	Grievance	R^2	F-value	DW
(1) MND								
South	0.37 (3.66)**	-0.25 (-2.86)***	216.38 (1.90)*	-0.14 (-0.44)	-204.88 (-0.73)	0.55	6.05***	1.38
North	-0.05 (-0.57)**	-0.002 (-0.02)	105.62 (0.77)		263.23 (1.89)*	0.10	0.80	1.84
(2) SIPRI								
South	0.22 (0.45)	0.02 (0.18)	283.82 (1.97)*	0.09 (0.15)	-52.57 (-0.13)	0.36	3.13**	1.82
North	0.03 (1.46)	-0.20 (-1.59)	28.30 (0.63)		122.51 (2.15)**	0.11	0.91	1.34
(3) IISS								
South	0.35 (1.46)	-0.41 (-2.69)**	-809.88 (-1.66)	-3.47 (-2.63)**	2998.77 (3.07)***	0.42	2.75*	2.19
North	0.14 (1.73)*	-0.25 (-1.49)	-274.84 (-0.83)		145.66 (0.51)	0.18	1.15	2.25

Notes: 1.Threat factor in North is the coefficient of the total defence spending of the US-South Korea alliance.

2. Figures in parentheses in the coefficients of independent variables are *t* -statistics.

3. IISS data represent the period 1970-1989.

***.01 level of significance; **.05 level of significance; *.10 level of significance

4.4.1.2. Sub-Period: 1990-2000

In the post-Cold War era (1990-2000), South Korea's reaction to North Korea's threat has intensified compared with the Cold War era. In Table 4.8, MND, SIPRI and IISS data show that South Korea's defence spending follows the Richardson's action-reaction process, while North Korea's defence spending follows a submissive-type Richardson model. Namely, when South Korea's defence spending is increased, North Korea's decreased in the post-Cold War era. This might be caused by its economic difficulties and concentration on the ballistic missile and nuclear development programme. South Korea's reaction coefficients are also increased using the MND and IISS data compared with those of the Cold War era. In other words, **it is noted that regardless of the end of the Cold War and the peace talks between the South and North, South Korea's military expansion continued and intensified in the post-Cold War era.** For example, South Korea's defence spending was 2.7 times larger than North Korea's in 1990 in real terms, but the gap between the two countries was 6.8 times in 1999, although it narrowed slightly in 2000. According to UNIDIR (2002), Asia's defence spending increased after the end of the Cold War, even though the defence spending of the two superpowers reduced in the post-Cold War era. Hence, it is not surprising that South Korea's reaction coefficient increased in the post-Cold War era. However, differently from our expectation, the nuclear crisis between the South and North reflected in the inter-state conflict dummy had no significant effect on South Korea's defence spending. South Korea chose a peaceful resolution of the nuclear crisis instead of military countermeasure.

US military aid is only significant in the IISS data and the effect of grievance varies with the data. In the statistical aspects, both countries' R^2 s are increased compared with those

of the Cold War era (1963-1989) and overall period (1963-2000). The R^2 s are increased from 0.36-0.55 in the Cold War era test to 0.77-0.84 in the test of post-Cold War era for South Korea. For North Korea, they are also increased from 0.10-0.18 (Cold War) to 0.20-0.74 (post-Cold War), but it does not indicate that North Korea follows Richardson's action-reaction model. The submissive effect of its reaction coefficients was strengthened and it increased the level of significance in the post-Cold War era. It is thought that the widening gap of military spending between the South and North led North Korea to develop weapons of mass destruction (WMD) such as nuclear weapons, because those weapons can incapacitate the dominant military power of the US-South alliance. Therefore, in the post-Cold War era, the alternative model shows better goodness of fit than any other period for South Korea, although it is a relatively small sample. Also, according to the empirical results, the submissive Richardson model represented by Richardson (1960) and Smoker (1964) seems to be adequate to explain North Korea's defence spending in the post-Cold War era.

Table 4.8. Empirical Results of the Alternative Model 1990-2000

Dependent	Coefficients of independent variables					Statistical values		
Dependent variable	Threat	Fatigue	Conflict	US Aid	Grievance	R^2	F-value	DW
(1) MND								
South	0.45 (2.41)*	-1.09 (-3.35)**	997.88 (1.64)	-9.84 (-1.35)	9207.46 (3.52)**	0.84	6.81**	2.03
North	-0.13 (-0.33)	-0.12 (-0.31)	857.81 (0.88)		1549.92 (0.34)	0.20	0.51	2.22
(2) SIPRI								
South	0.80 (1.16)	-0.26 (-1.64)	85.19 (0.24)	-3.18 (-0.63)	1404.41 (0.63)	0.77	4.09*	1.74
North	-0.13 (-3.74)***	-0.08 (-0.46)	227.47 (2.16)*		1750.18 (2.92)**	0.74	5.71**	2.60
(3) IISS								
South	0.65 (2.08)*	-1.35 (-2.94)**	-1439.87 (-0.87)	-24.37 (-2.13)*	8585.14 (1.76)	0.80	4.89*	1.84
North	-0.47 (-1.88)*	-0.10 (-0.41)	-569.23 (-0.65)		6413.05 (1.79)	0.42	1.42	2.75

Notes: 1.Threat factor in North is the coefficient of the total defence spending of the US-South Korea alliance.

2. Figures in parentheses in the coefficients of independent variables are *t* -statistics.

***.01 level of significance; **.05 level of significance; *.10 level of significance

4.4.2. Arm Races in Military Personnel and Tactical Aircraft

The arms race between the South and North can also be investigated not just in their defence spending but also in their number of military personnel and defence equipment. In Chapter II, it was found that South Korea has more capital-intensive defence forces than North Korea due to its economic superiority to the North. Thus, South Korea could lead the arms race with North Korea in terms of defence spending. In this section, the South-North arms races are examined in the aspect of military personnel and high technology weapons. As shown in Figure 4.3, South Korea outnumbered North Korea in its number of military personnel until the late 1970s. But, in the 1980s it was reversed by the North and the gap has widened since the 1990s. Also, Figure 4.4 shows the arms race for tactical aircraft between the South and North. North Korea has maintained a larger number of tactical aircraft than South Korea since the early 1960s and the South has never overtaken the North during the sample period. In the empirical tests using military personnel and tactical aircraft, it is argued that the quality difference between the South and North should be measured, for example, the human capital investment in defence forces, such as nutrition, education and training. But, it is thought that North Korea's military forces are well-trained and have strong combat capability as South Korea's. North Korea gives more priority to the military than any other sector, even though it suffers from economic difficulties and food shortages. Therefore, there is no reason to underestimate the capabilities of North Korea's military personnel. Also, the quality adjustment cannot be applied in the arms race of tactical aircraft. South Korea's main tactical aircraft, F-16C/D and F-5E/F are estimated to be slightly better than North Korea's MiG-17 and 19 in the speed and destructive power. But, North Korea's MiG-21 and 29 are faster and more destructive than South Korea's F-16C/D and F-5E/F. South Korea covers these weaknesses with the F-4D/E which F-4D/E

is faster and more destructive than MiG-21, but its operational range is relatively small. Instead, F-16C/D and F-5E/F have much greater operational range than MiG-21 and 29. Hence, North Korea's fighters are focussed more on speed and destructive power, while South Korea's are focussed more on the operational range. In general, it is considered that South Korea's fighters are technologically superior and newer than North Korea's, but there is no simple standard to estimate the quality of tactical aircraft between the two countries.

Table 4.9 shows the empirical results of the South-North arms races in the number of military personnel and tactical aircraft using the classical Richardson model for the period 1963-2000. According to the Table, South Korea has been sensitive and reacted to the number of North Korea's military personnel, and followed the Richardson-type action-reaction process in its numbers of military personnel. The number of South Korea's military personnel has been also significantly affected by the economic burden and grievance factors. But, it is found that North Korea has been indifferent to the number of South Korea's military personnel and does not follow the Richardson model.

However, North Korea has significantly reacted to the number of South Korea's tactical aircraft and follows the Richardson's action-reaction mechanism. South Korea's reaction coefficient is positive but not significant, and hence it does not seem to have reacted to North Korea in the number of tactical aircraft. This is a surprising result, but the increase of tactical aircraft in South Korea might not have followed the tit-for-tat strategy. As seen in Figure 4.4, from the late 1970s to the late 1990s, the number of South Korea's tactical aircraft have a somewhat different trend compared with that of North Korea's, although they show a high correlation with each other for the sample period. For example, the number of South Korea's tactical aircraft shows a very low growth during the 1980s, while

that of North Korea's rapidly increased during this period. However, it is doubted that Richardson's action-reaction framework is appropriate for the tests of the North's military personnel and the South's tactical aircraft, because their R^2 s are very low at 0.001 and 0.05.

Table 4.9. Empirical Results of the Classical Richardson Model in Military Personnel and Tactical Aircraft 1963-2000

Dependent	Coefficients of independent variables			Statistical values		
Dependent variable	Threat	Fatigue	Grievance	R^2	F-value	DW
Military Personnel						
South	0.04 (1.91)*	-0.49 (-3.31)***	280103.70 (3.25)*	0.25	5.53***	1.60
North	-0.02 (-0.14)	0.001 (0.06)	31248.57 (0.36)	0.001	0.01	1.95
Tactical Aircraft						
South	0.05 (0.72)	-0.13 (-1.00)	24.41 (0.98)	0.05	0.83	2.18
North	0.54 (2.93)***	-0.31 (-3.14)***	105.74 (2.91)***	0.23	4.96**	2.05

Notes: Figures in parentheses in the coefficients of independent variables are t -statistics

***.01 level of significance; **.05 level of significance; *.10 level of significance

Table 4.10 representing the South-North arms race with the number of military personnel and tactical aircraft using the alternative model for the period 1963-2000 shows a similar pattern to Table 4.9. Although the overall R^2 s are relatively improved compared with the Richardson model in Table 4.9, they are still low at 0.03-0.25. The statistical tests of the

number of military personnel for North Korea and tactical aircraft for South Korea result in low R^2 s at 0.03 and 0.13, and thus do not show any meaningful relationship between the dependent and independent variables. Adding inter-state conflict dummies does not much improve the statistical results. Thus, it is thought that neither the Richardson nor the alternative model is adequate to explain these two cases. As a result, Tables 4.9 and 4.10 show that the South follows an asymmetric Richardson model in the number of military personnel, while the North follows the same pattern in the number of tactical aircraft for the period 1963-2000. Therefore, it is found that South Korea regarded the number of North Korea's military forces as a potential threat and more actively reacted to it, while North Korea was more sensitive to South Korea's air force for this period.

Table 4.10. Empirical Results of the Alternative Model in Military Personnel and Tactical Aircraft 1963-2000

Dependent	Coefficients of independent variables				Statistical values		
Dependent variable	Threat	Fatigue	Conflict	Grievance	R^2	F-value	DW
Military Personnel							
South	0.04 (1.94)*	-0.50 (-3.31)***	-4722.74 (-0.47)	286341.0 (3.25)***	0.25	3.68**	1.59
North	-0.04 (-0.28)	0.01 (0.27)	-10139.30 (-1.00)	44639.67 (0.50)	0.03	0.34	1.80
Tactical Aircraft							
South	0.04 (0.66)	-0.13 (-1.07)	30.74 (1.79)*	23.18 (0.96)	0.13	1.66	2.07
North	0.54 (2.90)***	-0.31 (-3.16)***	22.24 (0.86)	104.85 (2.88)***	0.24	3.52**	2.02

Notes: Figures in parentheses in the coefficients of independent variables are t -statistics.

***.01 level of significance; **.05 level of significance; *.10 level of significance

Table 4.11 presents the empirical results of the arms race between the South and North Korea using the number of military personnel and tactical aircraft in the Cold War era (1963-1989). Compared with Table 4.10, it is found that South Korea's reaction to the number of North Korea's military personnel is insignificant, while North Korea follows the Richardson's action-reaction process in both the number of military personnel and tactical aircraft. Differently from the empirical test of defence spending, North Korea reacted to the number of South Korea's military personnel and tactical aircraft in the Cold War era. As a result, it is found that the South-North arms race in the number of military personnel and tactical aircraft was led by North Korea in the Cold War era. The R^2 of the equations are improved showing the range of 0.18-0.36, but they are not so satisfactory for the South's equations. In the Cold War era, the number of South Korea's military personnel is only affected by the economic burden and grievance factors, while its number of tactical aircraft is changed by the inter-state conflicts between the South and North.

Table 4.11. Empirical Results of the Alternative Model in Military Personnel and Tactical Aircraft 1963-1989

Dependent	Coefficients of independent variables				Statistical values		
Dependent variable	Threat	Fatigue	Conflict	Grievance	R^2	F-value	DW
Military Personnel							
South	0.004 (0.22)	-0.50 (-2.63)***	3639.83 (0.49)	310197.90 (2.58)**	0.24	2.37*	1.87
North	0.61 (1.85)*	0.07 (2.04)*	-20770.2 (-1.66)	-387971.0 (-1.90)*	0.25	2.53*	1.63
Tactical Aircraft							
South	0.07 (0.73)	-0.17 (-1.05)	38.18 (1.82)*	12.84 (0.41)	0.18	1.70	2.03
North	0.76 (3.23)***	-0.47 (-3.41)***	53.08 (1.77)*	145.90 (3.24)***	0.36	4.33**	1.52

Notes: Figures in parentheses in the coefficients of independent variables are *t* -statistics.

***.01 level of significance; **.05 level of significance; *.10 level of significance

In Table 4.12, the post-Cold War arms races using the number of military personnel and tactical aircraft between the South and North are described. It is noted that the number of military personnel in both countries does not follow the Richardson's action-reaction pattern in the post-Cold War era (1990-2000), although the overall R^2 s are relatively high at 0.31-0.55 compared with those of other periods. It seems that the numbers of military personnel in the South and North are not engaged in an arms race in the post-Cold War era. North Korea even relinquished its reaction to the number of South Korea's tactical aircraft. In Table 4.12, it should be noted that South Korea's reaction to the number of North Korea's tactical aircraft is also negative. In the arms race with an opponent, it might be

regarded as the indication of disarmament or submissiveness. But, in this case, it should be explained differently. In general, it is estimated that South Korea's tactical aircraft are technologically advanced compared with North Korea's, although the specifications of their tactical aircraft are different from each other. Also, since the mid-1990s, the number of North Korea's tactical aircraft has continually reduced except for 1998, while that of South Korea's consistently increased for the same period. Hence, the negative sign of reaction coefficient does not indicate South Korea's reduction in its number of tactical aircraft. Nevertheless, 10 years are an inadequate period to measure the pattern of the post-Cold War arms race between the South and North. A longer time period is needed to estimate a more accurate arms race mechanism between the two countries. The DW statistics are generally low, but autocorrelations are not detected.

Table 4.12. Empirical Results of the South-North Arms Race in Military Personnel and Tactical Aircraft 1990-2000

Dependent	Coefficients of independent variables				Statistical values		
Dependent variable	Threat	Fatigue	Conflict	Grievance	R^2	F-value	DW
Military Personnel							
South	-0.24 (-0.41)	-0.79 (-1.97)*	-17849.3 (-0.46)	778913.3 (1.10)	0.39	1.29	1.11
North	-0.04 (-0.58)	0.003 (0.03)	-11306.6 (-1.53)	39915.36 (0.30)	0.31	0.89	2.86
Tactical Aircraft							
South	-0.60 (-2.37)*	-1.25 (-2.58)**	90.09 (2.18)*	1686.01 (2.67)**	0.55	2.42	1.23
North	-0.95 (-1.15)	-0.95 (-2.20)*	66.16 (0.94)	2028.91 (1.88)*	0.48	1.87	0.97

Notes: Figures in parentheses in the coefficients of independent variables are *t* -statistics.

***.01 level of significance; **.05 level of significance; *.10 level of significance

4.5. SUMMARY

Some conclusions are drawn from these empirical tests. First, it is found that the change of South Korea's defence spending positively reacts to North Korea's following the Richardson's action-reaction process, but the North's reaction to the defence spending of US-South alliance is different from the Richardson-type arms racing process. All three data show similar empirical results indicating an asymmetric Richardson-type arms race led by South Korea for the period 1963-2000. It is a surprising result, because the North has always been offensive rather than defensive in the South-North conflicts. However, it can be explained that South Korea has been more sensitive to North Korea's potential threat and tried to react to its military expansion. South Korea should always prepare for North Korea's attack and subsequently its defence spending has been affected by North Korea's. But, North Korea does not have to prepare for South Korea's pre-emptive attack, because it could rarely happen, and its defence spending is believed to be less sensitive to South Korea's. Second, in the tests of defence spending in the Cold War era (1963-1989), the MND data show that North Korea follows a submissive-type Richardson model, while the IISS data represents North Korea's significant reaction to the threat from US-South alliance. Thus, it cannot be concluded that North Korea follows the submissive model or Richardson model in the Cold War era, because the empirical tests provide different results according to the data. However, South Korea is believed to follow the Richardson's action-reaction process in the Cold War era according to the empirical results of MND data.

South Korea has reacted to the number of North Korea's military personnel, as well as its defence spending for the period 1963-2000, although its reaction was weakened in the post-Cold War era. North Korea has followed the Richardson process in the number of tactical

aircraft for the period 1963-2000. Unlike defence spending, North Korea has reacted to the number of South Korea's tactical aircraft for this period. In the Cold War era (1963-1989), North Korea also significantly reacted to the numbers of South Korea's military personnel and tactical aircraft. The reaction coefficients in the Cold War era are larger than those in the whole period and hence, it is noted that North Korea is more intensely involved in the Richardson-type action-reaction arms race with South Korea in the number of military personnel and tactical aircraft in the Cold War era. It is thought that North Korea was threatened by the number of South Korea's military personnel and its air forces in the Cold War era, although the number of North's tactical aircraft already overwhelmed that of South Korea's in this period.

In the post-Cold War era, it is thought that the widening gap of defence spending between the US-South alliance and North Korea, caused by North Korea's economic difficulties has weakened the North's reaction to the threat from the US-South alliance. As a result, it shows a significant and negative reaction to the threat from the US-South alliance. Also, in the number of military personnel and tactical aircraft, the North's reaction to the South is alleviated and shows a submissive-type model in the post-Cold War era. But, it can be viewed in other aspects. North Korea's submissive reaction to the US-South alliance might be caused by its economic difficulties, but this phenomenon might suggest that North Korea concentrated on the development of nuclear weapons and long-distance ballistic missiles instead of purchasing conventional weapons. In so doing, it can reduce its defence burden and retain a deterrent to the US-South alliance to protect its political system.

Inter-state conflict between the South and North significantly affects the change of South Korea's defence spending, while it is not an important factor explaining North Korea's

defence spending. As mentioned earlier, inter-state conflicts mostly caused by North Korea's provocative acts stimulated South Korea's defence spending, but North Korea was not much affected by those conflicts. Finally, it is true that US military aid has contributed to the reduction of South Korea's defence burden, and to some extent provided a free-ride for the South until the late 1970s. However, only the IISS data prove that the US military aid is a significant factor affecting the change of South Korea's defence spending.

In conclusion, two research questions were posed which can now be answered. **First, the pattern of arms races between the South and North is different according to the time period and the data. The empirical findings show that the South-North arms race follows an asymmetric Richardson process led by the US-South alliance in defence spending and the military domination of US-South alliance is stronger in the post-Cold War era than in the Cold War era. Second, it is also found that North Korea led the South-North arms race in the number of military personnel and tactical aircraft in the Cold War era. North Korea's domination in the number of military personnel and tactical aircraft in the Cold War era might indicate its hidden cost in defence spending.** Therefore, the domination of the US-South alliance in defence spending in the Cold War era could be caused by North Korea's hidden defence spending.

The statistical results do not reflect all the features of the arms race between South and North Korea. In fact, the behavioural pattern of North Korea has been more aggressive than South Korea for the sample period, and it should not be disregarded that North Korea is still superior to South Korea not just in the number of conventional weapons and manpower but also in the strategic equipment, such as nuclear and bio-chemical weapons. Therefore, even though South Korea's defence spending overwhelms North Korea's, it cannot be simply

concluded that South Korea leads North Korea in the South-North arms race. This chapter describes only a part of arms races between the two countries based on the Richardson's action-reaction model. For further research, besides the quantitative methods, a more comprehensive approach is needed to analyse the arms race between the South and North. For example, the geo-political factors such as major countries including Russia, China and Japan surrounding the Korean Peninsula might be considered in the South-North relations since the end of the Cold War. By 2003, these countries played an important role for alleviating the military tension between the South and North and were involved in the nuclear crisis in the Korean Peninsula. As mentioned earlier, the arms race between the two countries has increased their defence spending, and the increased defence spending might affect the economic growth of the two countries. The next chapter will examine South Korea's defence-growth relationship, beginning with an overview of previous defence-growth studies.

CHAPTER V

DEFENCE SPENDING AND ECONOMIC GROWTH:

AN OVERVIEW

5.1. INTRODUCTION

In Chapter IV, the empirical results of the South-North arms race showed that South Korea has followed the Richardson-type action-reaction process in its arms race with North Korea. Despite its heavy defence burden, South Korea attained rapid economic development and became one of the most successful countries which transferred from a developing economy to a developed economy. Hence, it is important to study how South Korea's defence has affected its economic growth and contributed to its economy. In Chapter I, two research questions were posed. One is whether South Korea's defence spending promotes or inhibits its growth, and the other is whether the economy's stage of development changes South Korea's defence-growth relationship. In Chapter VI, these questions will be answered. Before South Korea's defence-growth relationship is examined in Chapter VI, the previous studies on defence-growth relationship are briefly reviewed in this chapter.

Since Benoit's (1973, 1978) pathbreaking work asserting the positive effect of defence spending on economic growth, there has been considerable debate on his finding. His results were very surprising, because defence spending had usually been recognised as a growth-inhibiting burden for economic development. In general, most empirical studies (Lim, 1983; Faini *et. al*, 1984; Deger, 1986; Huang and Mintz, 1990, 1991; Sheetz, 1991;

Ward and Davis, 1992) show that defence spending impedes economic growth or has no significant impact on it. Even when the supply-based Feder-Ram model supporting the growth-promoting effect of defence spending through technological spin-offs and externalities is used, only a few results have shown the positive impact of defence spending on economic growth mostly in Less Developed Countries (LDCs). Most LDCs experiencing a lack of social infrastructure (e.g. dams, airports, telecommunications) can promote economic growth by using defence spending to improve the social infrastructure (Benoit, 1978). Defence also contributes to the growth in LDCs by providing nutrition, education, training to the military personnel, and these human capital enhancing activities can give a positive impact on the development of civilian economy (Sandler and Hartley, 1995). However, defence spending is still regarded as a necessary cost for national security rather than a benefit to the economic development.

In the supply-side model, the defence-growth relationship is derived from the aggregate production function. In general, defence spending is expected to give a positive impact on economic growth, because defence is simply one of the input components with labour and capital affecting economic growth measured by output. In other words, the increase of defence level is predicted to generate more production.

In the demand-side model, the Keynesian demand function is represented. That is, different sources of demand compete with each other under constrained resources and one source of demand necessarily crowds-out another source of demand unless total output is increased. As a result, an increase in the output devoted to the military sector is likely to reduce aggregate consumption, and public and private investment, although the military sector also creates consumption and investment in itself. Namely, the resources diverted from civilian

economy to the military sector could deprive a nation of more opportunities for economic growth by crowding-out more productive civil investment. In this aspect, the demand-side models represent a negative impact of defence spending on economic growth considering the crowding-out of civilian production by defence. However, all economic activities result in crowding-out under full employment, but investment is regarded as a priority in the civilian economy. For example, government could invest in the telecommunication system instead of the construction of military airports, if it is prior to other investment. But, defence basically crowds out these investment opportunities for civilian economy.

In the Granger causality model, a different approach is needed. Both the supply-side and demand-side models are only interested in a unidirectional relationship between defence spending and growth. Their major interest is the impact of defence spending on economic growth while some studies are concerned about the bi-directional connection, the mutual relationship between defence and growth. Defence could affect a nation's economic growth, whereas a nation's economic growth (the growth of output) could itself be a determinant of defence spending. In other words, a country's income level and the growth of income can be significant factors influencing the increase of defence spending (Sandler and Hartley, 1995). By using the Granger-causality test, some studies detected the presence and direction of causation between defence spending and economic growth whether it is unidirectional or bi-directional. However, this test only provides a statistical causation between defence and growth, and does not prove the economic causality of any defence-growth relationship.

In summary, the impact of defence spending on growth can give different results depending on the type of model, sample, time period and testing methods, and according to whether it is a cross-sectional or time-series approach. When the supply-side model is employed,

it is generally expected that defence spending has a positive effect on economic development due to spin-offs and externalities, whereas the demand-side model is focussed on the competing demands under resource constraints. In the demand-side model, defence possibly contributes to crowding-out valuable civilian investment and hence, retarding economic growth. Through the Granger-causality test, the interaction between defence and growth is investigated as not only can defence spending cause economic growth but the growth of output can also stimulate defence expenditures.

5.2. THE MODELS OF DEFENCE-GROWTH RELATIONSHIP

5.2.1. Benoit's Study and a Critique

Benoit's (1973, 1978) study found that defence spending helps economic growth. It was based on the growth rates, investment rates, foreign economic aid and the growth in civilian products of 44 LDCs between 1950 and 1965. He used correlation as a statistical method for his empirical analysis. His study also included the sample case studies of India, South Korea, Mexico, Israel, the United Arab Republic and Argentina. He found that countries with heavy defence burdens generally attained high growth rates while those with relatively low defence burdens had low growth rates.

He explained his results through two mechanisms. First, only a small part of any income not spent on defence is put into highly productive investments, especially in LDCs. Most goes into consumption or less productive areas and hence, the increase of civilian investment instead of defence does not contribute much to real growth. Second, although defence programs are not intended to contribute to the civilian economy, they may, in fact,

give a positive impact on it in indirect ways (e.g. social infrastructures, technological spin-offs, human capital enhancement, etc.). However, his study has been criticised in that the empirical analysis is not merely partial but also dubious regarding statistical validation of the defence-growth relationship (Deger, 1986b). Deger (1986b), and Deger and Smith (1983) criticised Benoit for disregarding the simultaneity of the interrelationship between defence and growth without consideration of the overall effect of defence on growth. According to Deger and Smith (1983), the direct and indirect effects should be examined to accurately measure the defence-growth relationship. In other words, defence spending has a positive direct effect on economic growth while high defence spending also impedes economic growth by lowering savings and subsequently investment. Hence, defence has both positive and negative effects on growth but positive effects are offset by negative effects. Therefore, they concluded that defence spending, as a whole, should hamper economic growth and development.

Benoit's study has also been criticised due to its statistical weaknesses and standard of country selection. Lim (1983) pointed out the functional problem[1] of Benoit model (1978) and analysed the defence-growth relationship in the Harrod-Domar framework. He found a negative impact of defence spending on economic growth. Also, Benoit depended on a simple correlation analysis rather than modelling a theoretical econometric equation (Smith, 1980a,b) and as a result, his analysis was not comprehensive but partial (Deger 1986b). In terms of sample countries, the 44 LDCs which he chose were at the different stages of development and growth and hence, it is inadequate to compare these countries with the same standard. Also, there is no theoretical basis why he sampled these countries and the

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1 Benoit hypothesized that a higher defence spending results in a lower investment and so a lower growth. But he used both defence spending and investment as determinants in his functional form. Lim (1983) indicated that defence spending and investment should not appear together as independent variables in the same estimating equation.

relatively short time period is another problem. Fredericksen and Looney (1983) extended Benoit's study using the same sample of countries and time period, but they obtained different results from Benoit's. They found that the sample countries are divided into two different groups: one is a *resource-abundant group* (relatively rich countries) and the other is a *resource-constrained group* (poor countries). They showed that defence spending helps growth in *resource-abundant* countries while it rather impedes growth in *resource-constrained* countries[2].

Benoit's empirical results show that the defence burden has three times as strong a correlation with the growth of civilian products as does bilateral economic aid (0.35 vs 0.12), although it has two-thirds as strong a correlation as does the investment rate (0.54 vs 0.61). Anyhow, the defence burden has a positive effect on civilian growth in his analysis of partial correlations. However, the R^2 representing the overall significance of his equation, including the defence burden, bilateral economic aid and investment rate as independent variables is very low at 0.23.

Although Benoit (1973, 1978) made a significant contribution to defining the defence-growth relationship in LDCs, he did not consider the overall effects of defence spending on economic growth and his empirical estimation is also disputed. He simply ignored the negative effects of defence spending on growth which might crowd-out more productive civilian investment and slow down an economy. In addition, as Smith (1980a,b) mentioned,

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2 The *resource-abundant* group was characterised by high growth in foreign exchange earnings, high import elasticity, a low debt-service ratio, a low incremental capital-output ratio, a high current account deficit/GDP ratio, and a high government spending multiplier. On the other hand, the *resource-constrained* group was characterised by low growth in foreign exchange earnings, a high incremental capital-output ratio, a low percentage of exports to GDP, a high debt service ratio, a low current account deficit as a percentage of GDP, a low government expenditure multiplier, and low import elasticity.

his myopic estimation method has brought some scepticism about the empirical reliability of his findings. Therefore, the study of both supply-side models using aggregate production functions and demand-side models applying Keynesian demand functions is needed for a balanced investigation of the defence-growth relationship.

5.2.2. The Supply-Side Model

5.2.2.1. Biswas and Ram Model

Supply-side models explain the defence-growth relationship using aggregate production functions. In the supply-side model, defence is a partial component promoting economic output and thus expected to have a significant positive impact on growth. Feder (1983), Ram (1986) and Biswas and Ram (1986) contributed to developing the supply-based production function by applying export sector and government size. This model has also been extensively employed in the study of defence-growth relationship by Alexander (1990, 1995), Mueller and Atesoglu (1993), and Huang and Mintz (1990, 1991). Adapting Feder's original model, Biswas and Ram (1986) developed a simple two-sector model assuming that the defence sector affects aggregate economic output and growth. There might exist externality effects or spin-offs from civilian to the defence sector. For example, social infrastructure for civilian uses (e.g. harbour, telecommunication network, roads) can be utilised for military purpose on occasion, and civilian technology can be applied to the development of military equipment. However, the two-sector model developed by Biswas and Ram (1986) considers only the externality and spin-offs from defence to the civilian economy, and does not include the crowding-out of civil investment by defence.

Assuming that labour (L) and capital (K) are two separate inputs contributing to economic output, and that the size of the defence sector (D) gives an impact on the rest of the economy (C) through externalities (e.g. dams, airports, roads and communication network etc.), then the aggregate production functions for the two-sector model can be expressed as:

$$D = D(L_D, K_D) \tag{5.1}$$

$$C = C(L_C, K_C, D) \tag{5.2}$$

where subscripts represent the sectors. L_D and L_C denote the labour inputs employed in the defence and civilian sectors, and K_D and K_C are the capital stocks employed in both sectors. Subscripts on the inputs imply the allocation of inputs between the two sectors, so that:

$$L = L_D + L_C \tag{5.3}$$

$$K = K_D + K_C \tag{5.4}$$

where L and K are the total labour and capital stocks in the economy. Total output (Y) is the sum of the output from the defence sector (D) and civilian sector (C) and can be written as:

$$Y = D + C \tag{5.5}$$

Differential productivity in the two sectors can be represented by:

$$\frac{D_K}{C_K} = \frac{D_L}{C_L} = 1 + \delta \tag{5.6}$$

where the subscripts on D and C denote the partial derivatives of labour (L) and capital (K), and δ represents the productivity index. According to Biswas and Ram (1986), if the productivity index δ is positive, the defence sector is more productive than the civilian sector[3] and might have a positive impact on economic growth representing that the differential productivity is larger than 1 in equation (5.6). But, if it is negative (differential productivity is smaller than 1), the civilian sector will be more productive. In other words, in a positive δ, the defence sector shows a higher input productivity and results in an increase in total output for given resources as inputs are moved into the more productive defence sector (Ram, 1995). Biswas and Ram (1986) derived an equation for the growth of aggregate output applying above equations in the following form:

$$dY / Y = C_L(dL / L)(L / Y) + C_K(I / Y) + \Phi(dD / D)(D / Y) \tag{5.7}$$

where dY / Y denotes the growth rate, $C_L(L / Y)$ is an elasticity parameter, C_K is the marginal product of capital in the civilian sector, $I(dK)$ is aggregate investment, and the sum of the externality and the factor-productivity effects of defence on growth is:

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3 In the highly defence-oriented economy (e.g. former communist countries, North Korea), labour and capital centered on defence industry might be more productive than civilian industry, because human resources and capital investment are concentrated on defence. In this case, the economic output from defence could be larger than the output from civilian economy, and it might make a greater contribution to the national economy.

$$\Phi = \left[\left\{\delta/(1+\delta)\right\} + C_D\right] \tag{5.8}$$

The two sector-model derived by Biswas and Ram (1986) is the most basic form of the supply-side production function explaining the defence-growth relationship. Using the two-sector model they found that the impact of defence on economic growth is insignificant.

5.2.2.2. Other Supply-Side Models

Feder (1983), and Biswas and Ram (1986) models were extended to the three-sector model (Huang and Mintz, 1990, 1991; Sezgin, 1999) and even the four-sector model by Alexander (1990). Huang and Mintz (1990, 1991) divided the public sector into the non-military public sector and the military sector while Sezgin (1999) considered a human capital factor in his production function. Alexander (1990) separated the export sector from the civilian economy in the three-sector framework. On the other hand, Atesoglu and Mueller (1990) investigated the effects of defence cuts on economic growth using the two-sector model.

Although the supply-side models are expected to show a positive impact of defence on growth, those described above give different empirical results. Alexander (1990) tested the effects of defence spending on economic growth using the data of nine developed countries for the period 1974-85 and found no significant relationship between defence and growth. Huang and Mintz (1990, 1991), and Mintz and Huang (1990) also found that there is no significant and direct effect of defence on growth, but defence spending tends to dampen investment and thus hamper economic growth. By contrast, Atesoglu and Mueller (1990), and Mueller and Atesoglu (1993) found a significant and positive relationship between

defence spending and economic growth in their US studies for the period 1948-1990. But, the responsiveness of economic growth to changes in defence spending was small and therefore, the adverse effects of defence cuts on the economic growth were expected to be small. Also, Sezgin (1999) obtained a significant and positive effect of defence on growth in his Turkish studies for the period 1955-1994. The results from empirical studies are different due to the variety of models, different time periods and samples, and the type of data. However, when estimating the Feder-Ram type supply-side models, time-series data for a single country are most appropriate, because cross-sectional data aggregate across countries with vastly different economic, political, and strategic characteristics (Chan, 1985; Mintz and Stevenson, 1995).

The supply-based models have some weaknesses in spite of their useful interpretation for the defence-growth relationship. First, the Feder-Ram model ignored the trade-off between defence and investment. In the supply-side production function, defence is a factor stimulating economic growth if its productivity index is greater than zero. However, defence spending may harm economic growth by shrinking public (non-defence) and private investment even though its externality effect is positive. Second, the Feder-Ram model did not allow the possibility of the reverse effect of economic growth on defence spending. In the supply-based model, the effect of externalities is always unidirectional from defence to growth. Nevertheless, economic growth may also cause the increase of defence spending because economic success often entails military expansion. In the demand function for military expenditures, income is an important determinant of defence spending. As GDP rises, a nation can secure more resources for defence, and thus defence spending and GDP are hypothesised to be positively correlated, so that defence is a normal good whose demand rises with income (Sandler and Hartley, 1995). As a matter of fact, a

significant and positive effect of growth on defence spending has been found in some developing countries by Chowdhury (1991) and Kusi (1994) through Granger-causality tests. Hence, the causality test is very useful for detecting whether the causation is unidirectional or interactive. Third, if defence gives a net beneficial effect on economic growth, this is more likely to occur in LDCs where there are more avenues from which benefits can be derived (Sandler and Hartley, 1995, p.202). However, Frederiksen and Looney (1983) found a negative effect of defence on growth for poor countries while a positive effect for relatively rich countries. Not only do these inconsistent results highlight the weakness of the supply-side models but most empirical tests also fail to uncover the significant and positive effect of defence on economic growth.

The supply-based Feder-Ram model contributed to developing the aggregate production functions presenting a positive defence-growth relationship, but also showed some limitations by disregarding negative effects of defence on growth. Therefore, it is necessary to examine both positive and negative effects of defence on growth for a more comprehensive approach to the defence-growth relationship. In this aspect, the study of the demand-based models is also essential.

5.2.3. The Demand-Side Model

Defence may stimulate economic growth through supply-side factors such as technology spin-offs and social infrastructure as mentioned earlier. In contrast, defence may have a negative effect on growth by crowding-out savings and investment, and worsening the balance of payments. Demand-side models highlight these negative effects of defence on growth based on the Keynesian demand functions. An example of the Keynesian demand

relationship is:

$$Y = C + I + M + B \tag{5.9}$$

where Y is the total output, C is aggregate consumption, I is private and pubic investment, M is real defence spending and B is the balance of trade. When a Keynesian demand function is applied to the model, one source of demand competes for scarce resources with another source (Sandler and Hartley, 1995) and therefore, one source of demand might be crowded-out by other sources.

Smith (1980b) derived a Keynesian demand-based function and found a significant negative relationship between defence spending and investment in 14 OECD countries studies over the period 1954-1973. His empirical studies include cross-sectional, pooled and time-series estimates for these countries. His tests focussed on the relationship between the military and investment, and whether the coefficient on the military term is insignificantly different from -1. In the test, the assumption that the coefficient of the share of military expenditures is -1 in every year was accepted. In the various pooled estimates the coefficient was consistently around -1. In the times-series tests the coefficient of military expenditure was negative in all but two of the 14 countries, and the average long-run effect, measured by the weighted means of the coefficients, was -0.917. His empirical findings are significant, but it is already recognised that the military sector (M), and public and private investment (I) compete with each other. Hence, his empirical results are not surprising but expected. His model is based on the simple Keynesian demand equation and does not include the supply-side effect of defence on growth. In other words, the demand-side model disregards a possible positive effect of defence on growth.

5.2.4. The Demand and Supply-Side Model

5.2.4.1. The Deger-Type Model

Deger and Smith (1983), Deger (1986a,b), and Deger and Sen (1995) developed demand and supply side models containing three or four stage simultaneous equations representing growth, savings/investment, the trade balance and defence. Deger's (1986a) four stage simultaneous equation model is derived as follows:

$$g = a_0 + a_1 s + a_2 m + a_3 B + a_4 y + a_5 A \tag{5.10}$$

$$s = b_0 + b_1 m + b_2 g + b_3 yg + b_4 B + b_5 i \tag{5.11}$$

$$B = c_0 + c_1 m + c_2 g + c_3 i + c_4 D \tag{5.12}$$

$$m = d_0 + d_1 y + d_2 GB + d_3 N + d_4 q + d_5 D \tag{5.13}$$

where:

g = average annual growth rate of GDP

s = national savings ratio

m = share of military spending in GDP

B = balance of trade

y = per capita income at official exchange rate

A = annual growth rate of agricultural output

i = inflation rate

GB = growth rate of government budget

q = difference between per capita income across countries

N = total population

D = dummy variable for countries

In the growth equation, Deger (1986a) considered that the military and agricultural sectors were more significant than health and human capital investment. She did not include the size of the labour force. Even though the specific features of an LDC's economy are considered, some necessary variables are absent in her model. These estimating equations (5.10)-(5.13) present both the direct and indirect effects of defence on growth by including the savings and trade balance sectors. Deger (1986a), and Deger and Sen (1995) suggested that the application of a simultaneous equation system is needed to examine a more comprehensive defence-growth relationship reflecting the interaction between growth, savings, the trade balance and defence spending. Namely, the growth equation (5.10) reflects the traditional production function to show the supply-side effect of defence on growth, while the savings equation (5.11) reflects the Keynesian demand function to represent the demand-side effect of defence on growth. However, the choice of variables in the trade balance equation (5.12) is somewhat *ad hoc* and discretionary. The military equation (5.13) is derived from the demand for military expenditures. Hence, the Deger model includes both the supply and demand-side effects of defence on growth.

The growth equation (5.10) derived from a traditional production function includes agricultural growth, but this variable might be inadequate for industrial countries. In most underdeveloped countries, agriculture is an important sector for economic growth while in the industrial countries, agriculture is not a crucial variable determining their growth. Hence, agricultural growth is not a universal variable across countries. In the savings equation (5.11), savings are affected not only by growth but also by the growth influenced by per capita income, because the countries with low per capita income have also a low life cycle effect. That is, the savings ratio depends on the growth rate, but the parameter representing the effect of growth on savings is not constant across countries and rather it

varies positively according to per capita income (Deger, 1986a). However, this variable is not necessary to estimate time-series data for a single country and also might cause the multi-collinearity problem with growth. The trade balance equation (5.12) reflects the effect of defence on growth in an open economy. Deger (1986a) expected that defence has a negative effect on the trade balance by diverting resources from civilian uses to defence and induces imports by increasing demands for defence and reducing exportable civil goods.

The military equation (5.13) consists of the exogenous variables representing per capita income, growth of government budget, income differences between countries, total population, and dummy variables reflecting the strategic environment according to Deger and Smith (1983), and Deger (1986a,b) .

In the growth equation (5.10), all the explanatory variables are expected to have a positive effect on growth, but Deger (1986a) disregarded more important variables such as the size of the labour force and the human capital. However, it is considered that these are more necessary factors affecting a nation's growth than the agricultural growth in the industrial countries.

In the savings equation (5.11) derived from the output/expenditure function the share of savings in GDP is expected to be positively related to growth, per capita income, the trade balance and inflation. But, the defence burden is expected to have a negative effect on savings, since it is assumed to crowd-out civilian savings and investment. According to Deger (1986a), there is a negative and indirect effect of defence on growth via savings and investment.

In the trade balance equation (5.12), growth, defence burden, inflation and dummy variables

are expected to affect the trade balance, but Deger (1986a) did not include the exchange rates which can change the balance of payments. Defence is predicted to have a negative effect on the trade balance as mentioned earlier, but the expected signs of growth and inflation are unclear. Namely, the effect of growth on the trade balance might be different according to the industrial structure of a country. If a country follows export-promoting strategies, growth should give a boost to exports and thus have a positive effect on the trade balance. By contrast, if a country is at the stage of import-substituting industrialisation, it will require more imports to achieve future self-sufficiency and this affects the trade balance negatively (Deger, 1986a). Inflation might also affect the trade balance since LDCs often have a fixed exchange rate regime. Deger (1986a) asserted that high inflation rate would distort the relative price structure against the rest of the world. But, she did not clarify the relationship between the inflation and trade balance as to whether it is positive or negative.

In the defence equation (5.13), the share of military expenditures in GDP is supposed to be influenced by per capita income, government budget, income differences at purchasing power parity (PPP), total population, and dummies describing the oil producing Arab countries and the countries in regional conflicts, the Middle East, India and Pakistan. However, Deger's defence equation omitted some important variables related to the demand function for military expenditures. In the demand function for military expenditures, defence equation needs to include income, spill-ins, threat and price factors (Sandler and Hartley, 1995). A nation's defence spending might be affected by the spill-in from alliances or the spill-over to alliances and the arms race with opponent countries. However, Deger and Smith (1983), and Deger (1986a,b) ignored these crucial variables in their model. In terms of dummy variables, Deger and Smith (1983), and Deger (1986a,b) applied two

categories of dummy variable in the 50 LDCs empirical tests. First, they used the oil dummy for the countries that had high balance of payments surpluses from oil exports and thus could import military equipment with these earnings. Second, they also employed a war dummy for the countries involved in severe inter-state armed conflicts or war during the sample period (1965-1973). However, the sample period is during the Middle East War and this might affect the defence spending of Arab countries. If it was peace time, it is difficult to link oil exports with the import of defence equipment. For example, among the major oil-exporting countries only Saudi Arabia and UAE (United Arab Emirates) are included in the 10 major arms importers in the world for the period 1996-2000 (SIPRI, 2001). Hence, it does not appear that the oil-exporting countries spend more on defence.

5.2.4.2. The Empirical Results of Deger-Type Models

(i) Deger

Deger (1986a) estimated the defence-growth relationship of 50 LDCs employing a three stage least squares (3SLS) method. In the empirical test of the growth equation, only savings and defence spending have a positive and significant effect on growth while other variables are insignificant. Therefore, the overall significance of the growth equation (R^2) is relatively low at 0.32, and she failed to show a correlation between growth and other explanatory variables (the trade balance, per capita income and agriculture). By contrast, on the demand-side, the military burden significantly eroded savings and this result suggests that the indirect effect of defence on growth via savings is clearly negative. In her study, Deger (1986a) measured a multiplier effect of defence burden on growth considering both the supply and demand-side effects and the result was purely negative (dg/dm = -0.36).

In other words, the negative effect of defence on savings/investment and the trade balance outweighed the positive effect of defence on growth and thus the overall effect of defence spending on growth was negative.

Deger and Sen (1983), Faini, Annez and Tayler (1984), Deger (1985), Scheetz (1991) also found a negative effect of defence on growth in the Deger framework. Deger and Sen (1983) found that the economic spin-offs emanating from the defence sector are actually very small and thus the positive effect of defence on economic development is insignificant even in LDCs such as India. Faini *et.al* (1984) discovered that a 10% increase in the defence burden leads to 0.13% loss of annual growth in their empirical estimation of 69 countries over the period 1952-1970. Deger (1985) also found that the overall impact of defence on growth and development is negative in spite of some beneficial spin-offs from the defence sector. Scheetz (1991) investigated the defence-growth relationship for the four LDCs, including Argentina, Chile, Paraguay and Peru based on the Deger (1986a) model, and as a result, he found that defence has a negative direct effect on growth as well as on savings and trade balance.[4] Growth is positively correlated to defence spending in the growth equation of the Deger model (1986a,b) while Scheetz (1991) found that even the positive and direct effect of defence on growth turned out to be negative in his pooled empirical tests. This unexpected result might be caused by a relatively high defence share compared with the low growth of these countries. By contrast, in the individual country results, Scheetz (1991) failed to show a negative and direct effect of defence on economic growth, because not only the overall significance of growth equation was mostly very low but the direct effects of defence on growth were also insignificant in the three countries

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4 According to Scheetz, the differences might result due to a partially different time period, the limitation of the study to four Latin American countries sharing greater similarities among themselves than Deger's 50 sample countries, and much improved data set.

except for Chile. In the pooled tests, the R^2 of the growth equation is very low at 0.26, and it is even lower in individual country tests. Accordingly, his empirical results are relatively weak to show the overall significance of defence-growth relationship and are unreliable to prove the negative direct effects of defence on growth.

(ii) Roux and Sezgin

In contrast, Roux (1996) discovered that the direct effect of defence on growth is negative, but the indirect effect of defence on growth via savings and trade balance is insignificant in his South African studies over the period 1960-1990. According to his results, defence spending harms economic growth directly but does not give any effect on savings and the trade balance. Dunne and Nikolaidou (2001) found that both the supply and demand-side effects of defence on growth are harmful for economic growth in their empirical test of Greece's defence-growth relationship. Namely, their empirical results show that the direct and indirect effects of defence on growth are significantly negative. But, Sezgin (2001) provided a totally different result in his Turkish studies for the period 1956-1994. He also used a four stage simultaneous equation model in the Deger framework. He included exogenous variables such as the size of the labour force, inflation rate, exchange rate and political dummies in the Deger-Sen model (1995) to specify the Turkish economy. His empirical results show that the defence sector is an engine for Turkish economic growth and hence does not hamper its growth. The negative effects of defence on growth through savings and the trade balance are insignificant. Therefore, the overall effects of defence on the Turkish economy are positive and conducive to its economic growth. His results are remarkably different from previous demand and supply side studies, and demonstrates that defence may help economic growth even in the demand and supply side framework.

Therefore, demand and supply side models provide different empirical results depending on sample countries, the time period and empirical methods. Even in a single country, the effect of defence on growth can be different according to its development stage. In the developing stage, a country's defence spending is expected to have a positive effect on its growth, because the defence sector helps to create demand through its externality and spin-offs and contributes to human resource development. In other words, it provides the base for economic development when the civilian sector is relatively weak. But, in the developed stage, defence does not have enough room to provide benefits to the economy. When the civilian economy is highly developed, defence could rather harm economic growth by crowding-out a country's resources for its civil investment. Also, the empirical results might be different according to which estimation method is used. As a result, there must be considerable doubts about the reliability of empirical results in this field. Also, the defence-growth relationship may not be generalised and standardised because the development stage and role of defence spending are different among countries, and the variables affecting a nation's growth could vary.

The demand and supply side models developed by Deger and Smith (1983), Deger (1985, 1986a,b), and Deger and Sen (1995) contributed to estimating both the supply and demand-side effects of defence on growth and measuring its overall impact. Thus, the Deger-type demand and supply side model is more comprehensive for explaining the defence-growth relationship than the Feder-Ram type supply-side model. They also adopted a more sophisticated and detailed econometric model(simultaneous equations) and estimation method (3SLS) to measure an overall impact of defence on growth. Although the selection of variables is *ad hoc* rather than well-organised and often fails to show strong empirical results as mentioned earlier, the demand and supply side model provides better insights into

the defence-growth relationship than either the supply-side or demand-side model by reflecting both positive and negative effects of defence on growth. Nevertheless, to improve the weaknesses of the demand and supply-side model, the selection of well-organised variables is important considering the relationship between dependent and independent variables. For example, Deger (1986a) regarded the size of population as a determinant of a country's military expenditures, although a country with small population could spend more on defence than a large population country according to its security environment.

5.2.5. Causality Analysis of Defence-Growth Relationship

A defence-growth relationship may be examined through a causal analysis using Granger-causality tests. Defence spending can affect economic growth, while growth may reversely stimulate defence spending or both factors may have a bi-directional relationship with each other. Granger-causality tests are a useful method to investigate the presence and direction of causation between defence and growth (Sandler and Hartley, 1995, p.213). Joerding (1986) used Granger causality to examine defence-growth causation assuming the exogeneity of defence relative to growth. He found that defence spending is not a strong exogenous variable relative to economic growth. In the test of the hypothesis of Granger non-causality, he failed to reject Granger non-causality from defence spending to growth while he found some evidence that economic growth Granger caused defence spending. Also, Kinsella (1990), Chowdhury (1991) and Kusi (1994) applied Granger-causality tests to the analysis of defence-growth relationship. Kinsella (1990) introduced more complex vector autoregression models to uncover the causal relationship between defence spending and economic performance, such as inflation, unemployment, interest rate and output in the US over the period 1943-1989. He concluded that there is no substantial causal relationship

between defence spending and these factors in either direction. Chowdhury (1991) also tested the causal relationship between defence and growth employing Granger-causality tests for 55 developing countries and suggested that the defence-growth relationship could not be generalised across countries because of the use of a different sample period and the different socio-economic background in each country.[5] He found no evidence of causal relationship between defence and growth in 30 countries, while some negative causality from defence to growth was found in the remaining 15 countries. In the other 10 countries, there existed some uni-directional causality from growth to defence and bi-directional causality between defence and growth. Thus, Chowdhury (1991) did not find any positive effect of defence on growth in his 55 countries studies, but found some negative effect of defence on growth in 15 countries (27% of sample countries). However, over a half of the sample countries (55%) did not have any causal relationship between defence and growth. Kusi (1994) obtained somewhat different results from Chowdhury (1991) in his tests of 77 developing countries. He found some positive causation from defence to economic growth in Indonesia, Malaysia, Pakistan, and South Korea. Kusi did not explain why these four countries have a positive effect of defence on growth, but it is considered that some externality effects of defence contributed to the economic growth in these countries. These countries have increased the level of defence spending with their economic development except for Indonesia and are surrounded by potential military threats.

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5 Granger Causality Tests for 55 countries: DS (Defence Spending), EG (Economic Growth).
(+) DS->EG: None
(-) DS->EG: Argentina, Indonesia, Israel, Jordan, South Korea, Panama, Paraguay, Peru, Philippines, Sudan, Syria, Tanzania, Thailand, Uruguay, Venezuela.
(+) EG->DS: Chile, Ghana, Haiti, Libya, Saudi Arabia, Tunisia.
(-) EG->DS: Uganda.
(-) DS<->(+)EG: Egypt, Iran.
(-) DS<->(-)EG: Kenya.

No Causal Relationship: Afghanistan, Algeria, Bolivia, Brazil, Burma, Cameroon, Chad, Colombia, Dominican Republic, Ecuador, Ethiopia, Guatemala, Honduras, Iraq, Ivory Coast, Jamaica, Kuwait, Liberia, Malawi, Malaysia, Mexico, Morocco, Nicaragua, Nigeria, Senegal, Sierra Leone, Somalia, Togo, Zaire, Zambia.

Although Granger-causality tests are useful empirical method for detecting the existence and direction of causation between defence spending and economic growth, some precautions are needed when applying these tests. In the Granger-causality equations, the current value of each series is supposed to be linear and covariance-stationary where disturbance terms are assumed to be independent and identically distributed. If the series are non-stationary, they should be altered into stationary by differentiation processes. The causation analysis using Granger-causality tests provides a simple and practical method to examine the causal relationship between defence and growth. However, the equations are often oversimplified and stress only defining the connection between these two variables.

5.3. Empirical Results

Table 5.1 summarizes the empirical results of defence-growth relationship based on the supply-side, demand-side, demand and supply-side, and Granger-causality tests. According to Table 5.1, 12 cases show an overall negative effect of defence on growth, while only 3 cases find a positive effect of defence on growth. However, most cases (14 cases) find no significant relationship between defence and growth. Therefore, about 40% of the empirical results show a negative effect of defence on growth, while only 10% show a positive relationship between defence and growth. The remaining 50% find no particular relationship between defence and growth. Exceptionally, Frederiksen and Looney (1983) found some positive effects of defence on growth in resource-rich countries while some negative defence-growth relationship in resource-constrained countries. Therefore, most empirical results show that the defence-growth relationship is overall negative or insignificant.

Table 5.1. A Summary of Literature Review on Defence-Growth Relationship

Author (s)	Model/Sample/Time period	Conclusions
Benoit (1973, 1978)	Ad hoc single-equation model/44 LDCs/ 1950-65	Positive and significant effect of defence on growth
Smith (1980)	Keynesian demand function/OECD countries/1954-1973	Negative effect of defence on investment
Deger & Smith (1983)	Keynesian three equation (SEM) model with supply side/50 LDCs/1965-73	Positive direct but negative indirect effect of defence on growth and total effect is negative
Frederiksen & Looney (1983)	Benoit's sample and model/44LDCs in 4 groups/1950-65	Positive effect of defence on growth in resource-rich countries, but negative effect in resource-constrained countries
Lim (1983)	Harod-Domar growth model/54LDCs/1965-73	Negative effect of defence on growth
Faini, Annez & Taylor (1984)	Demand-side Keynesian model/69 mainly LDCs/1952-70	Negative effect of defence on growth
Deger (1985)	Keynesian four equation model with supply side/50LDCs/1965-73	Negative effect of defence on education
Biswas and Ram (1986)	Traditional Feder-type two-sector model /59ldcS/1960-70, 1970-77	No significant effect of defence on growth
Deger (1986a,b)	Keynesian three/ four simultaneous equation (SEM) model /50LDCs/1965-73	Positive direct and negative indirect but overall negative effect of defence on growth
Landau (1986)	Neoclassical production function model /52LDCs/1960-80	Little effect of defence on growth
Joerding (1986)	Granger causality tests/57LDCs/1962-77 time series	No evidence that defence causes growth
Lebovic & Ishaq (1987)	Deger-Smith type three equation model/20 Middle Eastern countries/1973-82	Negative effect of defence on growth
Alexander (1990)	Feder-type four-sector model/9 developed countries/1974-85	No effect of defence on growth
Atesoglu and Mueller (1990)	Feder-type two-sector model/US/1949-89	Small positive and significant effect of defence on growth

Author(s)	Model/Sample/Time period	Conclusions
Huang and Mintz (1990)	Feder-type three-sector model/US/1952-88	No significant effect of defence on growth
Huang and Mintz (1991)	Feder-type three-sector model/US/1952-88	No significant externality from defence to economy
Adams, Behrman & Boldin (1991)	Feder-type three-sector model/73LDCs /1974-86	No significant effect of defence on growth
Chowdhury (1991)	Granger causality tests/55 LDCs/1961-87 time series	Defence-growth relationship cannot be generalised
Scheetz (1991)	Deger-type three equation model/4Latin American countries/1969-87 pooled time series	Negative macroeconomic impact of defence on growth
Ward and Davis (1992)	Feder-type three-sector model/US/1948-90	Net negative effect of defence on growth
Chan (1992)	Two equation ad hoc model/Taiwan/1961-88	No significant effect of defence on growth and inequality
Chen (1993)	Granger causality tests/China/1950-91	Causal independence between defence and growth
Kusi (1994)	Granger causality tests/77 LDCs/1971-88 time series	Defence-growth relationship cannot be generalised
Dunne & Mohammed (1995)	Keynesian SEM with supply-side/13 countries /1967-85	No significant effect of defence on growth
Roux (1996)	Deger-type four simultaneous equation model/ South Africa/1960-1990	A significant and negative direct effect of defence on growth
Heo (1997)	Single equation model/Korea/1954-88 time series	No significant effect of defence on growth
Heo (1999)	Keynesian demand model/Korea/ 1954-88	A Negative indirect effect of defence on growth

Author(s)	Model/Sample/Time period	Conclusions
Dunne and Nikolaidou (2001)	Deger-type four simultaneous equation model/ Greece/1960-1996	Not only indirect but also direct effect of defence on growth is negative.
Sezgin (2001)	Deger-type four simultaneous equation model/ Turkey/1956-1994	A significant and positive overall effect of defence on growth

5.4. Previous Studies on South Korea's Defence-Growth Relationship

South Korea's defence-growth relationship has been mostly discussed by political scientists. Hong (1990) found a negative impact of defence spending on growth, while Park (1993) found no significant relationship between these two factors. Park applied change in the share of defence spending in GNP, real defence spending and the logarithmic function of defence spending to his model to analyse the growth effect of defence in South Korea. As a result, any of these variables had no significant effect on South Korea's growth. South Korea's defence-growth relationship was studied extensively by Heo (1997, 1999), and Heo and Ro (1998). Heo (1997, 1999) studied South Korea's defence-growth relationship based on the Mintz-Huang's (1990, 1991) three sector model over the period 1954-1988. He examined both the direct and externality effects of defence spending on growth using the OLS and GLS estimations. As a result, he found that South Korea's defence spending has neither direct nor externality effects on its growth. However, it was found that investment and non-military sector have a significant and positive effect on growth. By contrast, in his studies based on the Keynesian demand model, Heo (1999) found an overall negative effect of defence spending on growth in South Korea. Unlike the Deger (1986a) model, Heo's (1999) model consists of investment, export and growth equations. In his model, the immediate impact of defence spending on investment is not found, but the fourth lag of

defence spending shows a significant and negative impact on investment. The impact of defence spending on South Korea's export is immediate and negative. However, in the growth equation, he found no direct and significant effects of defence spending on growth in South Korea. Hence, he concluded that there is no direct relationship between defence spending and growth, but defence spending could affect growth indirectly and negatively through investment and export in South Korea. The empirical results of his tests are shown in Table 5.2.

In the Granger-causality analysis, Chowdhury (1991) found a negative effect of defence spending on growth in South Korea, while Kusi (1994) discovered that South Korea's defence spending Granger caused its economic growth positively. These different results might be caused by the difference of the time-period. Chowdhury (1991) estimated the data for the period 1961-1987, but Kusi (1994) used data from 1971 to 1988. In the 1970s and 1980s South Korea attained phenomenal economic growth with a high level of defence spending, and this might result in the positive defence-growth relationship.Therefore, the empirical results of South Korea's defence-growth relationship are different from each other according to models, the time-period and empirical methods. Nevertheless, most previous studies suggest that South Korea's defence spending has a negative or non-significant effect on its growth.

Table 5.2. Empirical Results of South Korea's Defence-Growth Relationship

Author and model	Stat. method	Empirical results	Findings
Heo (1997) Mintz-Huang model	OLS	Investment 0.002 (1.432)* Nonmilitary 0.014(2.382)*** Military -0.201(-0.077) Adjusted $R^2 = 0.24$ DW= 1.68	No direct effects of defence spending on growth
	GLS	Investment 0.956 (2.901)*** Nonmilitary 0.612 (0.857) Military -0.966 (-0.856) Adjusted $R^2 = 0.36$ DW= 2.06	No externality effects of defence spending on growth
Heo (1999) Keynesian-based demand and supply model	Unrestricted distributed lag and GLS	Military->Investment -4.40 ($p< 0.05$) Military->Export -2.88 ($p<0.01$) Military->Growth -0.091 ($p<0.44$)	No direct effects of defence on growth, but negative indirect effects found. Hence, overall negative effect of defence on growth

*Statistically significant at 0.10 level ** Statistically significant at 0.05 level *** Statistically significant at 0.01 level (two-tailed tests).

5.5. SUMMARY

Studies on defence-growth relationship define how defence spending influences economic growth or how they affect each other whether the relationship is positive, negative or non-significant. The empirical results vary depending on the adoption of model, data, and the time-period. Generally, supply-side models support a positive impact of defence spending on growth through externalities while demand-based models stress the dysfunction of defence for economic growth via the reduction of investment. However, the positive externalities from defence are usually very small and insignificant and hence, it is not

simple to find beneficial effects of defence spending on growth even with supply-side models. Accordingly, most supply-based models suggest that defence has no significant or very small positive effect on growth. In contrast, Keynesian demand-side models show that defence spending inherently crowds-out public (non-military) and private investments- supposedly more productive than military investment- and inhibits economic growth. Hence, defence is undoubtedly detrimental to growth in the demand-side model in spite of its contribution to the total output. Even in the Deger-type model combining the supply and demand-side equations, defence has a net negative effect on economic growth in spite of its positive externality effects. Therefore, as shown in Table 5.1, it is cautiously concluded that the net impact of defence spending on economic growth is, as a whole, negative or insignificant, although the results could be different according to model, sample and empirical method.

Further research will be based on the application and evolution of the Deger's (1986a) four stage simultaneous equation model containing both supply and demand-side approaches. By using the Deger model, both the direct and indirect effects of defence on growth are estimated and thus it is ascertained whether the overall effect is positive or negative. In the next chapter, the net impact of defence spending on growth in South Korea will be studied for the period 1963-2000 and two different sub-periods 1963-1979 and 1980-2000. By estimating three different time-periods, both the overall effect of defence on growth for the whole period and the defence-growth relationship according to the development stage might be examined. South Korea is extraordinary as it has attained a high economic growth despite its high level of defence spending to deter North Korea's potential threat. Hence, South Korea's exceptional case will provide valuable information and contribute to the study of the defence-growth relationship which is examined in the next chapter.

CHAPTER VI

DEFENCE SPENDING AND ECONOMIC GROWTH IN SOUTH KOREA: A DEMAND AND SUPPLY SIDE ANALYSIS

6.1. INTRODUCTION

This chapter examines the impact of defence spending on economic growth in South Korea using a demand and supply side (Deger-type) model over the whole period 1963-2000. Two different sub-periods (1963-1979 and 1980-2000) are also estimated to examine how the level of development affects the defence-growth relationship. For the period 1963-1979, South Korea pursued a strong economic development program under President Park's leadership and changed from one of the poorest countries in the world to a semi-developed country. In 1962, South Korea's per capita GNP was $938, but it attained $2,697 in 1979 (1990 constant prices) owing to an effective economic and social development plan. In this period, South Korea pursued a "self-reliant" defence policy and started to nurture defence industries, although US military support was absolute. Accordingly, the government encouraged defence industries to develop indigenous technologies and to be interested in the development of dual-use technologies. However, since the 1980s, South Korea's defence started to depend heavily on imports rather than the development of indigenous technologies with the change of its defence industrial policy, and also focus more on military co-operation with USA. Economically, South Korea has changed from a semi-developed to a developed country owing to consistent economic development for the period 1980-2000.

A demand and supply side model has its own weaknesses. The derivation of the equations is often theoretically unclear and is somewhat *ad hoc,* and if there is substantial mis-specification, it may contaminate the entire set of estimates (Ram, 1995). Nevertheless, this model provides more insights in analysing the defence-growth relationship than provided by the supply-side model only (Sezgin, 2001). A demand and supply side model enables us to investigate direct and indirect, and thus the overall effects of defence spending on growth. Such a model is applied to examine the overall effects of defence spending on economic growth in South Korea.

This chapter consists of 5 parts. The second section reviews the link between defence and growth in South Korea. In the third section, the demand and supply side model based on the Deger model (1986a) representing four multi-equation models and its specifications will be introduced. It is a typical model for most demand and supply-side studies, because it is well qualified to explain the defence-growth relationship in the open economy by including a trade balance sector. In this chapter, Deger' s (1986a) basic model will be modified by adding some different variables to explain South Korea's defence-growth relationship. For example, Deger (1986a) considered the agricultural sector in the growth equation, but it is removed in the model for South Korea's defence-growth relationship, because agriculture is believed to have made little contribution to South Korea's economic growth for the sample period. Instead, human capital and technology sectors will be added in the growth equation, because they are more likely to have led South Korea's growth. Also, US military aid and North Korea's threat are included in the defence equation to explain South Korea's demand for military expenditure. In section 4, statistical results and major findings using ordinary least squares (OLS), two-stage least squares (2SLS) and three-stage least squares (3SLS) methods will be explained and conclusions will be presented in the final section.

6.2. DEFENCE-GROWTH LINK IN SOUTH KOREA

Since the Korean War (1950-1953), responding to the military threats from North Korea has been one of the most critical issues and these external threats have necessitated a high level of defence spending in South Korea. Despite a strong economic development drive under military governments (1962-1988), the share of defence spending in GNP has reached approximately 5-6% representing an average 30% of the government budget. In other words, the defence sector has been the major component of government expenditures. Although the annual share of defence spending in GNP has tended to decrease since the advent of democratic government, and since the 1990s it has reduced to 3-4% (annual average 3.2%), it is unclear whether this downward trend is temporary or permanent. Since the late 1990s, South Korea's engagement policy toward the North and ensuing peace talks between the two Koreas have increased the possibility of disarmament, but it is not expected that South Korea's defence spending will be rapidly diminished, because there is no clear evidence that North Korea's military threat has reduced as mentioned in Chapter II. For example, North Korea's nuclear development programme is one of the major reasons why the South must maintain its level of defence spending.

In terms of the defence-growth relationship in South Korea, many debates have been raised whether defence is growth-promoting or growth-inhibiting. As mentioned in Chapter V, the empirical results on the defence-growth relationship vary with the selection of model, data, and the time-period. In the case of South Korea, there are some complexities in studying the defence-growth relationship. On one hand, South Korea is one of the extraordinary countries which attained high economic growth with a high level of defence spending (Moon and Hyun, 1992). In absolute size, South Korea' defence spending is the 13th largest in the world

(IISS, *The Military Balance*, 2002). In this respect, it seems that the defence spending of South Korea helps its economic growth or, at least, does not hamper growth despite the crowding-out of civil investment. However, the rapid economic growth of South Korea could also lead its military expansion. South Korea has actually maintained both strong defence and economic superiority to North Korea since the 1980s and defence has been one of the most important priorities under all successive governments. In spite of the "defence-emphasis" policy, South Korea's economic growth has been phenomenal and its civilian economy has also been very successful. In addition, until the 1970s, the government attempted to transfer military technology to civilian industry, and to some extent it contributed to raising the level of civilian technology. Hence, South Korea may be an example where defence has a positive effect on economic development.

On the other hand, the large share of defence in government spending has restrained non-military public and private investment. In other words, the defence sector might "crowd-out" investment in education, social security, health, and other necessary economic services, such as social infrastructure (e.g. transportation , roads and telecommunications etc.). In fact, as shown in Chapter II, South Korea's share of defence budget in government spending is much higher than other OECD member countries, while it spends relatively less on other welfare sectors. Specifically, human capital through education is definitely one of the significant factors promoting economic growth (Becker, 1993), but defence might have been detrimental to growth by hampering investment in human capital in South Korea. Also, the structural weakness of the South Korean defence industry might inhibit the economy's development. South Korea has depended heavily on the import of defence products, especially from the US even under the "self-reliant" defence policy due to its technological difficulties. The quality of weapons has also played a critical role in the arms race with

North Korea. For this reason, South Korea's balance of payments in the military sector has been negative and thus this might give a negative effect on growth. Consequently, using descriptive statistics, it is not simple to determine whether the defence-growth relationship in South Korea is positive or negative or insignificant.

One of the necessary considerations which we must not ignore in South Korea's defence-growth relationship is US military aid to South Korea. Since the Korean War, US grants and military support to South Korea have played an important role in the economic development of South Korea. Owing to the US military assistance, South Korea could reduce its defence burden to some extent, even though its level of defence spending is still high. Obviously, US military aid must have provided an opportunity to "free-ride" for South Korea until the early 1980s, because the South Korean government could reallocate resources from defence to civil investment and lay a foundation for economic development. But, since the mid-1980s, the USA ended its grant to South Korea and South Korea began to share the costs of its US forces. However, the share of costs is only 2-3% of the total defence spending of South Korea and hence, it is not an influential factor determining economic growth in South Korea. Another external factor affecting South Korea's defence spending is the threat from North Korea. North Korea's threat has definitely affected the demand for defence spending in South Korea as shown in Chapter IV, and it must have escalated South Korea's defence spending. Thus, the threat from North Korea could indirectly influence economic development in South Korea. Consequently, both US military aid and North Korea's threat might have been significant determinants of the defence-growth relationship in South Korea whether they are positive or negative.

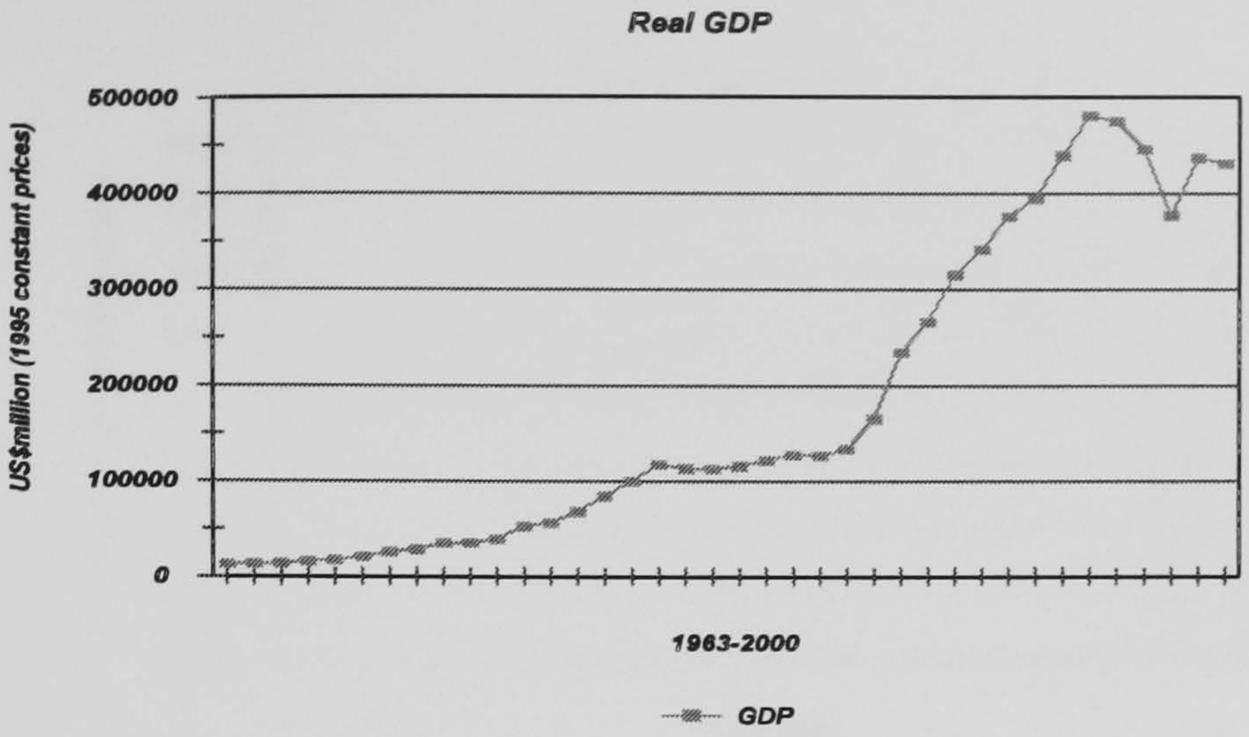
In summary, there are many complexities in examining defence-growth relationship in

South Korea. There are many variables which should be considered, so that it is not simple to uncover the link between defence and economic growth in South Korea. However, the demand and supply side (Deger-type) model will provide valuable insights into the overall effects of defence on growth in South Korea. A modified model applying demand and supply equations will contribute to the analysis of defence-growth relationship in South Korea. Figures 6.1 and 6.2 represent the real GDP and defence spending of South Korea over the period 1963-2000. In Figure 6.1, South Korea's GDP has grown consistently since the 1960s except for 1980 and the late1990s. Although political instability in 1980 caused a temporary economic setback, South Korea's economy quickly recovered after 1981 and recorded high economic growth again until 1996. However, the economic crisis in 1997 seriously damaged the South Korean economy and GDP in 1998 fell sharply recording a negative GDP growth (-6.7%). South Korea's defence spending also grew in this period, although it had small downswings. Its defence spending rapidly increased from the mid-1970s to the early 1980s and from the late1980s to the mid-1990s, although it showed small downswings for the late 1980s and a large decrease in 1998. As shown in Figures 6.1 and 6.2, the trend of GDP and defence spending correspond to each other because the growth of the national economy generally entails a high level of defence spending in most developing countries. As the result of Spearman's rho test, the correlation coefficient between the two sectors is 0.97. Thus, it is noted that the real GDP and defence spending in South Korea are highly correlated.

On the other hand, Figures 6.3 and 6.4 represent the real growth of GDP and real growth of defence spending in South Korea for the same period. Although South Korea's real GDP growth is relatively low until the early 1970s, it shows quite a consistent pattern. South Korea's GDP grew rapidly between the mid-1970s and the mid-1990s with some

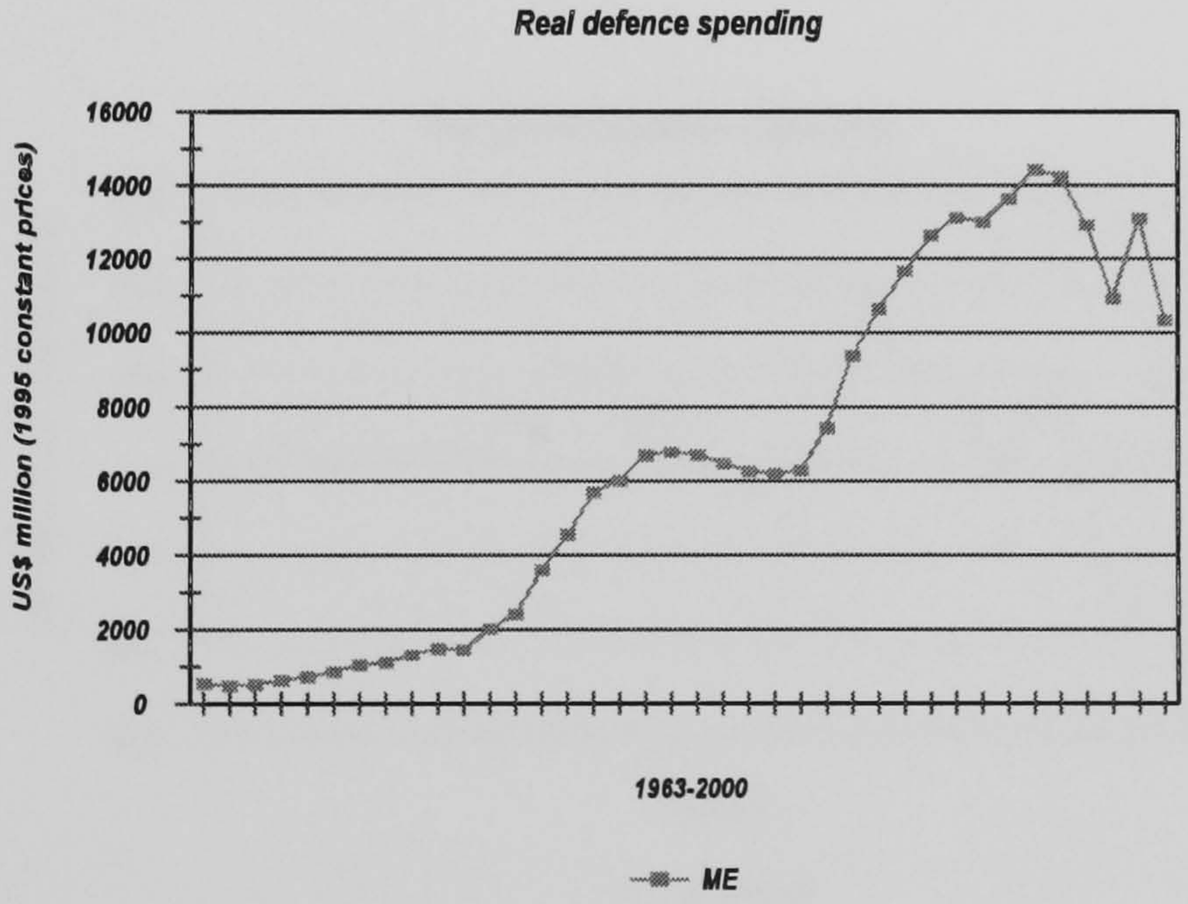
downswings, but it fell sharply in 1997 and 1998 even though growth recovered in 1999. The growth of South Korea's defence spending, as a whole, corresponds to its GDP growth for the period 1963-2000, although there are some exceptions in the 1980s. The growth of GDP and growth of defence spending are negatively correlated from the early 1980s to the mid-1980s and in the early 1990s. As shown in Figures 6.3 and 6.4, both GDP growth and the growth of defence spending peaked in 1988 and 1999. South Korea attained the highest GDP growth in 1988 and the growth of defence spending also largely increased in this year. Not only the high growth of GDP but the 1988 Olympic Games in Seoul also might have stimulated the growth of defence spending in South Korea. The high growth of GDP and defence spending in 1999 seems to be a rally to retrieve the slump in the previous year and might be induced by the sea battle between the South and North in the West Sea near the southern borderline. The correlation between real GDP growth and the growth of defence spending is also high at 0.79. Unlike Figures 6.1 and 6.2, Figures 6.3 and 6.4 show how the change in real GDP and change in defence spending are correlated to each other in South Korea. In the empirical tests of South Korea's defence-growth relationship, the first-differenced form of real GDP and defence spending is employed to prevent possible non-stationarity.

Figure 6.1. Real GDP of South Korea, 1963-2000



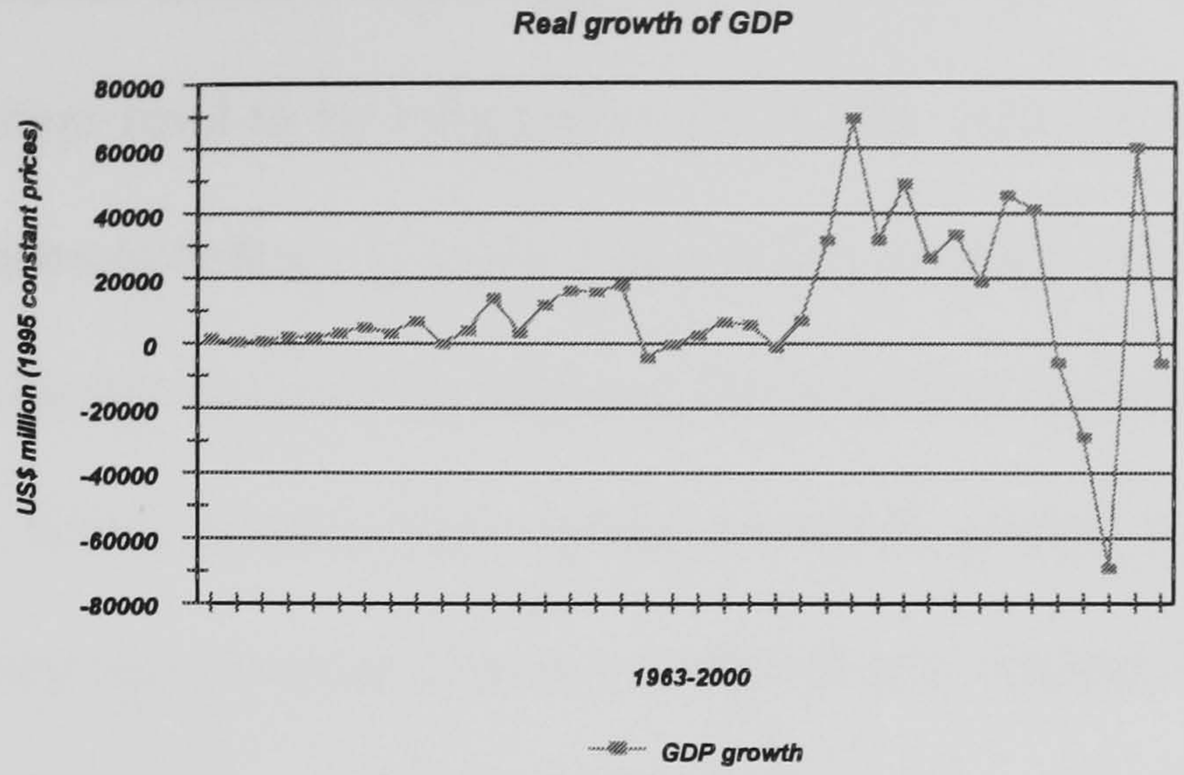
Sources: World Bank, *World Development Indicators* 2000 ; Korea National Statistical Office, *Korea Statistical Yearbook* 2000.

Figure 6.2. Real Defence Spending of South Korea, 1963-2000



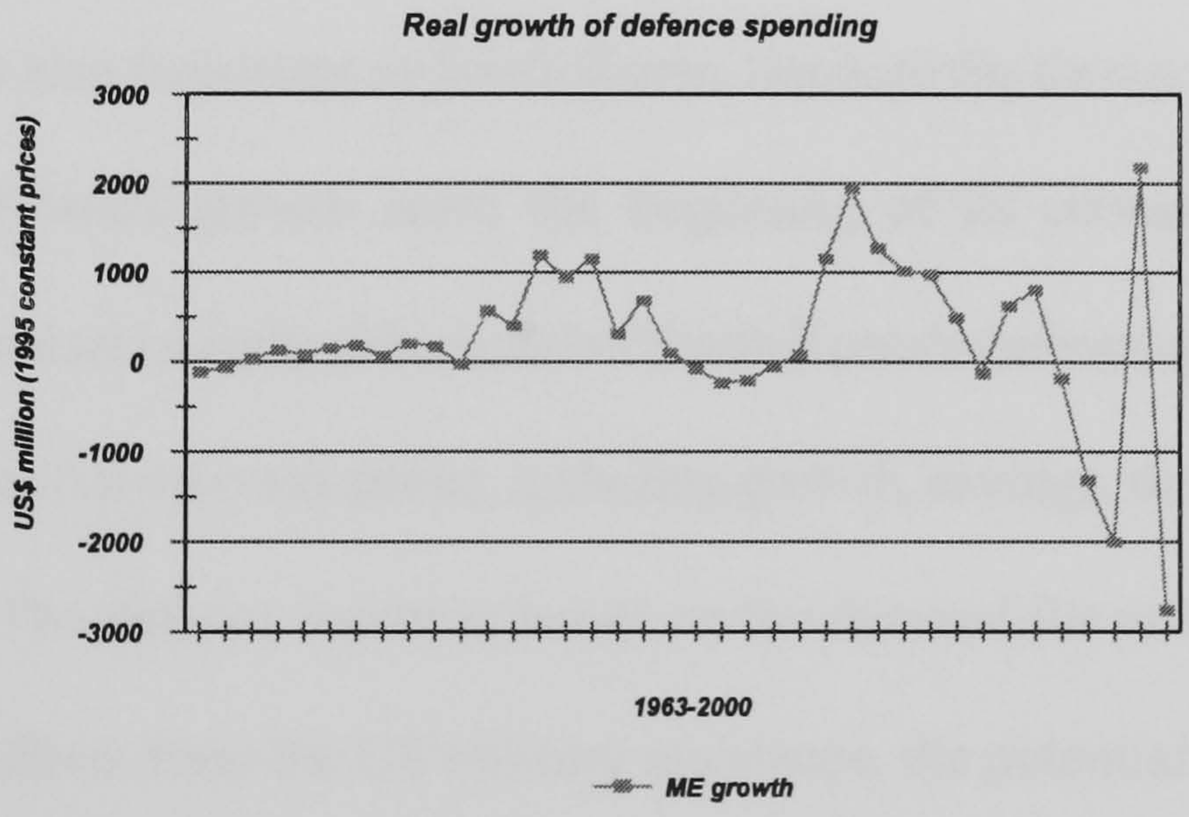
Sources: International Institute for Strategic Studies, *Military Balance*, various years; SIPRI, *SIPRI Yearbook,* various years, Ministry of National Defense, *Defense White Paper*, various years.

Figure 6.3. Real Growth of GDP in South Korea, 1963-2000



Sources: World Bank, *World Development Indicators* 2000 ; Korea National Statistical Office, *Korea Statistical Yearbook* 2000.

Figure 6.4. Real Growth of Defence Spending in South Korea, 1963-2000



Sources: International Institute for Strategic Studies, *Military Balance*, various years; SIPRI, *SIPRI Yearbook,* various years, Ministry of National Defense, *Defense White Paper*, various years.

6.3. SOUTH KOREA'S DEFENCE-GROWTH MODEL

In the analysis of South Korea's defence-growth relationship, its unique political and economic development need to be reflected in the model. First of all, one of the most important contributions of defence in South Korea is that it could stabilise the investment climate of the South Korean economy by deterring North Korea's threat and securing peace. In so doing, South Korea could achieve steady economic growth by inducing foreign investment and developing its civilian economy. Domestically, South Korea has maintained a relatively high savings ratio in spite of a high level of defence spending and thus could secure domestic investment. Some demand and supply-side models used investment instead of savings in their equations. But, in the output/expenditure function, saving equals investment, and most demand and supply-side studies, including Deger (1986a,b), Dunne and Nikolaidou (2001) and Sezgin (1999, 2001) used saving in their equations. Hence, savings equation will also be used in the South Korea's defence-growth model.

The trade balance is also important in South Korea, because the foreign trade has been an engine for South Korea's growth since the beginning of its economic development. Therefore, the demand and supply-side model of South Korea's defence-growth relationship comprises a four simultaneous equations, including growth, savings, the trade balance and defence equations. The defence equation based on the demand for military expenditures includes "spill-in" effects from the US military assistance, the potential threat from North Korea and also inter-state conflicts dummy between the South and North. Thus, the Deger's (1986a) demand and supply-side model needs to be modified to include these relevant variables describing South Korea's unique circumstances. The defence-growth model in South Korea can be represented by the following simultaneous equations:

$$g = a_0 + a_1 m + a_2 s + a_3 TB + a_4 L + a_5 H + a_6 T \tag{6.1}$$

$$s = b_0 + b_1 m + b_2 g + b_3 TB + b_4 NGE + b_5 i \tag{6.2}$$

$$TB = c_0 + c_1 m + c_2 g + c_3 EXCH + c_4 DUM_{econ} \tag{6.3}$$

$$m = d_0 + d_1 PCY + d_2 NGE + d_3 US + d_4 NK_{-1} + d_5 DUM_{ic} \tag{6.4}$$

where

g = real level of gross domestic product (GDP)

s = real level of domestic savings[1]

m = real level defence spending

TB= real level of trade balance

L= size of employed labour forces

H= ratio of students entering high school (%) (proxy for human capital investment)

T= civilian R&D expenditures to GDP (%) (proxy for technology)

NGE = share of non-military government expenditure in total government expenditures

i= inflation rate (%)

$EXCH$ = real exchange rate

PCY = real per capita GDP

US = share of US grant in the defence spending of the US-South Korean alliance (%)

NK_{-1} = North Korea's real defence spending in the previous year

DUM_{econ} = impulse dummy variable for South Korea's economic crises in 1980 and 1998

(DUM_{econ} = 0: no economic crisis; DUM_{econ} =-1: economic crisis)

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1 Investment (I) might be used instead of savings (s).

DUM_{ic} = dummy variable for Inter-Korean conflicts in the period 1963-2000.

(All endogenous variables are real terms (US$ in1995 constant prices) and a_0, b_0, c_0, d_0 are constants).

This model is based on the Deger (1986a) framework, but it is believed to be more applicable to industrial countries, such as South Korea. Unlike the Deger (1986a) model, this model considers the human capital and technology sectors in its growth equation (6.1) instead of the agricultural sector. It is believed that these sectors contribute more significantly to South Korea's growth than agriculture. The savings and trade balance equations ((6.2) and (6.3)) are little different from the Deger (1986a) model, but some additional variables, such as non-military government expenditures and the exchange rate are included to obtain more specific results. Also, the defence equation (6.4) representing the demand for defence spending includes income, spill-ins and threat factors. Additionally, it includes the conflict dummy between the South and North Korea, because this is considered as one of the important factors affecting South Korea's defence spending (Bae, 2003). This equation might be used not only for South Korea but also for other countries involved in an arms race or military alliance. Therefore, this model modifies and improves the Deger (1986a) and other demand and supply-side models by employing alternative explanatory variables to estimate the defence-growth relationship in South Korea.

Growth equation

The growth equation is derived from a traditional production function: $Y=f(K, L, T)$ where Y is output, K and L are capital and labour inputs and T is a measure of technology (Deger and Smith, 1983). The growth equation (g) (6.1) comprises four endogenous variables

(growth, saving, trade balance and defence spending) and three exogenous variables (employed labour forces, human capital and technology). Given these conditions, it is hypothesised that savings (s) and defence spending (m) have positive effects on growth, because the increase of saving raises investment and thus promotes economic growth. The increase of defence spending also contributes to growth through spin-offs and externalities for the rest of the economy in most developing countries (Deger and Sen, 1983; Deger and Smith, 1983; Deger, 1986a,b; Sezgin, 2001). By contrast, the sign for the coefficient of the trade balance is assumed to be negative, because net foreign capital inflows through a deficit of balance of payments might help economic growth (Deger 1986a). South Korea has depended heavily on foreign trade since the beginning of its economic development and the ensuing expansion of trade volume has played the role of locomotive for its economic growth. Especially, the rapid growth of exports contributed to the acceleration of GNP growth since the mid-1960s (Kim and Hong, 1997). On the other hand, the size of employed labour forces is expected to have a positive effect on growth as in other growth models (Deger and Sen, 1983; Deger and Smith, 1983; Faini *et al.*, 1984; Deger, 1986 a,b). Human capital investment is expected to have a positive effect on growth as Becker (1993) explained and technology (knowledge accumulation) is an important input increasing economic growth in the traditional Solow (1956, 1957, 1960) production function. The size of the labour force and human capital investment are not multi-collinear, because the human capital investment is expressed as the ratio of students entering high school. Therefore, all exogenous variables are expected to have a positive effect for South Korea's growth equation.

Savings equation

The savings function is derived from the output/expenditure relation: $Y= C+I+M-A$ where Y is total output, C is civilian consumption, I is total civilian investment, M is defence spending, and A is net capital flows (Deger and Smith, 1983; Sezgin, 1999; Dunne and Nikolaidou, 2001).Total civilian investment can be replaced by total savings (s).The savings equation (s: 6.2) includes three independent endogenous variables (growth, trade balance and defence) and two exogenous variables (non-military government expenditure and inflation). High economic growth might raise savings and accumulate resources for investment in terms of the life-cycle theories of consumption (Deger, 1986a,b; Lebovic and Ishaq, 1987; Dunne and Nikolaidou, 2001; Sezgin, 2001). Therefore, it is generally assumed that growth also promotes savings. Defence is expected to have a negative effect on savings by reallocating saving away from more productive private and public investment, and impede growth (Deger, 1986a,b), although South Korea has maintained a relatively high gross savings ratio (average 35% for the 1990s) compared with other developing countries. South Korea might have achieved a higher savings ratio if it had not spent so much on defence. However, Benoit (1978) argued that defence does not give a significant negative impact on savings, because only a small part of income not spent on defence goes to highly productive investment. Most income is spent on less productive social investment and consumption for consumer satisfaction. Sezgin's (2001) recent studies on Turkey show that the effects of defence on savings are insignificant in the simultaneous equation model. Despite Benoit's finding, defence is generally assumed to negatively affect savings in South Korea, even though its savings ratio has been high. The trade balance is expected to have a positive effect on savings through either income-multipliers or trade taxes (Deger 1986a; Scheetz, 1991; Sezgin, 2001). Non-military

government expenditure (*NGE*) is assumed to potentially affect government savings and investment decisions (Roux, 1996).[2] The increase of non-military government expenditures (*NGE*) might reduce the government savings and have a negative effect on the total savings. Inflation is expected to have a positive effect on savings by causing "forced savings" according to Deger (1986a).

Trade Balance equation

The trade balance equation (*TB*) (6.3) contains two independent endogenous variables, defence spending (*m*) and growth (*g*), and an exogenous variable, real exchange rate (*EXCH*), and an impulse dummy variable for the economic crises in 1980 and 1998. The trade balance equation represents two other equations, export and import equations, but Deger-type demand and supply-side models employ the trade balance to estimate the effect of defence on growth via the balance of payments (net capital flow) in the open economy. Defence spending is generally assumed to have a negative effect on the trade balance by increasing aggregate demand and constraining domestic supply. The subsequent reduction of exports might increase imports and lead to a deterioration in the balance of payments (Deger 1986a; Scheetz, 1991; Sezgin, 2001). However, it should be considered that US military aid was large until the mid-1970s. The US military transfer might contribute to alleviating the negative effect of defence on the trade balance in South Korea. Growth is expected to positively affect the trade balance, because South Korea has been one of the major countries pursuing export-promoting strategies. On the other hand, the exchange rate

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2 As the result of empirical tests, Roux (1996) found that both defence spending and non-military government expenditures had a negative effect on growth in South Africa for the period 1960-1990. The size of coefficient is -1.51 for defence spending and -0.87 for non-military government expenditures. By contrast, defence spending and non-military government expenditures had no significant effect on savings.

is expected to be positively correlated to the trade balance. The exports and imports of South Korea have been affected by the change of exchange rate since its economic development. It is considered that the exchange rate to the US Dollar and Japanese Yen is a major determinant of South Korea's trade balance. That is, when the rate is high (devaluation of domestic currency), generally, exports are increased and imports are decreased. In contrast, the revaluation of domestic currency tends to reduce the exports and raise imports. Hence, in general, the devaluation of domestic currency (Won) improves the balance of trade in South Korea. On the other hand, the impulse dummy variables represent the impact of economic crises in 1980 and 1998 on the trade balance. The sudden death of President Park- who ruled South Korea for 18 years- in 1979 led the country to unexpected political turmoil. In 1980, South Korea experienced another *coup* and the military leader came to power. However, during this period, South Korea underwent a serious economic recession. It has rapidly recovered since 1981 and so continued its growth. At the end of 1997, South Korea met another crisis which came from the misjudgement of foreign exchange management and failure of foreign investment, especially, in Asian countries. Since 1999, the South Korean economy has rapidly recovered and achieved about 9.0% annual GDP growth in 2000.[3]

Defence equation

The general functional form of the demand for defence spending is: $M = M$ *(INCOME, SPILL, THREAT, PRICES)* where M is defence spending, *INCOME* is a measure of real national income, *SPILL* is the real defence spending of allies, *THREAT* is the defence

3 Although South Korea achieved a high GDP growth rate in 2000, the real GDP rather decreased due to the devaluation of domestic currency. As shown in Figure 6.1, the real GDP indicated by US dollar slightly decreased.

spending of the enemy, and *PRICES* is the relative price of defence as compared with non-military goods (Sandler and Hartley, 1995; Solomon, 2003). Based on this general demand function, the defence equation (*m*) (6.4) consists of the explanatory variables, namely, per capita GDP, non-military government expenditure, US military aid and the North Korean threat. Per capita GDP is assumed to be positively correlated to South Korea's defence spending in spite of the public good nature of defence spending (Deger and Smith, 1983; Deger, 1986a,b), because the defence budget has rapidly increased with its speedy economic development. In terms of the positive relationship between GDP and defence spending, defence might be regarded as a normal good, because demand rises with income (Sandler and Hartley, 1995). However, non-military government expenditure is expected to have a negative effect on defence as the increase of non-military government expenditures should generally entail the reduction of the share of defence spending in total government expenditures. In fact, the South Korean government spent approximately 30-35% of total government expenditures on defence until the late 1980s, but it decreased to 17% in 2000. As shown in Chapter II, through the Spearman test, it was found that defence had some trade-off relationships with social welfare and other public investments. US military aid is generally assumed to be negative to South Korea's defence spending, because South Korea could benefit from the US military grant (free-riding) and save resources for defence to invest in its economic development instead. But, the free ride[4] of South Korea ended in the early 1980s when it began to share the costs for the presence of US troops with USA (Hamm, 1999). As shown in Chapter IV, North Korea's lagged defence spending might affect the decision of South Korea's defence spending in the present year. South

4 It is difficult to say that South Korea enjoyed a complete "free ride" owing to US military aid, because it has maintained a high level of defence spending. But it's military power was absolutely inferior to North Korea's until the mid-1970s, and thus South Korea's rapid economic development might be impossible without US military support due to the heavy defence burden.

Korea has always been sensitive to the North Korean threat since the Korean War and this should be included in the defence equation. Therefore, it is expected to be positively correlated to South Korea's defence spending. The conflict factor is also expected to have a positive and significant effect on South Korea's defence spending (Bae, 2003; Galvin, 2003). Table 6.1 shows the hypotheses for the possible effects of each explanatory variable on growth, saving, the trade balance and defence spending.

Table 6.1. Predicted Effects for the South Korea's Defence-Growth Model

Dependent	Growth	Savings	Trade Balance	Defence
Coefficient	Savings(s) + Defence(m) + Trade Balance (TB) – Labour forces (L) + Human capital (H) + Technology (T) +	Defence (m) – Growth (g) + Trade Balance (TB) + Non-military GE (NGE) – Inflation (I) +	Defence (m) – Growth (g) + Exchange rate (EXCH) + Economic crisis (DUM*econ*) –	Per capital GDP (PCY) + Non-military government expenditures (NGE) – US military aid (US) – North Korean threat (NK) + Inter-Korean conflict (DUM*ic*) +

6.4. EMPIRICAL RESULTS

6.4.1. Test of the Deger (1986a) Model

Before the test of my defence-growth model, Deger's (1986a) original model will be estimated for South Korea. Deger's (1986a) model is represented in the Equations (5.10)-(5.13) in Chapter V. She used the three-stage least squares (3SLS) for the 55 LDCs tests and hence, South Korea is also examined using the same empirical method to compare both

results. The aim of this test is to show whether my model is a better fit than Deger's (1986a) for South Korea's defence-growth relationship. As shown in Table 6.2, the empirical results of defence-growth relationship in South Korea applying Deger's (1986a) model are very different from her original expectations explained in Chapter V.

Table 6.2. Test of Deger's (1986a) Model for South Korea

Sample		Cross-Sectional LDCs (Deger)	South Korea
Equation	Variables	Coefficients & t-statistics	Coefficients & t-statistics
Growth	Intercept	-4.2 (-1.56)	9.14 (3.23)***
	s	0.58 (3.37)†	- 0.30 (-4.33)***
	m	0.29 (2.50)†	0.81(1.64)
	B	-0.15 (-1.75)	0.08 (1.58)
	y	-0.14 (-1.75)	0.01 (6.81)***
	A	0.19 (1.85)	-0.04 (-0.59)
	R^2	0.32	0.63
Savings	Intercept	12.5 (6.91)†	19.87 (4.46)***
	m	-0.56 (-3.72)†	2.38 (2.59)***
	g	0.74 (2.42)†	-1.65 (-6.34)***
	yg	0.038 (3.92)†	0.30 (7.68)***
	B	0.32 (4.22)†	0.10 (0.83)
	i	-1.75 (-0.56)	-0.11 (-0.84)
	R^2	0.79	0.74
Trade balance	Intercept	-2.33 (-0.86)	-1018.65 (-0.12)
	m	-2.45 (-2.88)†	402.50 (0.22)
	g	1.22 (3.08)†	360.64 (0.51)
	i	0.16 (0.032)	-395.40 (-2.26)**
	D1	41.5 (7.08)†	-
	D2	23.6 (0.92)	-
	Decon		-21513.90 (-1,89)*
	R^2	0.67	0.25

Defence	Intercept	1.47 (1.52)	13.40 (3.66)***
	y	0.15 (2.80)†	-0.38 (-5.30)***
	GB	0.16 (3.07)†	0.25 (1.04)
	N	0.0042 (1.32)	-0.17 (-3.22)***
	q	-0.25 (2.52)†	-
	D1	4.02 (3.42)†	-
	D2	11.2 (10.2)†	-
	USAID		-0.68 (-8.15)***
	NKLAG		0.41 (1.53)
	R^2	0.87	0.79

*** 1% level of significance ** 5% level of significance * 10% level of significance

Notes: 1. Numbers in the parentheses are *t*-statistics of each variable.

2. In the test of Deger (1986a), the level of significance is unknown. † only indicates that the variable is statistically significant.

3. g= annual growth of GDP; s= national savings ratio; m= annual growth of military expenditures; y= *per capita* income; B= balance of trade; A= annual growth rate of agriculture; i= inflation rate; D1= dummy for capital surplus oil-exporting countries; D2= dummy for war economies: Israel, Jordan, South Vietnam, Egypt, Syria; Decon= dummy for economic crises in South Korea; GB= growth rate of government spending; N= total population; q= difference between *per capita* income among countries; USAID= US military aid to South Korea; NKLAG= military expenditures of North Korea in the previous year (South Korea's data are 1995 constant prices).

Deger's (1986a) tests for the 55 LDCs showed the positive effect of defence spending on growth and its negative effect on savings, but it is found that the expected signs of coefficients are non-significant or completely different in South Korea. Furthermore, the R^2 s of the growth and trade balance equations are generally low. The R^2 of the growth equation in Deger's (1986a) tests was lower at 0.32 and this indicates that the choice of independent variables does not fit well for the model. Other variables, such as growth in the savings equation and per capita income in the defence equation have different signs from our previous expectations. This might be caused by the difference between cross-sectional and time-series data. Hence, it is found that Deger's (1986a) original model is not appropriate for South Korea. Also, the choice of explanatory variables, such as agriculture is problematic, because it is not an important variable for the growth in industrialised countries, such as South Korea. Consequently, the new defence-growth model for South

Korea is expected to increase the goodness of fit of equations and improve the explanatory variables by considering the specific circumstances surrounding South Korea.

6.4.2. Test of South Korea's Defence-Growth Model

6.4.2.1. Period 1963-2000

Three different statistical methods are applied to examine the effects of defence spending on economic growth in South Korea. As mentioned earlier, ordinary least squares (OLS), two-stage least squares (2SLS) and three-stage least squares (3SLS) methods will be used to obtain more consistent empirical results. In the estimation of over-identified structural equation belonging to a simultaneous equation system, the two-stage least squares (2SLS) method could lead to a consistent estimation (Kmenta, 1986; pp.681). However, the application of three-stage least squares (3SLS) might bring more efficient results than the use of single equation method by avoiding the interrelationships between the variables and disturbances across equations, although 3SLS method needs both perfect information and much data in the simultaneous equation model. Most demand and supply-side studies using simultaneous equations (Deger, 1986a,b; Scheetz, 1991; Dunne and Nikolaidou, 2001; Sezgin, 2001) apply 3SLS method to obtain more specific and unbiased results. Thus, it is believed that single equation methods(OLS and 2SLS) are not enough for satisfactory empirical tests and the application of 3SLS is more effective in the analysis of defence-growth relationship in South Korea. As shown in Table 6.3, the test of real level data using OLS estimation provides high R^2 s except for the trade balance equation. According to the real level tests, defence spending and civilian R&D have a negative effect on South Korea's growth.

Table 6.3. Empirical Results of South Korea's Defence-Growth Relationship Using Real Levels

Variable	Equation			
	Growth	Savings	Trade Balance	Defence
Intercept	-78964.80 (-4.41)***	-39087.70 (-1.11)	-15212.90 (-1.05)	6281.65 (2.31)**
m	-3.93 (-1.86)*	1.40 (0.90)	-0.26 (-0.18)	-
g	-	0.31 (5.83)***	-0.02 (0.59)	-
s	2.71 (21.72)***	-	-	-
TB	-0.45 (-2.81)***	-0.09 (0.87)	-	-
L	8.41 (3.87)***	-	-	-
H	1078.32 (7.47)***	-	-	-
T	-37162.60 (-3.96)***	-	-	-
NGE	-	431.53 (0.95)	-	-51.60 (-1.40)
i	-	-51.83 (-0.34)	-	-
EXCH	-	-	12.04 (1.05)	-
PCY	-	-	-	1.15 (14.78)***
US	-	-	-	-40.77 (-5.11)***
NKLAG	-	-	-	0.10 (1.25)
DUM*econ*	-	-	13084.52 (1.59)	-
DUM*ic*	-	-	-	-120.65 (-0.84)
R^2	0.998	0.992	0.094	0.994
Durbin-Watson	1.115	0.364	0.982	0.739

*** 1% level of significance ** 5% level of significance * 10% level of significance

Notes: 1. Numbers in the parentheses are *t*-values of each variable.
2. g= real gross domestic product (GDP); s= real domestic savings; m= real defence spending; TB= real trade balance; L= size of employed labour forces; H= human capital investment; T= civilian R&D expenditures to GDP; NGE= share of non-military government expenditures in total government expenditures; i= inflation rate; EXCH= real exchange rate; PCY = real per capita GDP; US= share of US grant in the total defence spending of US-South Korean alliance; NKLAG= real North Korean defence spending in the previous year; DUM*econ*= impulse dummy variable for economic crises in 1980 and 1998; DUM*ic*= dummy variable for Inter-Korean conflicts for the period 1963-2000 (All figures are 1995 constant prices).

However, the low Durbin-Watson statistics show serial correlations, and as the result of Augmented Dickey-Fuller test, most real levels are found to be non-stationary. Accordingly, all the variables should be first differenced to avoid serial correlations and non-stationary problems. Dickey-Fuller unit root test in Table 6.4 shows that first-differenced variables are stationary. Hence, it is necessary to use the first-differenced form to estimate South Korea's defence-growth relationship more accurately. The empirical results representing the defence-growth relationship of South Korea for the period 1963-2000 are shown in Table 6.5.

Table 6.4. Augmented Dickey-Fuller Test for Unit Roots

Variables	Test Statistics		Critical Values (Levels)			Critical Values(1st differences)		
	Levels	1st differences	1%	5%	10%	1%	5%	10%
g	-3.38	-3.75	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
s	-2.90	-4.21	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
m	-4.02	-3.79	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
TB	-7.48	-7.93	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
L	-2.09	-5.26	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
H	-3.53	-5.18	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
T	-3.21	-6.57	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
i	-6.31	-9.30	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
NGE	-5.19	-5.42	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
US	-3.77	-6.15	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
NK	-3.05	-5.56	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
PCY	-3.29	-3.76	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20
EXCH	-5.41	-6.47	-4.24	-3.54	-3.20	-4.25	-3.55	-3.20

Note: The trend and intercept are included in this unit root test (E-Views 3.1).

Table 6.5. Empirical Results of Defence-Growth Model in South Korea (1963-2000)

Equation	Variables	Estimation Method		
		OLS	2SLS	3SLS
Growth equation	Intercept	114.10	1305.02	1305.02
		(0.07)	(0.82)	(0.82)
	Δ m	6.08	4.57	4.57
		(3.41)***	(1.57)	(1.57)
	Δ s	1.82	2.00	2.00
		(13.12)***	(7.59)***	(7.59)***
	Δ TB	-0.65	-0.77	-0.77
		(-6.25)***	(-4.22)***	(-4.22)***
	Δ L	-3.92	-6.88	-6.88
		(-1.22)	(-1.87)*	(-1.87)*
	ΔH	246.83	274.32	274.32
		(1.66)*	(1.60)*	(1.60)*
	ΔT	3079.78	2823.73	2823.73
		(3.61)***	(2.80)***	(2.80)***
	R-Square	0.98	0.97	0.97
	DW	1.65	1.68	1.68
Savings equation	Intercept	-1134.32	-882.65	-882.65
		(-2.18)**	(-1.60)	(-1.60)
	Δ m	-0.46	0.85	0.85
		(-0.36)	(0.50)	(0.50)
	Δ g	0.44	0.38	0.38
		(10.90)***	(6.89)***	(6.89)***
	Δ TB	0.27	0.19	0.19
		(4.55)***	(2.19)**	(2.19)**
	Δ NGE	-130.23	-58.18	-58.18
		(-0.68)	(-0.30)	(-0.30)
	Δ i	23.25	20.64	20.64
		(0.36)	(0.33)	(0.33)
	R-Square	0.93	0.92	0.92
	DW	1.33	1.65	1.65
Trade Balance equation	Intercept	1853.80	1748.20	1748.20
		(1.42)	(1.44)	(1.44)
	Δ m	-6.70	-5.61	-5.62
		(-2.40)**	(-1.53)	(-1.53)
	Δ g	-0.01	-0.32	-0.32
		(-0.08)	(-0.27)	(-0.27)
	Δ EXCH	-23.19	-22.59	-22.59
		(-3.35)***	(-3.44)***	(-3.44)***
	Δ DUMecon	-16057.68	-16182.63	-16182.63
		(-3.49)***	(-3.75)***	(-3.75)***
	R-Square	0.65	0.65	0.65
	DW	1.73	1.76	1.76

(*Cont.*) Table 6.5.

Equation	Variables	Estimation Method		
		OLS	2SLS	3SLS
Defence equation	Intercept	-123.92	-12.67	-12.67
		(-1.76)	(-0.18)	(-0.18)
	Δ PCY	1.02	1.20	1.20
		(9.08)***	(11.20)***	(11.20)***
	Δ NGE	-17.92	-35.69	-35.69
		(-0.88)	(-1.72)*	(-1.72)*
	Δ US	-20.75	-22.15	-22.15
		(-2.35)**	(-2.30)**	(-2.30)**
	Δ NKLAG	0.08	0.97	0.97
		(1.46)	(1.60)*	(1.60)*
	Δ DUMic	372.67	94.09	94.09
		(3.39)***	(0.93)	(0.93)
	R-Square	0.89	0.85	0.85
	DW	1.37	1.32	1.32

*** 1% level of significance ** 5% level of significance * 10% level of significance

Notes: 1. Numbers in the parentheses are *t*-values of each variable.
2. Δ g= real growth of gross domestic product (GDP); Δ s= real growth of domestic savings; Δ m= real growth of defence spending; Δ TB= real growth of trade balance; Δ L= size of employed labour forces (first difference); Δ H= human capital investment (first difference); Δ T= civilian R&D expenditures to GDP (first difference); Δ NGE= share of non-military government expenditures in total government expenditures (first difference); Δ i= inflation rate (first difference); Δ EXCH= real exchange rate (first difference); Δ PCY = real growth of per capita GDP; Δ US= share of US grant in the total defence spending of US-South Korean alliance (first difference); Δ NKLAG= real growth of North Korean defence spending in the previous year; DUM*econ*= impulse dummy variable for economic crises in 1980 and 1998; DUM*ic*= dummy variable for Inter-Korean conflicts for the period 1963-2000.
3.OLS tests have been carried out by SPSS 10.1., and the results from 2SLS and 3SLS tests have been computed by LIMDEP 7.0.

(i) Growth equation

Table 6.5 shows the test results for the period 1963-2000. In the growth equation, domestic savings, human capital investment and civilian technology have a positive and significant effect on South Korea's economic growth in its 2SLS and 3SLS estimations. On the other hand, the trade balance and the size of the labour force have a negative effect on growth in both estimations, although the size of the labour force does not show any significant relationship with growth in the OLS estimation. The negative effect of the size of the labour force on growth is different from our expectations shown in Table 6.1, but the level of significance is relatively low at 10%. This is an unexpected result because most previous studies (Deger 1986a,b; Dunne and Nikolaidou, 2001; Sezgin, 2001) find a positive and significant relationship between the size of the labour force and growth in their empirical tests. Defence spending is found to have no significant direct effect on growth, although South Korea's defence spending is expected to have a positive direct effect on its growth. The R^2 of 0.97 shows a high overall significance of the growth equation and the DW of 1.68 indicates no evidence of autocorrelation. Thus, as predicted, it is found that savings, human capital and civilian R&D investment have played an important role in South Korea's growth.

(ii) Savings equation

In the savings equation, growth and the trade balance have a positive and significant impacts, while other factors are all insignificant. The trade balance has a positive and significant effect on savings in all estimations. But, no meaningful relationship between defence spending and savings is found in this test. Most demand and supply side studies

(Deger and Smith, 1983; Deger, 1986a,b; Levobic and Ishaq, 1987) support the negative indirect effect of defence on economic growth via savings, but our test results do not correspond with these results. Therefore, it is found that defence spending has not crowded out the resources for savings and investment in South Korea for the sample period. Growth is positively correlated to savings and hence it is found that growth raises savings as well as savings stimulate growth in South Korea. By contrast, the relationship between non-military government spending and savings is not clearly defined. Roux (1996), and Dunne and Nikolaidou (2001) applied non-military government spending to the savings equation as an exogenous variable, but they could not find any meaningful relationship between these two sectors. Our test results are also insignificant like previous studies and therefore, it is concluded that there is no significant relationship between the non-military government spending and savings in South Korea. Inflation is expected to have a positive effect on savings by causing forced savings in the developing countries according to Deger (1986a,b), but it is found that in South Korea, this is not the case. Inflation has no significant effect on savings in South Korea. In addition, the overall R^2 is also high at 0.92 and the DW test shows no evidence of autocorrelation.

(iii) Trade Balance equation

In the trade balance equation, it is found that defence spending has a significant and negative effect on the trade balance only in the OLS estimation. This is in accordance with our expectations in Table 6.1. Nevertheless, it shows no significant relationship with the trade balance in both 2SLS and 3SLS estimations. Also, according to Deger (1986a), growth is supposed to have a positive relationship with the trade balance, because South Korea has consistently pursued export-promoting strategies in its development process.

However, it is found that there is no significant relationship between the growth and trade balance in our tests. By contrast, the effect of exchange rate on the trade balance is found to be negative. It was expected to be positive in our hypotheses, because the devaluation of domestic currency stimulates exports and capital inflows, and thus might improve the balance of payments. However, it is found that the exchange rate is rather negatively correlated to the trade balance in South Korea. The impulse dummy variable for the economic crises in 1980 and 1998 is found to have a negative effect on the trade balance. The R^2 of the trade balance equation is relatively low at 0.65 compared with other equations, but it is acceptable. Also, the Durbin-Watson *d* statistic is 1.76, so there is no autocorrelation. In conclusion, from the simultaneous equation tests, it is found that defence spending has no significant effect on the trade balance in South Korea for the period 1963-2000.

(iv) Defence equation

The defence equation reflects the unique situation of South Korea. Through the test, it is found that per capita GDP, North Korea's defence spending and the dummy for inter-Korean conflicts have a significant positive relationship with South Korea's defence spending, although the conflict factor is significant only in the OLS estimation. By contrast, US military grants to South Korea and non-military government spending are negatively correlated to South Korea's defence spending. In Chapter IV, it was found that real US military aid to South Korea has no significant effect on the change of South Korea's defence spending. However, in this test, the share of US military aid in the total defence spending of US-South alliance is found to be negatively correlated to the South Korean defence spending. In other words, South Korea's defence spending is affected by the share of US

military aid in the total defence spending of US-South alliance rather than real level of US military aid. On the other hand, it is also found that the growth of North Korea's defence spending has a positive and significant effect on South Korea's defence spending. In Chapter IV, it was proven that North Korea's defence spending has a positive effect on the South's defence spending. Hence, the defence spending of North Korea has been a significant factor determining South Korea's defence spending in this period. As predicted, non-military government expenditures have a significant and negative relationship with South Korea's defence spending in the simultaneous equation test. In Chapter II, the increase of non-military public expenditure reallocated resources from defence to other sectors, such as social welfare and other public services in South Korea. Therefore, it is found that South Korea's defence spending has been stimulated by income, threat and conflict for the period 1963-2000. However, aid from the alliance (spill-in) and non-military government spending have a negative effect in this period.

In conclusion, the expected signs are confirmed by our empirical results except for the exchange rate. Through the results, it is found that defence spending has no significant relationship with economic growth in South Korea for the period 1963-2000. It has no direct and positive effect on growth, and also has no indirect and negative effect on growth via savings and the trade balance in South Korea. Therefore, it is concluded that South Korea's defence spending neither promoted nor impeded its growth for the period 1963-2000.

6.4.2.2. Sub-Period 1963-1979

South Korea's economic development is divided into two different periods according to its

development stage and defence policy. The period 1963-1979 is regarded as a developing stage, because its per capita GDP is not sufficient to be a semi-developed country. Also, South Korea's defence is expected to have a greater effect on its economy by focussing more on the "self-reliant" system in this period. Table 6.6 shows the empirical results of the defence-growth relationship in South Korea during its developing stage.

The empirical tests for the period 1963-1979 show different results from those for the period 1963-2000 (Table 6.5.). In the growth equation, it is found that defence spending has a positive and direct effect on South Korea's economic growth in its developing stage, but the human capital and civilian R&D investment have no significant effect on its growth. It is believed that the effects of defence on growth are stronger than those of human capital and civilian R&D in this period. In fact, civilian R&D investment was relatively low in the developing stage. Also, as predicted, savings have a significant positive effect on growth, while the trade balance has a negative effect on growth in both single equation and 3SLS estimations.

In the savings equation, both the growth and trade balance have a positive and significant effect on savings, but other variables are irrelevant to the savings. Defence spending is found to have no significant effect on savings. Therefore, for the period 1963-1979, it is found that defence spending did not crowd-out the resources for savings in South Korea. Non-military government expenditure and the inflation rate have no significant effects on savings.

Table 6.6. Empirical Results of Defence-Growth Model in South Korea (1963-1979)

Equation	Variables	Estimation Method		
		OLS	2SLS	3SLS
Growth equation	Intercept	2001.85	6428.80	6428.80
		(0.61)	(1.67)*	(1.67)*
	Δ m	6.79	9.33	9.33
		(2.18)*	(2.56)**	(2.56)**
	Δ s	1.14	1.66	1.66
		(2.47)**	(3.38)***	(3.38)***
	Δ TB	-1.12	-1.27	-1.27
		(-3.62)***	(-3.87)***	(-3.87)***
	Δ L	-4.09	-9.99	-9.99
		(-0.82)	(-1.56)	(-1.56)
	ΔH	187.67	229.01	229.01
		(0.77)	(0.99)	(0.99)
	ΔT	2334.71	-7449.96	-7449.96
		(0.31)	(-0.93)	(-0.93)
	R-Square	0.94	0.92	0.92
	DW	1.93	1.81	1.81
Savings equation	Intercept	-431.23	-550.99	-550.99
		(-1.02)	(-1.48)	(-1.48)
	Δ m	0.45	-0.75	-0.75
		(0.24)	(-0.04)	(-0.04)
	Δ g	0.38	0.45	0.45
		(2.84)**	(3.29)***	(3.29)***
	Δ TB	0.47	0.67	0.67
		(1.95)*	(2.37)**	(2.37)**
	Δ NGE	4.83	41.66	41.66
		(0.04)	(0.39)	(0.39)
	Δ i	9.75	20.61	20.61
		(0.28)	(0.67)	(0.67)
	R-Square	0.85	0.84	0.84
	DW	1.64	1.47	1.47
Trade Balance equation	Intercept	629.56	638.48	638.48
		(1.19)	(1.36)	(1.36)
	Δ m	6.03	5.26	5.26
		(4.24)***	(3.54)***	(3.54)***
	Δ g	-0.48	-0.44	-0.44
		(-5.20)***	(-4.92)***	(-4.92)***
	Δ EXCH	-0.27	-0.50	-0.50
		(-0.11)	(-0.24)	(-0.24)
	R-Square	0.68	0.67	0.67
	DW	2.22	2.01	2.01

(*Cont.*) Table 6.6.

Equation	Variables	Estimation Method		
		OLS	2SLS	3SLS
Defence equation	Intercept	-83.64	-23.08	-23.08
		(-0.93)	(-0.36)	(-0.36)
	Δ PCY	1.38	1.42	1.42
		(3.34)***	(4.14)***	(4.14)***
	Δ NGE	-33.55	-48.55	-48.55
		(-1.62)	(-3.23)***	(-3.23)***
	Δ US	-16.47	-13.62	-13.62
		(-2.00)*	(-1.82)*	(-1.82)*
	Δ NKLAG	-0.08	0.95	0.95
		(0.59)	(0.79)	(0.79)
	Δ DUMic	186.86	153.13	153.13
		(1.48)	(1.35)	(1.35)
	R-Square	0.82	0.80	0.80
	DW	1.79	1.61	1.61

*** 1% level of significance ** 5% level of significance * 10% level of significance

Notes: 1. Numbers in the parentheses are *t*-values of each variable.
2. Δ g= real growth of gross domestic product (GDP); Δ s= real growth of domestic savings; Δ m= real growth of defence spending; Δ TB= real growth of trade balance; Δ L= size of employed labour forces (first difference); Δ H= human capital investment (first difference); Δ T= civilian R&D expenditures to GDP (first difference); Δ NGE= share of non-military government expenditures in total government expenditures (first difference); Δ i= inflation rate (first difference); Δ EXCH= real exchange rate (first difference); Δ PCY = real growth of per capita GDP; Δ US= share of US grant in the total defence spending of US-South Korean alliance (first difference); Δ NKLAG= real growth of North Korean defence spending in the previous year; DUM_{econ}= impulse dummy variable for economic crises in 1980 and 1998; DUM_{ic}= dummy variable for Inter-Korean conflicts for the period 1963-2000.
3.OLS tests have been carried out by SPSS 10.1., and the results from 2SLS and 3SLS tests have been computed by LIMDEP 7.0.

The trade balance is affected by the defence spending and growth. Surprisingly, defence spending has a positive effect on the trade balance in this period, while growth is found to be negatively correlated to the trade balance. The negative effect of growth on the trade balance might be caused by the chronic trade deficit of South Korea. South Korea's trade volume was increased with its rapid growth, but its trade deficit was also increased in this period.

The test results of defence equation are very different from those of the period 1963-2000. North Korea's defence spending and inter-Korean conflicts are changed to be non-significant to South Korea's defence spending for the period 1963-1979. These are unexpected results, because it is believed that the arms race between the South and North was more intense in this period. The trade-off relationship between defence spending and non-military government budget is also found to be significant in this period. US military aid is found to have a negative and significant effect on South Korea's defence spending and shows an evidence of free-riding. As the result of the test for the period 1963-1979, it is found that South Korea's defence spending had an overall positive effect on its growth both directly and indirectly in its developing stage. As shown in Table 6.6, the equations have high R^2 s at the range of 0.67-0.92 and the DW tests show no autocorrelation.

6.4.2.3. Sub-Period 1980-2000

Table 6.7 represents the empirical results of South Korea's defence-growth relationship for the period 1980-2000. The test results show that defence spending has a positive and direct effect on South Korea's economic growth in both single and simultaneous equation tests.

The human capital and civilian R&D investment (technology) have also significant effect on its growth in the semi-developed or developed stage. The size of the labour force did not help South Korea's growth like other periods. This implies that South Korea's growth depended more on the development of technology and education than the simple increase of the size of the labour force. Savings and the trade balance have also a positive and negative effect on growth respectively in both single equation and 3SLS estimations.

In the savings equation, both the growth and trade balance have the same positive effect on savings and other variables are insignificant for the savings. Defence spending is found to have no significant effect on savings. Hence, defence spending had no indirect and negative effect on growth via savings in this period. Non-military government expenditure and the inflation rate are not significant like other periods.

In the trade balance equation, defence spending has a significant negative effect on the trade balance unlike the developing stage. The negative effect of defence on the trade balance might be caused by South Korea's import-substitution defence policy in this period. Since the 1980s, South Korea has depended heavily on the import of weapons and became a major importer of defence equipment in the world defence market. The exchange rate and dummy variable for economic crises have a negative effect on the trade balance. The negative effect of the exchange rate on the trade balance implies that the devaluation of local currency did not raise the balance of trade.

Table 6.7. Empirical Results of Defence-Growth Model in South Korea (1980-2000)

Equation	Variables	Estimation Method		
		OLS	2SLS	3SLS
Growth equation	Intercept	-6310.70	-5265.24	-5265.24
		(-1.66)	(-1.60)	(-1.60)
	Δ m	7.91	7.68	7.68
		(2.99)***	(2.78)***	(2.78)***
	Δ s	1.78	1.82	1.82
		(9.13)***	(8.17)***	(8.17)***
	Δ TB	-0.51	-0.63	-0.63
		(-3.37)***	(-4.24)***	(-4.24)***
	Δ L	-1.90	-5.07	-5.07
		(-0.42)	(-1.25)	(-1.25)
	ΔH	317.64	304.94	304.94
		(1.60)	(1.67)*	(1.67)*
	ΔT	5418.54	5460.29	5460.29
		(3.15)***	(3.79)***	(3.79)***
	R-Square	0.98	0.98	0.98
	DW	1.92	1.92	1.92
Savings equation	Intercept	-1707.28	-1610.09	-1610.09
		(-1.56)	(-1.57)	(-1.57)
	Δ m	-1.48	-1.35	-1.35
		(-0.70)	(-0.62)	(-0.62)
	Δ g	0.47	0.46	0.46
		(7.37)***	(6.33)***	(6.33)***
	Δ TB	0.27	0.26	0.26
		(2.93)**	(2.65)***	(2.65)***
	Δ NGE	-127.41	-114.88	-114.88
		(-0.26)	(-0.27)	(-0.27)
	Δ i	102.91	111.03	111.03
		(0.47)	(0.60)	(0.60)
	R-Square	0.94	0.94	0.94
	DW	1.15	1.18	1.18
Trade Balance equation	Intercept	-1169.95	-65.15	-65.15
		(-0.51)	(-0.03)	(-0.03)
	Δ m	-14.08	-8.99	-8.99
		(-3.67)***	(-1.91)*	(-1.91)*
	Δ g	0.24	0.84	0.84
		(1.78)*	(0.53)	(0.53)
	Δ EXCH	-49.51	-45.60	-45.60
		(-4.72)***	(-4.60)***	(-4.60)***
	Δ DUM_{econ}	-26141.20	-23383.34	-23383.34
		(-4.28)***	(-3.98)***	(-3.98)***
	R-Square	0.83	0.81	0.81
	DW	1.40	1.63	1.63

(*Cont.*) Table 6.7.

Equation	Variables	Estimation Method		
		OLS	2SLS	3SLS
Defence equation	Intercept	-229.27	-338.91	-338.91
		(-1.77)*	(-1.89)*	(-1.89)*
	Δ PCY	0.98	1.33	1.33
		(5.35)***	(9.05)***	(9.05)***
	Δ NGE	-3.57	45.99	45.99
		(-0.07)	(0.96)	(0.96)
	Δ US	-82.81	-132.50	-132.50
		(-1.63)	(-2.83)***	(-2.83)***
	Δ NKLAG	-0.07	-0.26	-0.26
		(0.79)	(-0.03)	(-0.03)
	Δ DUMic	510.12	219.10	219.10
		(2.47)**	(1.36)	(1.36)
	R-Square	0.92	0.90	0.90
	DW	1.36	1.27	1.27

*** 1% level of significance ** 5% level of significance * 10% level of significance

Notes: 1. Numbers in the parentheses are *t*-values of each variable.
2. Δ g= real growth of gross domestic product (GDP); Δ s= real growth of domestic savings; Δ m= real growth of defence spending; Δ TB= real growth of trade balance; Δ L= size of employed labour forces (first difference); Δ H= human capital investment (first difference); Δ T= civilian R&D expenditures to GDP (first difference); Δ NGE= share of non-military government expenditures in total government expenditures (first difference); Δ i= inflation rate (first difference); Δ EXCH= real exchange rate (first difference); Δ PCY = real growth of per capita GDP; Δ US= share of US grant in the total defence spending of US-South Korean alliance (first difference); Δ NKLAG= real growth of North Korean defence spending in the previous year; DUM_{econ}= impulse dummy variable for economic crises in 1980 and 1998; DUM_{ic}= dummy variable for Inter-Korean conflicts for the period 1963-2000.
3.OLS tests have been carried out by SPSS 10.1., and the results from 2SLS and 3SLS tests have been computed by LIMDEP 7.0.

In the defence equation, North Korea's defence spending is insignificant to South Korea's for the period 1980-2000. Inter-Korean conflicts are significant only in the OLS estimation. Per capita GDP and US military aid are the most influential factors determining South Korea's defence spending like other periods (1963-2000 and 1963-1979), with US military aid being negative since 1984. The trade-off between defence spending and non-military government budget is not found in this period. Since the 1980s, the share of defence in total government spending has continually reduced while the share of social development expenditures has steadily increased. Therefore, South Korea's defence-growth relationship seems to be negative for the period 1980-2000. Although the direct effect of defence on growth is positive, the indirect and negative effect of defence on growth via the trade balance is large and the overall effect of defence on growth is negative. Following the estmation method of Deger and Sen (1995), the multiplier effect of defence on growth (*dg/dm*) is -16.17 in the 3SLS test.[5]

As shown in Tables 6.5, 6.6 and 6.7, our empirical estimation is robust and unbiased. The R^2 representing the overall significance of equations are reasonably high and the Durbin-Watson statistics are generally acceptable. In the defence-growth model of South Korea based on the Deger (1986a) framework, some different empirical results are found according to the time period. For the period 1963-2000, the overall effect of defence on growth is non-significant- i.e. South Korea's defence spending neither helps nor harms its economic growth in this period. By contrast, the effect of defence on growth is significant and positive for the period 1963-1979, while it is negative for the period 1980-2000. Hence,

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5 According to Deger and Sen (1995), the multiplier effect of defence on growth can be measured by following formula:

$$\frac{dg}{dm} = \frac{a_1 + a_2(b_1 + b_3c_1) - a_3c_1}{1 - (a_2b_2 + a_2b_3c_2 + a_3c_2)}$$

our conclusion is that **the defence-growth relationship can change according to the time-period and development stage even in the same country.** In the developing stage, defence must have contributed to South Korea's growth through the externalities and spin-offs, but it seems to have been an obstacle to its growth becoming a middle-income country since the 1980s. After the 1980s, the externality and spin-off effect of defence was diminished, because the civilian economy was more developed and advanced than the defence sector and defence had no avenue to contribute to raising growth. In contrast, defence crowded-out more productive civilian investment and affected adversely the trade balance. These different results according to different development stages are supported by Galvin (2003). She suggested that the effect of defence burden on growth differed between income groups. Galvin (2003) found that the negative effect of defence on growth is only significant for the middle-income countries. This implies that the negative effect of defence spending on growth is more significant for the developed countries than for the developing countries.

6.5. SUMMARY

Previous demand and supply side studies have generally applied either Deger (1986b)-type three stage simultaneous equation or Deger's (1986a) four stage simultaneous equation in the analysis of defence-growth relationship. This study has investigated the defence-growth relationship of South Korea in the Deger (1986a) framework, and it shows a different result from previous Deger-type studies (Deger and Smith, 1983; Deger, 1986a,b; Dunne and Nikolaidou, 2001). Through the tests, it is estimated that the overall effect of defence on economic growth is neither positive nor negative for the period 1963-2000. The direct and indirect effects of defence on growth are insignificant in South Korea in the long-run (1963-

2000) as Park (1993) and Heo (1997) found. However, the positive effect of defence on growth is found for the period 1963-1979 and this positive effect becomes negative since the 1980s. This might be caused by the difference between development levels. The wealthier countries have a more developed social infrastructure (e.g. telecommunications, roads, dam, etc.) and have a more productive labour force and less to gain from defence (Deger, 1986a; Galvin, 2003). Also, it is believed that the change of defence policy from the "self-reliant" policy to the import-substitution strategy contributed to the negative effect of defence spending on growth via the trade balance since the 1980s. As a result, the empirical tests for the period 1980-2000 using simultaneous equation estimations present a negative effect of defence on growth. The impact of disarmament and a peace dividend on the South Korean economy are presented in the Annex.

CHAPTER VII

CONCLUSIONS

7.1. SUMMARY AND CONCLUSIONS

This chapter summarises the empirical results of the earlier chapters and presents the final conclusions of this thesis. The main chapters of this thesis are divided into three parts. First, the defence economy and military balance between South and North Korea were studied. Second, based on the arms expansion of the two countries, the existence of a South-North arms race has been detected by applying an alternative Richardson model. Third, the effect of South Korea's defence spending on its economic growth was examined using the Deger-type demand and supply side model. Chapter I hypothesised that the action-reaction pattern of arms races might exist between South and North Korea, and that South Korea's defence-growth relationship was not clear. This study made an original contribution to detecting the existence of the South-North arms race and the effect of South Korea's defence on its growth since the early 1960s.

Chapter II described the defence economy, and military capabilities of the two Koreas and evaluated the military balance between the two countries. The two countries' military expansion was intensified between the 1960s and 1990s, but it has been alleviated since the mid-1990s. US military aid is believed to contribute to the economic development of South Korea by helping the South to free ride. South Korea's defence industry contributed to its "self-reliant" defence and also its civilian economy through the technology spin-offs until

the 1970s. But, since the 1980s, South Korea's defence has depended heavily on imports, including high technology weapons and now South Korea is the world's fourth largest importer of defence equipment. The share of defence spending in the government budget is still high compared with other developed countries, although it has been rapidly reducing with the increasing need for social welfare spending since the economic crisis of 1998. Thus, one of South Korea's policy aims should be the reallocation of resources from defence to the civilian sector following the effective deterrence of North Korea's threat (see Annex).

In Chapter III, the literature on arms races was reviewed. Although there are many alternative arms race models, they are mostly influenced by the Richardson's action-reaction model. Thus, the review of arms race literature was mainly focussed on the Richardson-type action-reaction models, because the arms race between the two Koreas was also modelled on this action-reaction mechanism. This chapter introduced the classical Richardson model and its variants, the Intriligator-Brito (1976) model, and other arms race models including the budgetary process approach, and the bureaucratic and organisational politics models. The literature review found that a nation's military expenditure is not only stimulated by the external threat but is also affected by internal factors.

In Chapter IV, two research questions were posed and answered. First, it detected the existence of the arms race between South and North Korea using an alternative Richardson model for the period 1963-2000. Second, two different sub-periods, the years 1963-1989 (the Cold War era) and 1990-2000 (the post-Cold War era) were compared to study how the pattern of the South-North arms races have changed. As the result of empirical tests, it was found that the South-North arms race follows an asymmetric form led by the US-South

alliance. It was found that South Korea's defence spending is affected positively by the North Korea's threat and inter-state conflict, while negatively by the economic burden. By contrast, it was found that North Korea's defence spending follows a submissive Richardson model. It reacted negatively to the defence spending of US-South alliance for the period 1963-2000. In contrast, North Korea led the South-North arms race in the number of military personnel and tactical aircraft in the Cold War era. North Korea's domination in the number of military personnel and tactical aircraft might indicate its hidden cost in defence spending, but also reflect the problem of weapons in their quality and vintage. In conclusion, despite some differences between data, it was generally found that the arms race between the South and North was more intense in the Cold War era and the military power of US-South alliance was steadily strengthened for the period 1963-2000. South Korea's defence spending exceeded North Korea's in the 1980s and North Korea's behaviour became submissive to the US-South alliance after the end of the Cold War, because the North did not have capabilities to react to the US-South alliance due to its economic difficulties.

Chapter V reviewed the studies on the defence-growth relationship. The supply, demand, and combined demand and supply side and Granger-causality models were studied. The supply-side model considers defence as an input in the traditional production function increasing output. Defence might be an important factor affecting production with capital, labour and technology. Defence might have a positive effect on growth through externalities and spin-offs from defence to civilian sector. In contrast, the demand model focusses on the negative effect of defence on growth based on the Keynesian demand function. In the demand-side model, defence crowds-out the more productive civilian economy and harms growth. The combined demand and supply side model estimates both

the direct and indirect effects of defence on growth. The Deger-type simultaneous equation model is generally used to estimate the overall effect of defence on growth, and most of these models find an overall negative effect of defence on growth in spite of some exceptions. The Granger-causality tests estimate the presence and direction of causation between defence and growth, but the test results are different according to the sample period and across countries. The review of empirical results found 10% of positive, 40% of negative, and 50% of insignificant relationships between defence and growth. Therefore, most previous studies on the defence-growth relationship show that defence has a negative or non-significant effect on growth. In South Korea's defence-growth relationship, most previous studies found a negative or non-significant relationship except for one case. There were 3 negative, 2 non-significant and 1 positive relationships among 6 studies.

Two key research questions were answered in Chapter VI. First, it examined the effect of South Korea's defence spending on its growth for the period 1963-2000 to find the long-term relationship between the two variables. As a result, the relationship was non-significant. Defence had neither direct nor indirect effect on growth via savings and the trade balance. Second, how the defence-growth relationship changed according to the development stage was also estimated. The results were different according to the time-period. In the first sub-period (1963-1979), the defence-growth relationship in South Korea was estimated to be positive. Not only the direct effect of defence on growth was positive but the indirect effect via the trade balance was also positive in this period. The indirect effect via savings was insignificant. But, in the second sub-period (1980-2000), defence had an overall negative effect on growth in South Korea. The direct effect of defence on growth was positive, but the indirect effect through the trade balance was negative. Therefore, it is concluded that the effect of defence on growth can be different according to the time-

period (the economy's stage of development) even in the same country.

The thesis posed three major research questions. The major findings and contributions to knowledge of this thesis can be summarised as follows:

1) ***The arms race between the two Koreas exists and is affected by other exogenous variables, such as inter-state conflicts and US military aid. It follows an asymmetric Richardson model led by the US-South alliance.*** The US-South alliance significantly reacts to the North's threat, while North Korea's behaviour became submissive to the US-South alliance since the end of the Cold War.

2) ***The pattern of South-North arms race changed between the Cold-War and the post-Cold War era.*** The arms race between South and North Korea was more intense in the Cold War era due to North Korea's reaction to the South's numbers of military personnel and defence equipment. But, the domination of US-South alliance in the defence spending over North Korea was more strengthened in the post-Cold War era.

3) ***South Korea's defence-growth relationship is non-significant, positive and negative according to the time-period. The effect of defence on growth is different according to the economy's stage of development even in the same country.*** South Korea's defence-growth relationship is non-significant for the period 1963-2000, positive for the first sub-period 1963-1979, and negative for the second sub-period 1980-2000.

7.2. PROPOSALS FOR FURTHER RESEARCH

Theoretically, the Richardson's arms race model was improved by including the conflict factor between states and aid from the military alliance. Social and political conflicts between two nations are a significant factor influencing a nation's military spending besides an opponent's military spending. Aid from military alliance is also an influential factor in the arms race model, because it provides a free-ride to the alliance country, while it is a threat to the opponent country. Also, the Deger-type demand and supply side model was improved by including human capital and technology as well as labour force in the growth equation. Human capital was used by some authors, such as Sezgin (1999) in the supply-side model, but it was not used in the combined demand and supply based model. Civilian technology is also an important determinant of growth, but previous demand and supply side models disregarded this factor. The improvement of the existing model provided a better fit to explain an arms race and defence-growth relationship in South Korea. Those developed models in this thesis might be applied to other countries or regions in a similar situation. Examples include Greece-Turkey and India-Pakistan which are also developing nations in an arms race situation.

Empirically, this thesis contributed to revealing the arms race mechanism between South and North Korea. Mathematical arms race studies using the Richardson model have not been attempted before in South Korea and proved an asymmetric arms race led by the US-South alliance in defence spending. In the South-North arms race, not only defence spending but the numbers of military personnel and defence equipment were also studied and this enabled an in-depth analysis of arms race in the Korean Peninsula.

In the analysis of South Korea's defence-growth relationship, this thesis showed that the effect of defence on growth can be different according to the development stage in the same country. Some authors showed that defence tends to have a negative effect on growth in the high-income countries and have a positive effect in the low-income countries in their cross-sectional studies, but it has not yet been proved in single country analysis.

However, the empirical results of this thesis are not always clear. Autocorrelations are doubted in some results. Some of the DW statistics are in the inconclusive zone, although they are generally acceptable in most cases. Data consistency is another major problem of this thesis. South Korea's defence data are quite reliable, but the discrepancies between institutions are large. For example, the data from SIPRI and IISS have a large difference between each other. The situation of North Korea's defence data is much worse. They have many missing variables and do not even exist in most institutes. North Korea's hidden defence spending could not be estimated. Hence, the empirical research of this thesis mainly depended on the official data from the Korean Ministry of National Defense (MND), Stockholm International Peace Research Institute (SIPRI) and International Institute for Strategic Studies (IISS) and the results from these data were compared with each other.[1] Although the actual defence spending of both countries are veiled, it is assumed that the official data have little difference from the actual data, and the research was performed based on these official data. Nevertheless, the veiled data need to be unveiled to obtain better empirical results.

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1 The economic data were quoted from "*Major Statistics of Korean Economy*" published by Korea National Statistical Office and "*World Development Indicators*" published by World Bank. Other sources, including "*International Financial Statistics Yearbook*" from International Monetary Fund (IMF) and "*National Accounts of OECD Countries*" from OECD were also referred.

There are further areas for future research. First, some critics point out that the South-North arms race has been changed from a two- person zero sum game to a six-person non-zero sum game. They suggest that the major powers, such as USA, Russia, China and Japan are involved in the arms race between the South and North. However, in this thesis, only US military aid to South Korea was considered. The US-South alliance tends to have been developed into the US-South Korea-Japan alliance to cope with North Korea and China in the East Asia. However, South Korea does not have any military relationship with Japan, and China does not support North Korea militarily. China and Russia still have an intimate relationship with North Korea, but did not make a military alliance with it. Hence, these factors were not reflected in this thesis. Nevertheless, the nuclear development of North Korea might cause a new military conflict between the South and North involving major powers surrounding the Korean Peninsula. Thus, the arms race in the Korean Peninsula might need to be re-examined according to the political and military change in this region.

Second, the military data of both countries need to be improved. Although the specific situation of the two Koreas should be considered, the secrecy of military data prevents acquiring more accurate and consistent empirical results. North Korea's actual defence spending is still veiled, and thus researchers must depend on official data. But, it is inferred that North Korea's actual defence spending is much larger than its official data.

Third, North Korea's defence-growth relationship was not investigated due to the lack of data. If the related data are available, the effect of North Korea's defence spending on its growth might be estimated. In terms of the economic transition of centrally planned economies (CPE), studying North Korea's defence-growth relationship is crucial to estimate the effect of disarmament on growth in North Korea. Most studies emphasise the positive

effect of defence reductions on an economy. However, defence reductions did not contribute to economic growth in the former communist countries, although most of these countries are transforming from a centrally planned economy (CPE) to a market economy. Accordingly, the sudden reduction of North Korea's defence sector might entail adjustment costs and harm its economy like other CPEs and this must be a burden to the unification of the two Koreas.

Fourth, the effect of growth on defence was not studied in this thesis. South Korea's defence-growth relationship was examined bi-directionally using Granger-causality tests in some previous studies, but the empirical results were not identical but different from each other. Although it was found that defence spending had no significant effect on growth for the period 1963-2000, growth might have led defence spending for the same period in South Korea. Hence, the Granger-causality analysis might be used to investigate the bi-directional relationship between defence and growth in South Korea using longitudinal data.

Besides the above issues, the reform of South Korea's armed forces and its defence industrial base (DIB) might be included in the future researches. Further analytical and empirical work is required to assess the economic impact of disarmament and a peace dividend for the two Koreas (see Annex).

The results of this thesis are not universal. The arms race models and defence-growth relationship might be different across countries. The specific circumstances of each country are different and these factors should be reflected in single country analysis. This thesis made an effort to reflect the specific factors of South Korea and reached the result that the

South-North arms race is asymmetric led by the US-South alliance and the pattern of arms race differs between the Cold War and the post-Cold War; South Korea's defence spending has different effects on its growth according to the economy's stage of development.

ANNEX

ANNEX

DEFENCE REDUCTIONS AND ECONOMIC GROWTH IN SOUTH KOREA

1. INTRODUCTION

In this Annex, the effect of defence reductions on economic growth is estimated based on the model presented in Chapter VI. A major research question is whether a reduction of South Korea's defence spending would promote its economic growth and produce a peace dividend. If the reduction of defence spending helps its growth, there will be an economically beneficial peace dividend to South Korea including peace itself. If a bilateral disarmament is accomplished between South and North Korea, it will be possible that diminished fears of war might contribute to increased savings and investment, and lead to the peace dividend in South Korea as found by Russet and Slemrod (1993). Using the simultaneous equation model as shown in Chapter VI, the adjusted economic figures assuming South Korea's defence retrenchment will be simulated over the period 1980-2000. In the 1980s, South Korea's defence spending reached approximately 5-6% of GDP and exceeded North Korea's in its real level. Although South Korea's Force Improvement Plan (FIP) initiated in the early 1980s contributed to the increase of its defence burden, and is believed to have crowded-out some public and private investment, South Korea attained high economic growth consistently in this period until it was faced with the economic crisis in 1997. Hence, the purpose of this Annex is to investigate whether the diversion of the resources from defence to other civilian sectors, such as human capital could have raised

South Korea's growth for the period 1980-2000.

In the second section, previous studies on the effect of defence reductions will be reviewed. In general, there are two different theories on disarmament. Most studies (UN, 1989; Klein, 1990; Ward and Davis, 1992) cautiously highlight the positive effect of defence reductions on economic activities, while UNIDIR (1993) and Intriligator (1994) pointed out that if disarmament involves high conversion costs and relatively low benefits, the social rate of return from disarmament could be small or even negative. In South Korea, a positive effect of defence reduction on its growth is expected for the period 1980-2000 according to the empirical results in Chapter VI. In the third section, the disarmament plans of the two Koreas will be studied. The disarmament plans of the two countries have a significant gap between each other and show that the arms reductions are not simple in the Korean Peninsula. In the fourth and fifth section, the effects of defence reductions will be modelled and simulated based on Chapter VI, and their results will be presented. In the sixth section, costs and benefits from the two Koreas' unification are briefly described based on Germany's experience. The conclusion will be presented in the final section.

2. PREVIOUS STUDIES ON DISARMAMENT

In general, disarmament contributes to peace and economic development by reducing a nation's or region's defence burden (Fontanel, 1995). Resources released from defence can be reallocated for other alternative uses, such as social welfare or public and private investment, and contribute to developing the civilian economy (UN, 1989; Klein, 1990; Davis and Chan, 1990; Aben and Daures, 1993). Nevertheless, the effect of disarmament in the countries having a positive defence-growth relationship is not yet detected precisely.

Although peace itself might increase savings and investment by providing a secure environment in the long run, the defence reductions might also cause damages to the economy and regions depending heavily on defence industries and military bases. However, previous studies on the economic effect of disarmament are mostly focussed on the positive economic effect of defence reductions.

2.1. Positive Effects of Defence Reductions

Most previous studies on the economic effect of defence reductions assume the hypothetical reduction of defence spending and simulate its effect on the rest of the economy. Using the LINK model, Klein (1990) explains that a 10 % reduction of defence spending with an improvement in international aid (0.7 % of the GNP of the developed countries) might lead to a 1.7 % GNP growth in developing countries and 0.2 % growth in the developed countries if 60 % of the aid is spent on capital goods. Barker, Dunne and Smith (1991) also evaluated the impact of UK defence cut on the rest of the economy using a multi-sectoral macroeconomic model. The simulation reduced the real value of defence spending in 1992 by one-half by the year 2000 implying an annual average reduction in real defence spending of just over 8.5% per annum, starting in 1993. For simplicity, they assumed that defence reductions are matched by balanced increases in other public spending which leave total public spending unchanged. They also assumed that the cuts fall broadly, proportionately on the major components and that the current balance between personnel, equipment and other spending is maintained. Simulations were undertaken for the situation where there is no compensatory adjustment and for the situation where there is a resource reallocation from defence to other sectors. As presented in Table A.1, the simulation results show that the reduction of UK defence spending to one-half of its 1992 level by the year 2000

decreases the UK GDP by 3.64% and increases unemployment by 0.46 million in the uncompensated situation. However, in the compensated situation, the reduction of defence spending leads to the decrease of unemployment by 0.52 million and the increase of GDP by 1.84% between 1992 and 2000. Their previous study (Dunne and Smith, 1984) using the Cambridge Growth Project model also presents similar results. Dunne and Smith (1984) found that a cut in the share of UK defence spending from 5% of GDP to 3.5% of GDP, the European average, balanced by matching increases in other forms of defence spending leads to a net increase in total employment of some 100,000 jobs. Hartley (1997) estimated the UK resources released from defence based on simple extrapolations of linear trends for the period 1985-1990. Over the period 1990-1996, there were cumulative savings of almost £3.5 billion of defence spending (savings in 1995-1996 were equivalent to some 0.25% of GDP); manpower savings of over 50,000 service personnel in 1995; and over 100,000 defence industry jobs in 1993-1994. Bayoumi, Hewitt and Schiff (1995) also examined the peace dividend from the reduction of world military spending using the IMF MULTIMOD model.[1] In their study, the cut of world military spending by 20% could produce a long-run increase in private consumption and investment in industrial countries of 1% and 2%, respectively. Those countries that implement the largest cuts achieve the largest long-term benefits in consumption and investment as well as the largest short-term costs in output. The long-run impact of reduced defence spending on LDCs is also large, because these countries benefit both directly from the direct defence reduction and indirectly from lower interest rates and increased demand for their exports. Non-military consumption is estimated to rise by some 1% and investment by 3.5% producing overall gains in economic

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1 MULTIMOD is a system of linked models designed to analyse the interaction of economic policies and developments among the industrial countries, as well as to examine how changes in economic conditions in the industrial world affect developing countries as a group. The system contains econometric models (estimated on the basis of annual data) for each of the G7 countries, the smaller industrial countries as a group, high-income (capital-exporting) developing countries as a group, and other (capital-importing) developing countries as a group.

welfare. Hence, their major finding is that substantial benefits from the reduction of defence spending are mainly generated in the long run. In the short run, output is generally lower than it would have been otherwise, reflecting the negative impact on demand of lower government spending and entailing adjustment costs.

Table A.1. Simulation Results for a 50% Reduction of UK Defence Spending

Economic Factors	Uncompensated			Compensated		
	1993	1996	2000	1993	1996	2000
Private consumption	-0.31	-1.97	-4.41	0.22	1.73	5.39
Gov. consumption	-1.87	-6.99	-12.13	-0.21	-1.31	-2.79
Investment	-0.3	-1.77	-3.64	0.25	1.58	4.27
Exports (G&S)	-0.01	0.06	0.69	-0.02	-0.25	-0.79
Imports	-0.50	-2.34	-4.39	0.09	0.99	3.21
GDP factor cost	-0.45	-2.03	-3.64	0.10	0.63	1.84
Trade balance (pp)	0.16	0.93	2.17	-0.04	-0.40	-1.36
Unemployment (mil.)	-0.057	-0.252	0.46	-0.046	-0.221	-0.52

Notes: 1. G&S= goods and services; pp= percentage points. 2. The compensated results are for the simulation where the reduction in defence spending is reallocated proportionately to other categories of government current and capital expenditure while for the uncompensated simulation there is no reallocation.

Source: Barker. T, P. Dunne and R. Smith (1991) "Measuring the Peace Dividend in the United Kingdom", *Journal of Peace Research*, 28(4): 345-358.

However, disarmament does not always have a positive effect on the national economy. The failure of management of adjustment costs could bring economic problems. The basic economic danger is that defence reductions could result in the unemployment or under-employment of resources, including labour and capital, thereby leading to social and economic problems (UNIDIR,1993; Intriligator,1994). Another danger is that arms-producing countries might continue to produce weapons for export to avoid the socio-economic problems stemming from disarmament. Disarming countries might also sell existing weapons and defence plants to the countries engaged in arms races instead of

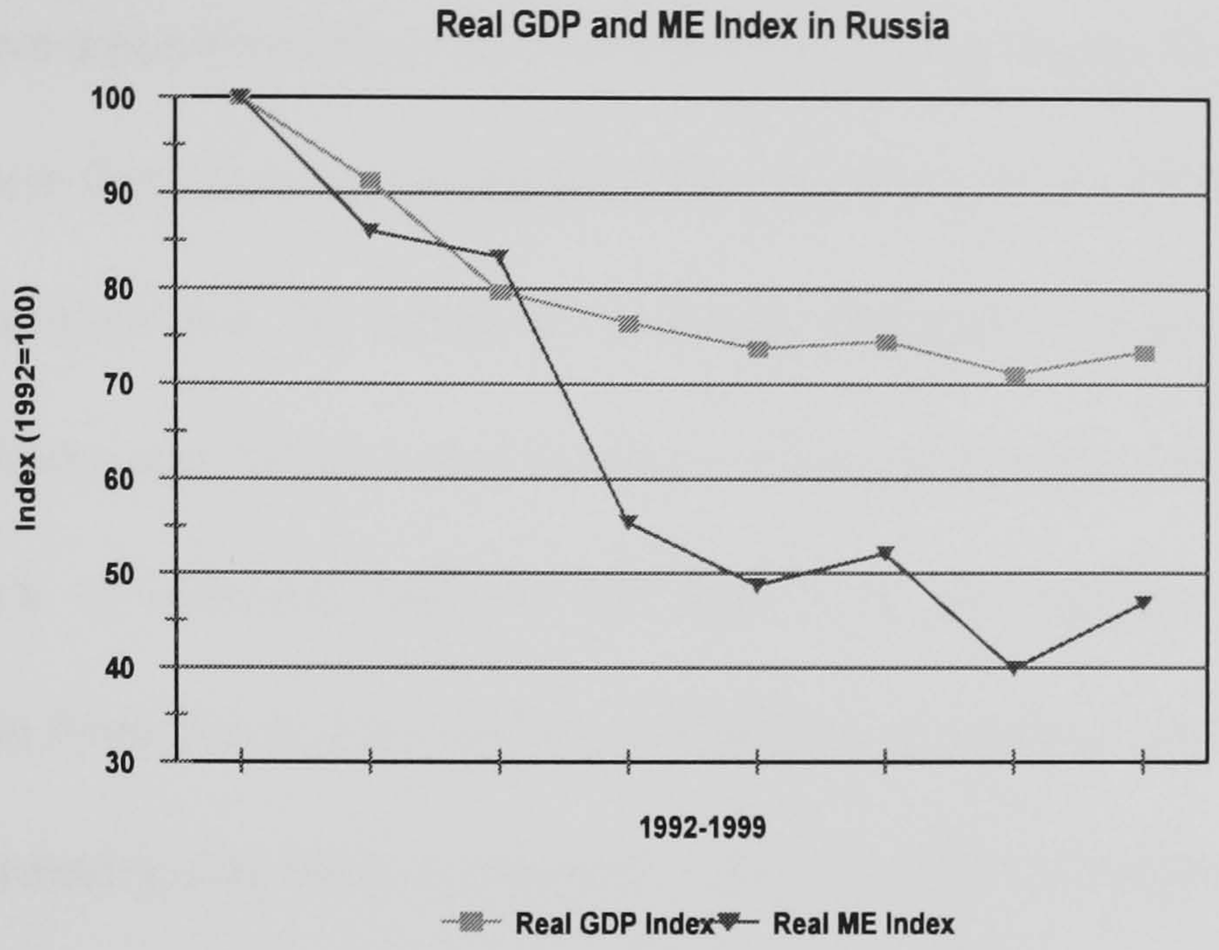
destroying and dismantling them. Unemployed military scientists and technicians might emigrate into arms developing countries rather than work for civilian industry. Hence. delayed adjustment and resource reallocation might be dysfunctional for disarming countries in the long run as well as in the short run.

2.2. Negative Effects of Defence Reductions

Thomas, Stekler and Glass (1991) estimated the economic effects of US defence reduction for the mid-1980s and 1990s. In their simulations, reducing the level of defence spending caused a decrease of real output, the price level, and employment, although the effects of such a reduction tend to attenuate after about five years. An explicit example of adjustment failure can be found in the former Soviet Union. It is assumed that there has been a large reduction of defence spending in Russia since the end of the Cold War as all members of the former WTO concentrated on civilian production and overall reorientation of their entire economies (Klein, 1995) However, Russian statistics of all sorts are still weak. Employment and real GDP have decreased in spite of its adjustment efforts (Lavigne, 1999; Davis, 2002). As shown in Figure A.1, Russia's real GDP index decreased from 100 in 1992 to 73.4 in1999, although its index of real defence spending decreased from 100 in1992 to 46.8 in 1999 (1992= 100). Russia's real defence spending was reduced from 47.5 billion roubles to 22.4 billion roubles in this period (1995 constant prices). The unemployment rate also increased from 5.8% to 8.5% between 1993 and 1997 (Figure A.2). Since the end of the Cold War, many bold statements were made about demobilization and about reduced production of arms in the entire WTO, but now the countries struggling with their economic reforms are rebuilding their arms industries (Klein, 1995). In Russia, the Putin Administration has raised the priority of defence sector and

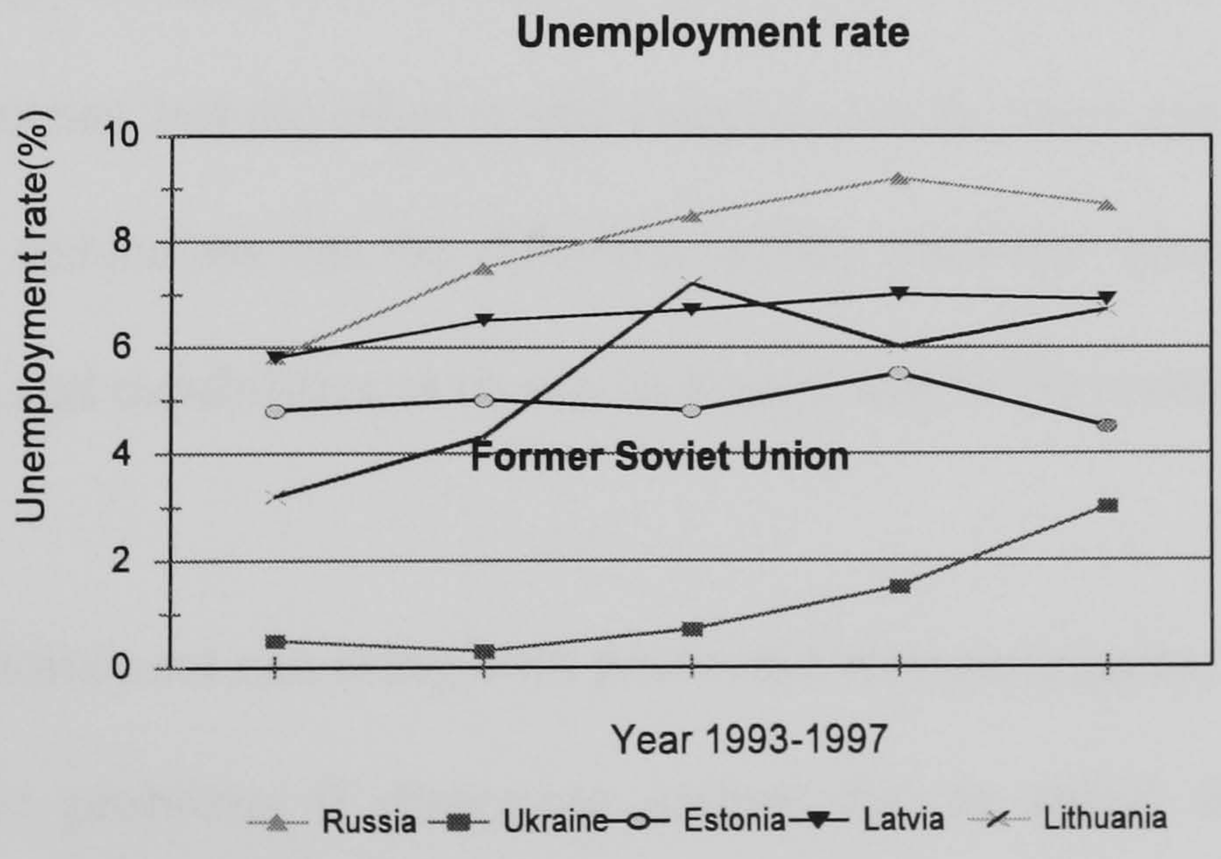
increased real defence spending again (Davis, 2002).

Figure A.1. Real GDP and Defence Spending Index in Russia, 1992-99



Source: Davis, C. (2002) "Country Survey XVI: The Defence Sector in the Economy of a Declining Superpower: Soviet Union and Russia, 1965-2001", *Defence and Peace Economics*, 13(3):145-177.

Figure A.2. Unemployment Rate in the Former Soviet Union, 1993-97



Source: Lavigne, M. (1999) *The Economics of Transition: From Socialist Economy to Market Economy*, London: Macmillan.

The success of disarmament is also likely to be affected by the economic fundamentals of a nation. The countries having a high economic growth and large civilian production will be able to quickly absorb the unemployed labour forces from the defence sector and transform defence industry into civilian industry. Accordingly, defence reductions are more likely to have a positive effect on the countries having highly developed civilian economies, because they have more opportunities to reduce both adjustment costs and the adjustment time-period. By contrast, centrally planned economies, such as the former Soviet Union and WTO countries have relatively weak civilian economies, including the lack of efficient markets and thus it is not simple to reallocate the resources released from the defence sector. In addition, the defence-oriented countries in the market economy can have a negative effect on their economy by disarming, because reductions in the defence sector might cause a decrease of demand, employment and national output, and it might also take longer to transform the defence-weighted industrial structure. The empirical results of studies on the economic effects of disarmament are presented in Table A.2. This Table shows that the reduction of defence spending has a positive effect on the economy in the long run, especially in the developed countries, but the effect is often negative in the short run. However, the effect of defence reductions can be different across countries according to their economic systems and capabilities as shown in Russia and WTO countries.

In conclusion, disarmament can bring both peace and economic gains, but it can also result in economic problems if disarming nations fail to adjust their economy. Furthermore, defence reductions might impede economic growth in the countries having a positive defence-growth relationship and thus it is doubted whether these countries can also have an economic peace dividend through defence reductions.

In terms of literature, most studies depend on simulations to estimate the effect of defence reductions in the future. But, their simulation results are uncertain, because their studies are based on assumptions, and do not consider unexpected political and economic events which might occur in the future. For example, people simulating the effect of defence reductions on the US economy from 1995 to 2005 could not expect the 9.11 terror and Iraq War. Although these are the most significant factors affecting US defence spending by 2003, they could not be expected in the 1990s. Hence, a major gap of simulation is that its results are just unreliable and uncertain. In South Korea, using simulations to estimate the future effect of defence reductions might also be inaccurate and uncertain, because the political and military situations are not always stable and the South-North relationship is changeable. As a consequence, South Korea's defence-growth relationship was studied by some scholars introduced in Chapter V, but the effect of South Korea's defence reductions on its economy has not been studied empirically. To remove the uncertainty of simulation, this research will compare the actual defence spending and GDP with the hypothetical reallocation of defence resources to the civilian sectors and its effect on GDP for the period 1980-2000. Through the study, the effect of defence reductions in South Korea will be revealed, and it will contribute to investigating whether the hypothetical reduction of South Korea's defence spending and the reallocation of resources released from defence to other civilian sectors might help or impede its growth.

In the disarmament process, the design of public policies, such as creating new jobs and supporting the change of industrial structure is particularly important to reduce the negative economic effect of defence reductions, such as adjustment costs. Adjustment costs are one of the most crucial factors which cause the failure in disarmament. The

development of retraining and retooling programmes is also needed to prevent the rapid increase of unemployment and decrease of productivity (Sandler and Hartley, 1995).

Table A.2. Empirical Results on the Economic Effect of Defence Reductions

Author(s)	Model	Sample	Economic effects
Domke, Eichenberg and Kelleher (1983)	Resource allocation model	4 NATO allies: US, UK, Germany and France, 1948-1978	No trade-offs between defence and welfare in the short term, but they are detected in the long term.
Dunne and Smith (1984)	Cambridge growth project model	UK, 1983-1987	Positive effects on employment
Harris, Kelly and Pranowo (1988)	Longitudinal regression model	12 Asian developing nations, 1967-1982	Few trade-offs between defence and welfare.
Davis and Chan (1990)	Physical Quality of Life Index (PQLI) model	Taiwan, 1961-1985	No trade-offs between defence and welfare.
Barker, Dunne and Smith (1991)	Multi-sectoral macro-economic model	UK, 1992-2000	Positive effects on UK economy in the compensated situation.
Thomas, Stekler and Glass (1991)	Macroeconomic model and input-output model	US, the mid-1980s and the 1990s	Negative effects in short and medium-term, but they are attenuated after 5 years.
Ward and Davis (1992)	Input-output model	US, 1948-1996	Positive impact on economic growth.
Aben and Daures (1993)	Input-output model	France, 1992-1996	Diverting resources from defence into education helps economic performance.
Bayoumi, Hewitt and Schiff (1995)	MULTIMOD model	US and industrial countries, 1992-2000	Negative effects in the short-term and positive effects in the long-term.
Hartley (1997)	Simple extrapolations of linear trends	UK, 1990-1996	Peace dividend is obtained in savings and manpower.

3. ARMS CONTROL AND DISARMAMENT IN THE KOREAN PENINSULA

3.1. Arms Control Regime in the Korean Peninsula

The military confrontation between the South and North since the Korean War (1950-53) has led both countries to a ceaseless arms expansion. The East-West Cold War also intensified the military build-up of the South and North until the 1980s. Accordingly, in this high state of tension, arms control between the two countries has been rarely discussed. Although North Korea has often suggested the South-North dialogue for the arms control between two countries[2], it was only a propaganda strategy to disturb the South (Chun, 1993). In the military strategy, the approach to arms control is completely different between the two countries. North Korea has focussed on the superiority to the South in the number of conventional striking weapons, such as tanks and armoured vehicles due to its advantageous geographical condition, while South Korea has stressed its defensive policy to cope with the North's threat. On the other hand, the large gap of defence spending between the US-South alliance and North Korea, and the North's economic difficulties might induce the North to insist on the disarmament of both parties. As shown in Chapter IV, North Korea's inferior defence spending in the South-North arms race might lead to proposals for disarmament, but at the same time, the North's anxiety about the overwhelming military power of US-South alliance might have led it to develop strategic weapons, such as nuclear and bio-chemical weapons, and long-distance missiles. However, South Korea had been relatively passive on the arms control issue until the mid-1980s because of the presence of US forces as well as its inferiority to the North in the number of conventional weapons and military

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2 North Korea suggested the arms control between the South and North over 236 times until the late 1980s.

personnel. But, the South started to be more concerned about arms control from the late-1980s and agreed on constituting the "South-North Military Joint Committee" in the South-North dialogue in 1992. This Committee was constituted to implement and secure the South-North Non-aggression Agreement, and achieve disarmament between the two countries based on "Inter-Korean Basic Agreement on Reconciliation, Non-aggression, Exchanges and Co-operation Between the South and the North" concluded in 1992. However, these efforts for peace and disarmament failed due to the nuclear crisis which occurred from 1993 to1994, and the US and South Korea restarted joint military training (Team Spirit) from 1993. By 2002, the US-South joint military training was stopped, but the discussion on disarmament between the South and North is at a standstill, although the economic exchange and co-operation has increased.

The proposed disarmament by the South and North focussed mainly on their strategic dominance. The military tension caused by the South-North arms race has prevented the considerable reduction of defence spending for both countries. As shown in Chapter II, the overwhelming military spending of US-South alliance prevented North Korea from disarming, while North Korea's military threat and hostile behaviour to the South contributed to South Korea's military expansion. Hence, two countries are not willing to lose their strategic dominance in pursuing disarmament. In this state, the optimal strategy of both countries is maintaining the status quo, or reducing the number of military personnel (e.g. paramilitary or reserved army). By doing so, both countries might reduce their defence spending and use these labour forces for other economic activities. However, it is difficult to fulfill the full-scale arms reduction as long as two nations are engaged in an arms race. Disarmament can involve one or more of the following (UNIDIR, 1993):

1) Reductions in military expenditure due to unilateral initiatives or to bilateral and/or multilateral agreements;

2) The reduction or destruction of specific weapons (nuclear, chemical etc.);

3) The reduction in the number of military personnel and closure of military bases;

4) A ban or limitation on the production of certain types of military equipment;

5) Controls on defence R&D for military purposes;

6) Limitations on arms transfers;

7) A monitoring and verification process.

3.2. Disarmament Policies of South and North Korea

Although the disarmament policies of South and North Korea include the above conditions, they are hardly put into action. The proposed disarmament plans by South and North Korea appear to have little difference from each other, but partly differ according to the strategic importance of both countries. South Korea suggests firstly, the formation of political trust, secondly, the formation of military trust and finally, gradual disarmament. First, the formation of political trust can be achieved by approving the other's political and ideological system, ending the provocative acts towards each other, and establishing liaison offices in Seoul and Pyongyang. Second, the formation of military trust includes the mutual visit and exchange of military officers, the mutual openness and exchange of military information, the pre-information of corps movement and inspection of manoeuvres from the brigade level, the installation of a hot line between defence ministers to prevent an accidental armed collision, and the peaceful use of the DMZ (Demilitarized Zone). Third, gradual

disarmament should follow after the establishment of mutual political and military trust. The South's disarmament contains the following elements: first, the change of an offensive military structure to a defensive military structure by reducing offensive weapons (e.g. fighters, missiles, etc.); second, the maintenance of military balance, that is, a side holding larger number of weapons and military personnel should disarm more while the other side holding less should disarm less, and thus both countries attain a military balance based on numbers. This model representing that the balanced disarmament between two opponents reduces the probability of war by enlarging the cone of mutual deterrence as shown by Intriligator and Brito (1976, 1977, 1984, 1987) in Chapter III; third, the number of military personnel should be reduced with the reduction of weapons simultaneously; fourth, the mutual verification of disarmament is necessary; finally, the level of military power of both countries is determined by the South-North agreement considering the defence of unified Korea in the future. Therefore, South Korea's disarmament policy stresses the military balance in the numbers of military personnel and weapons between the South and North to reduce the threat from North Korea.

By contrast, the North's disarmament proposal is focussed on the immediate arms reduction and the withdrawal of US troops from South Korea. First, it suggests the formation of mutual trust between the South and North as South Korea's plan does. Second, the North proposes the immediate arms reduction between the South and North in a few years. Third, it insists on the withdrawal of foreign (US) troops from the Korean Peninsula. Finally, it suggests a disarmament and peace treaty between the two Koreas. The details of North Korea's proposal are as follows: (i) the mutual trust between the South and North should be formed through the restriction of military exercises and training. That is, it proposes to

ban all joint military exercise and training with foreign troops, the exercise and training from the divisional level and the exercise near the military demarcation line, and also pre-inform any military exercise by each other. It also suggests the change of DMZ into a peace zone and a safety plan to prevent an accidental collision, including the installment of a hot line between high-level military authorities and the prohibition of provocative military action near the military borderline; (ii) it suggests a specific arms reduction level between the South and North, including a reduction in the number of military personnel to 100,000 in 3-4 years and the abolition of all reserves and paramilitary forces. It proposes to reduce and destroy military equipment proportionately to the reduction of armed forces personnel, and restrict the development of new military technology and equipment, although it does not provide the detailed method of restriction. It also includes the exchange of information on the arms control process and mutual verification; (iii) the North stresses the withdrawal of US troops from the Korean Peninsula. It includes de-nuclearisation of the Korean Peninsula, withdrawal of US troops and equipment corresponding to the South-North disarmament and closure of US bases in South Korea; (iv) it proposes to constitute the South-North military joint committee to discuss and resolve the arms control and conflict between the South and North, and declare and conclude a non-aggression and peace treaty between the two Koreas. However, unlike its proposals, North Korea is developing nuclear and bio-chemical weapons and testing long-distance ballistic missiles, and this has exacerbated the arms race between the two Koreas. Hence, the purpose of its disarmament proposals is not trustworthy and is doubted by South Korea. Table A.3 summarises and compares the disarmament plans of South and North Korea.

Table A.3. Arms Control Plans of South and North Korea

Nation	Arms Control Plan
South Korea	● Approval of political and ideological system ● Ban of provocative acts to each other ● Establishment of liaison offices in capital cities ● Formation of military trust including exchange of military information and officers and the installation of a hot line ● Gradual disarmament including the reduction of offensive weapons and military personnel, the maintenance of military balance and mutual verification
North Korea	● Focus on military trust ● Rapid arms reduction with the restriction of military exercise ● Withdrawal of US troops from South Korea and a peace treaty between the two Koreas ● Rapid reduction of military personnel and the dismissal of all reserves and paramilitary forces ● Restriction of the development of new military technology and equipment

3.3. Dilemma of Disarmament in South and North Korea

The two countries agree that mutual trust should be formed between the South and North before they disarm. However, the South focusses on the establishment of both political and military trust, while the North focusses mainly on military trust. In other words, the South requires the North to stop provocative acts and thus alleviate the political and military tension between the two countries at first, while the North insists that the South should reduce its military threat and capabilities. Even though it is unrealistic, the North also requires the South to stop military exercises and training, and abandon the US-South alliance to create military trust.

On arms reductions, the two Koreas have three major unyielding differences. First, the speed of arms reduction is different from each other. The North insists on an imminent reduction of military personnel, while the South stresses the maintenance of military

balance between the two countries. For North Korea, it is important to convert the military personnel to civilian labour forces to increase economic output, but one of the important strategic reasons is that it is easier for the North to mobilize civilians and change them to military personnel in wartime due to its totalitarian system. By contrast, for South Korea, it is important to reduce the number of North Korea's weapons stock and military personnel to correspond to the South's. Also, the rapid reduction of military personnel might damage South Korea's economy by the sudden release of labour forces from the defence sector and the possible increase of unemployment. Second, North Korea focusses on banning military training, exercises and joint military exercises with foreign troops. It is assumed that the intensive US-South military training has been a great threat to the North and it is going to weaken the military preparation of the South and disintegrate the US-South military co-operation. Another reason is that the North can also use its military personnel for economic activities, such as the construction of infrastructure, by reducing military exercises and training. However, the North's superiority in the number of weapons and military personnel is a serious threat to the South, and the South requires the North to reduce its number of weapons and military personnel to the South's level first.

In recent years (2001-2003), North Korea's nuclear development programme is a serious international issue, and South Korea and USA are requiring the North not only to reduce conventional weapons but also to abolish and relinquish its nuclear and bio-chemical weapons, and missile development programmes. Third, North Korea has consistently insisted on the withdrawal of US troops from South Korea. North Korea is still defining the Korean War as the National Liberation War and there is no evidence that its ultimate goal to drive out US power from the Korean Peninsula and thus communise the South has changed. The North also insists that the presence of US troops obstructs the reconciliation

and unification between the South and North. However, it is perceived that the US-South military alliance is a must rather than an option not only for South Korea but also for East Asia, because the potential military threat from the North, such as the development of nuclear and bio-chemical weapons, and long-distance missiles, is still not diminishing but rather increasing the tension in this region.

Therefore, two different approaches are needed to analyse the disarmament of the two Koreas. On one hand, both countries agree on the arms reductions to alleviate military tension and avoid a war between the South and North. However, on the other hand, both countries seek to maintain their military power. The North attempts to maintain its military strength by developing nuclear and bio-chemical weapons instead of reducing its number of military personnel and conventional weapons. The South also attempts to strengthen its military power and the relationship with USA to cope with the increasing threat, such as nuclear and bio-chemical weapons from North Korea. Thus, this contradictory situation prevents the disarmament of both countries, although they have agreed on the non-aggression to each other.

Figure A.3 shows the game theoretic approach of two nations' disarmament. Two nations depend on a *dominant strategy*, giving a greater payoff to one nation regardless of the other nation's actions. In spite of its disarmament policy, arms escalation is a dominant strategy to South Korea, because its payoffs (4 and -6) in the escalate row are greater than the corresponding payoffs (of 2 and -8) in the limit row. Similarly, North Korea's payoffs (of 4 and -6) in the escalate column exceed the corresponding payoffs (of 2 and -8) in the limit column. Both nations increase their armaments (or defence spending) to play their dominant strategy and end up in an arms race in the cell marked with an asterisk. Paradoxically, even

though both nations spend more on defence, they get negative payoffs in the matrix reflecting the fact that a positive opportunity cost in terms of less civilian goods is paid with no resulting benefits. The escalate-escalate cell in Figure A.3 is a *Nash equilibrium* representing that neither nation is willing to disarm unilaterally. Either South or North would lose 2 if it disarms unilaterally, because payoffs would change from -6 to -8. Hence, in the Prisoner's Dilemma game, each nation's optimising choice is increasing armaments (or defence spending) when its opponent increases them. Figure A.4 represents an ordinal rank of payoffs from best to worst. The best payoff is assigned a rank of 4, the second best outcome is 3, the next-to-worst payoff is 2, and the worst payoff is 1. These ranks are given in the corresponding matrix of Figure A.3.

Figure A.3. Disarmament Prisoner's Dilemma

		North: limit	North: escalate
South	limit	2, 2	-8, 4
	escalate	4,-8	**-6,-6***

Figure A.4. Disarmament Prisoner's Dilemma (ordinal)

		North: limit	North: escalate
South	limit	3, 3	1, 4
	escalate	4, 1	**2, 2***

3.4. Economic Effects of Disarmament

In the economic aspects, it was found that defence spending helped economic growth in South Korea until the late 1970s, but since the1980s, it impeded growth. Hence, the reduction of defence spending is expected to help South Korea's growth since the 1980s. The economic effects of defence reductions on North Korea's economy are not estimated, but the former Soviet Union and WTO countries exemplify the negative effect of defence reductions on the centrally-planned economies. North Korea's economy depends heavily on its military industries and its export of defence products, such as long-distance missiles exceeds South Korea's as shown in Chapter II. Hence, the rapid reduction of North Korea's defence might harm its economy by increasing unemployment and reducing national output. For a successful disarmament, it should increase civilian investment gradually and absorb its labour forces in the civil market so that it can reduce its adjustment costs for conversion. Namely, the economic base for civilian industries should be formed before a disarmament in North Korea. Therefore, a possible scenario for North Korea is that it will enhance the economic relationship with the developed countries, including South Korea and attract foreign investment. By galvanizing its civil market, North Korea can reform its collapsed economy and depend less on the military sector. However, as long as North Korea does not relinquish the development of strategic weapons, such as nuclear and bio-chemical weapons, it will not be easy to solve its economic difficulties. But, it is evident that those weapons are a leverage for North Korea for the deal with USA and the protection for its political system.

4. MODELLING THE DEFENCE REDUCTIONS IN SOUTH KOREA

4.1. The Model

This section estimates how the reduction of South Korea's defence spending affects its economic growth. The effect of South Korea's defence reductions on its growth has never been studied before empirically. According to the early studies of Benoit (1973, 1978), defence spending generally promotes economic growth in developing countries, while other studies (Deger, 1986a,b; Deger and Smith, 1983; Deger and Sen, 1983) show that defence spending inhibits economic growth. In Chapter VI, it was found that South Korea's defence spending impeded its growth for the period 1980-2000. Hence, it is assumed that the reduction of defence spending might have a positive effect on the South Korean economy, but the effects of reduced defence spending will be different according to the method of defence reductions. In other words, the simple reduction of defence spending without the diversion of resources released from defence to other more productive sectors will have a negative effect on growth (i.e. it might worsen South Korea's economy by reducing the total output). Therefore, it is assumed that the resources released from defence spending are reallocated to other sectors, such as investment (or savings), human capital and civilian R&D. In Chapter VI, it was proved that savings, human capital and civilian technology are significant factors leading to South Korea's growth. Thus, it is assumed that the resource reallocation from defence to these sectors might be more helpful for South Korea's growth. Also, the reduction of defence spending might affect the trade balance by reducing the import of weapons and increasing the export of civil goods. As shown in Chapter VI, South Korea's defence spending had a significant negative effect on its trade balance. South Korea has surpluses in its total trade, while it has significant deficits in the arms trade. Hence,

reallocating the resources released from defence spending to other civilian sectors might also help improve the balance of payments. Besides the explanatory variables used in the growth equation in Chapter VI, two exogenous variables, social welfare and public economic services are added in the following model. Social welfare has become one of the important factors affecting growth since the 1980s by providing better conditions to increase productivity. Public economic services, such as telecommunication system, energy and transportation are also necessary to attain higher growth.

Based on the regression analysis of South Korea's defence-growth model, the growth equation used in this chapter is as follows:

$$\begin{aligned} g = {} & \mathbf{-32973.30} + \mathbf{11.70}m + \mathbf{1.82}I - \mathbf{0.41}TB - \mathbf{7.43}L + \mathbf{1189.50}H \\ & \quad (-0.60) \quad (2.42) \quad (4.82) \quad (-2.71) \quad (-1.35) \quad (5.27) \\ & + \mathbf{16077.44}T + \mathbf{2257.94}W + \mathbf{1647.16}PE \\ & \quad (1.24) \quad (0.98) \quad (3.04) \end{aligned}$$

$$R^2 = 0.999 \qquad (1)$$

where

g = real level of gross domestic product (GDP)

m = real level of defence spending

I = real level of domestic investment

TB = real level of trade balance

L = size of employed labour force

H = ratio of students entering high school (%) (proxy for human capital investment)

T = civilian R&D expenditures to GDP (%) (proxy for technology)

W = share of social welfare expenditure in total government budget (%)

PE = share of public and economic services expenditure in total government budget (%)

and the figures in parentheses are t-statistics. R^2 is very high at 0.999. Therefore, the given equation is well-fitted to explain South Korea's growth.

4.2. Assumptions

The following assumptions are made:

(i) It is assumed that 10% of real defence spending is reduced every year from 1980 to 2000 and the resources released from defence spending move to other civilian sectors, including civil investment, human capital, civilian R&D, social development and public economic services.[3] These sectors are believed to be more productive for South Korea's growth than the defence sector. Thus, these are the alternative scenarios to estimate how the resource reallocation could contribute to South Korea's growth. Each scenario (defence→ civil investment, defence→ human capital, defence→ civilian R&D, defence→ social development, and defence→ public economic services) will be simulated and the adjusted growth will be re-estimated for the period 1980-2000.

(ii) It is assumed that the labour force released from the military do not affect the unemployment rate (ie. the civilian market absorbs all redundant labour and the

3 Public and economic services include expenditures on economic development, general public and economic services, such as fuel and energy, agriculture, forestry, mining, transportation and communication etc.

unemployment rate is not changed for the period 1980-2000), although it is unrealistic in the object economy. The labour force released from the military will be absorbed slowly into the civilian economy, but the speed of absorption will depend on a nation's economic condition. Also, it requires aggregate demand to be maintained. In other words, even though the demand for defence is reduced, the demand for civilian sectors is increased, and so the aggregate demand is unchanged in the scenarios.

(iii) The diverted resources released from defence to the civilian sectors do not have inflationary effects on the rest of the economy. The diverted resources from defence to the civilian sectors, such as public and private investment or consumption might increase the domestic demand, and cause inflation. But, the inflationary effect is ignored here, because it is assumed that government will control the expected inflation caused by the defence reductions using fiscal policies.

Based on these assumptions, how the diversion of resources released from defence to the civilian sectors, such as civil investment, human capital, civilian R&D, social development and public and economic services affects South Korea's growth will be simulated.

5. SIMULATION RESULTS

The simulation is based on the period 1980-2000 and compares the actual results (real GDP in 1995 constant prices) with what might have happened under various disarmament scenarios. As mentioned earlier, based on the econometric model provided in Equation (1), five different scenarios will be simulated.

5.1. Scenario 1: Increased Civil Investment

In the Scenario 1, the resources released from defence spending are all reallocated to civil investment. In other words, it is assumed that 10% of real defence spending is diverted to civil investment every year for the period 1980-2000. As shown in Table A.4, this reallocation results in a large increase of GDP throughout the period. The reallocation from defence to civil investment raises GDP by 21.2% throughout the period. The total real GDP during the period is US$ 5,400,350 million, while the reallocation from defence to civil investment is expected to produce US$ 6,546,182 million of GDP for the same period. The GDP simulated by Scenario 1 is greater than the real GDP every year without exception. Even in the economic crises during the period 1997-1998, the simulated GDP is about 8.8% greater than the real GDP on average. As a result, it is proved that disarmament through the resource reallocation from defence to civil investment could raise South Korea's growth for the given period.

5.2. Scenario 2: Increased Human Capital

Disarmament through the resource reallocation from defence to human capital is estimated to increase South Korea's GDP by 1.0% during the period. Unexpectedly, human capital expressed by the ratio of students entering high school did not contribute much to South Korea's growth. The adjusted total GDP is US$ 5,469,247 million. This is much smaller than the GDP in Scenario 1, although it is larger than the actual GDP. According to Table A.4, it is expected that the reallocation from defence to human capital could increase GDP until the late 1980s, but it is harmful for growth since the 1990s. Considering South Korea's employment structure, this might be explainable. In 1989, the total number of unemployed

high school graduates was 231,000, but it was increased every year and reached 713,000 in 1999. Even though the ratio of students entering high school is increased through the increase of government expenditures on education, it could not lead South Korea's growth due to the high unemployment rate of high school graduates. As a result, it is found that the effect of reallocation from defence to human capital is small and even negative because of the under-employment of high school graduates since the 1990s.

5.3. Scenario 3: Increased Civilian R&D[4]

According to Scenario 3, the reallocation from defence to civilian R&D raises GDP by 2.45% on average during the sample period. For the period 1980-2000, the expected GDP is larger than the real GDP every year. The adjusted total GDP is US$ 5,532,666 million during the period. Even though Scenario 3 is more productive for South Korea's growth than Scenario 2, it is less effective than Scenario 1. However, the diverted resources from defence to civilian R&D could have helped South Korea's growth. As shown in Chapter II, South Korea reduced the development of indigenous military technology and dual technologies for both military and civilian uses since the 1980s. That is because the direct investment in civilian R&D is more helpful for growth than the transfer of military technology to civilian uses. Hence, Scenario 3 shows that the defence reductions for the development of civilian technology have a positive effect on growth in South Korea.

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4 Civilian R&D expenditures exclude the research expenditures on military, humanities and social science.

5.4. Scenario 4: Increased Social Development[5]

The diversion of resources released from defence to social development has a positive effect on growth throughout the period. The adjusted total GDP is raised about 2.38% compared with the actual GDP. The adjusted total GDP is US$ 5,529,229 million. Hence, the reallocation of defence reductions to social development is proven to be more beneficial to South Korea's growth than the reallocation to human capital (Scenario 2), but less helpful than the reallocation to civil investment (Scenario 1) and civilian R&D (Scenario 3). Since the 1980s, the importance of social development was increased and its share in government budget was also escalated. Social development expenditures are significant for growth by securing and raising the standard of living. As mentioned in Chapter II, the South Korean government started to pay greater attention to social development since the 1990s, because it perceived that the social welfare, including health and social security is an important factor for productivity. Nevertheless, the diversion of resources released from defence to social development is less beneficial than the other two scenarios, because it does not contribute to growth directly. Increasing expenditures on social welfare might lead to a higher growth by increasing people's efficiency and productivity, but social welfare is not an input raising growth. Also, many European countries having a high standard of social welfare system attain a relatively low growth compared with South Korea. Therefore, increasing social welfare expenditures may not always be good for growth, because it requires a balance between efficiency and equity (or distribution).

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5 Social development expenditures include expenditures on social security and welfare, housing, and health.

5.5. Scenario 5: Increased Public and Economic Services

The reallocation of resources released from defence to public and economic services raises total GDP by 1.56% according to the simulation. The reallocation to public and economic services is more productive than the allocation to defence, but it is less beneficial to growth than Scenarios 1, 3 and 4. The adjusted total GDP is US$ 5,484,554 million for the period.

As shown in Table A.4, the resources released from defence could be an important financial source for public and economic services until the late 1980s. Until 1989, the adjusted total GDP is 3.80% larger than the real GDP and this indicates that the reallocation to public and economic services could be more important for growth in the 1980s than in the 1990s. Since the 1990s, the adjusted total GDP is only 0.49% larger than the real GDP. In the 1980s, public and economic services by government could have more opportunities to contribute to South Korea's growth, because South Korea was not fully developed and still needed infrastructure. However, the necessity of public and economic services was gradually reduced, because most economic services were provided by the civilian economy since the 1990s. The civilian economy is largely involved in these services except for some necessary public services, such as postal service, water supply and sewage disposal. Hence, it is better for raising growth to reallocate defence spending to civil investment, civilian R&D or social welfare than to reallocate to public and economic services since the 1990s.

In conclusion, as shown in Table A.4, it is believed that defence spending crowded out civilian economy and impeded growth in South Korea for the period 1980-2000. The diverted resources released from defence to other sectors, including civil investment, human capital, civilian R&D, social development, and public and economic services result in a higher growth for the period 1980-2000. Among those scenarios, it was shown that the

reallocation of resources from defence to civil investment brought the highest increase of total output, while the diversion of resources to human capital resulted in the lowest increase of total output. Since the 1990s, the reallocation of resources to human capital expressed by the ratio of students entering high school could have reduced the total output by increasing the unemployment rate of high school graduates.

Through the above simulations, **it is found that the reduction of South Korea's defence spending and the reallocation of resources released from defence to other civilian sectors could have increased its total GDP and produced economic peace dividend.** However, this analysis has limitations in that, unemployment rate and aggregate demand are fixed, and there are no inflationary effects. In the object economy, the reduction of defence spending is generally expected to entail adjustment costs and thus reduce peace dividend in the short-run.

Table A.4. Simulation Results

(US$ Million: 1995 constant price)

Year/ GDP	Actual GDP	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		Defence-> Civil Investment	Defence-> Human Capital	Defence-> Civilian R&D	Defence-> Social Development	Defence-> Public and Economic Services
1980-1981	104696	183674	127475	116300	116898	112067
1981-1982	115842	198444	140640	128623	125611	121946
1982-1983	110037	187207	125124	122384	119851	116491
1983-1984	115161	176105	126742	126821	124831	121716
1984-1985	117518	165144	127159	129214	127221	124412
1985-1986	118201	162612	125618	130197	129038	126516
1986-1987	124088	162242	129567	135783	134621	132239
1987-1988	163535	205266	167878	172916	172750	170654
1988-1989	225877	268431	228346	232240	232973	230609
1989-1990	251569	323347	252080	257515	256993	254916
1990-1991	301968	363156	299473	305331	305417	303359
1991-1992	336986	409823	334635	340178	339396	337728
1992-1993	364540	435716	361430	365555	367410	365516
1993-1994	380030	437646	376401	382061	383560	381850
1994-1995	425105	477799	421573	426633	428741	427214

(*Cont.*) Table A.4

Year/ GDP	Actual GDP	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		Defence-> Civil Investment	Defence-> Human Capital	Defence-> Civilian R&D	Defence-> Social Development	Defence-> Public and Economic Services
1995-1996	470329	520077	466526	471141	473054	471710
1996-1997	459908	523477	455362	460076	462823	461766
1997-1998	429065	475265	424872	435054	435011	433075
1998-1999	362861	388261	359121	368191	367753	366819
1999-2000	423034	482490	419225	426453	425277	423951

6. A PEACE DIVIDEND FROM KOREAN UNIFICATION: THE GERMAN EXPERIENCE

Previous simulations are restricted to the effect of defence reductions on South Korea's growth. However, the alleviation of military tension between South and North Korea is essential for a substantial disarmament. Although the North's military threat to the South, including the nuclear development programme still exists, South Korea is preparing for the unification of two Koreas. South Korea's economic aid to the North might be regarded as a South's strategy to reduce the unification cost, because North Korea's economic development might reduce South Korea's economic burden after the unification of the two countries. In this aspect, South Korea might take Germany as a precedent. As shown in Table A.5, the level of Germany's defence spending has gradually decreased since the unification in 1989, but its economic indicators have not been much improved. In other words, it is thought that the peace dividend from defence reductions was small or even negative due to the sudden increase of adjustment costs caused by the difference between two Germanies' economic capabilities.

In Table A.5, Germany's real level of defence spending was steadily reduced from 2.9% of GDP in 1988 to 1.5% of GDP in 1998. For the period 1988-1998, Germany's GDP grew, but the growth rate was not high compared with other European countries, such as France and UK. Furthermore, the economic indicators, including investment growth, R&D and unemployment rate were not much improved in this period. R&D/GDP (%) became lower and the unemployment rate increased. This indicates that the reduction of defence spending from the unification does not contribute to the increase of civilian investment and the reallocation of resources released from defence to other sectors might entail high

adjustment and environmental 'clean-up' costs, such as the relocation and retraining of military personnel and the dismantlement of military equipment and bases in the former East Germany.

Table A.5. Economic Statistics of Germany 1988-1998

(US $ Million; 1995 constant price)

Year/ Indicator	Defence spending	GDP	R&D/GDP (%)	Unemploy -ment (%)	FDI Inflows/ GDP (%)	Investment growth (%)
1988	54022	1862827	1.27	-	-	
1989	53840	1922857	1.28	-	-	
1990	56760	2027143	1.37	-	-	
1991	52533	2284043	1.14	5.6	0.24	1.65
1992	49951	2378619	1.1	6.6	0.13	-6.2
1993	44930	2364737	0.98	7.9	0.1	7.18
1994	41906	2465059	0.89	8.4	0.09	-0.15
1995	41160	2421176	0.86	8.1	0.5	-3.28
1996	40343	2521437	0.83	8.8	0.23	5.79
1997	39106	2444125	0.82	9.8	0.49	-
1998	39012	2600800	-	-	0.88	-

Sources: SIPRI, SIPRI *Yearbook*, various years; World Bank, *World Development Indicators* 2000.

In spite of Germany's strong economic capability, the defence reductions from unification were not enough to promote its growth. It is believed that unification costs, such as the costs for the reform of former East Germany's economy, social infrastructure and welfare, and the exchange rate problem between West and East Germany were so large that the benefits from the two nations' unification, such as defence reductions had no positive effect on its economy. Intriligator (1993, 1994) said that the defence reductions involving high

conversion costs and relatively small benefits could provide a small or negative social rate of return.

From Germany's experience, South Korea might learn how to reduce the costs and increase the benefits from the unification of two Koreas. Germany's GDP is about 6 times larger than South Korea's and its defence spending is also 3 times larger than South Korea's in 2000. South Korea might have two options for unification. On one hand, it might open North Korea by providing economic aid and increasing the trade volume between the two countries. The trade volume between the South and North was US$ 22,559,000 in 1989, but it was increased to US$ 397,334,580 in 2000 in real terms (1996 constant price). Also, South Korea is supplying rice to the North to resolve its chronic food shortages. South Korea's direct investment in North Korea has also been increasing since the peace talks in 2000. The South and North restored the railway around the borderline and agreed on constructing industrial complexes in some North Korean cities. Tourism by South Korean people became an important financial resource for North Korea. Investment in North Korea might increase the per capita income of North Korea and its economic growth. Actually, North Korea attained a positive growth since the late 1990s due to the increasing economic co-operation with South Korea. Hence, the steady investment in the North might help reforming North Korea's economy and reduce the economic burden and conversion costs of a united Korea in the future.

In contrast, South Korea might reach early unification by a collapse of North Korea's economy. The intense arms race led by South Korea can increase the defence burden of North Korea and worsen its economy. In the 1980s, the US-Soviet arms race led the Soviet Union to economic and political collapse. However, it is not simple to adopt this strategy.

First, this strategy might increase military tension between the two Koreas and precipitate North Korea's nuclear development and a pre-emptive strike. Furthermore, the North might increase arms export to resolve its economic difficulties. In fact, the economic blockade of North Korea might not be so effective, because the North could run its economy through trade with China and Russia, and its political system is unlikely to collapse in spite of economic difficulties. Therefore, the second option might make the South-North relationship worse without any gain. Consequently, South Korea is better to help North Korea reform its economic structure and reduce the economic gap with the South, and induce the change of North Korea's economic and political system before unification. The study on the economic effects of the two Koreas' unification is beyond the scope of this thesis, but it was briefly analysed in terms of defence reductions and peace dividend.

7. SUMMARY

Defence reductions in the Korean Peninsula have not been successful in spite of the bilateral non-aggression agreement between the South and North, because the two Koreas have not yet resolved their deep distrust of each other. The prospects of full-scale disarmament between the two Koreas are still unclear in spite of the South-North peace talks. It is expected that there might be no disarmament in both South and North Korea, especially in defence equipment whether of conventional or strategic weapons in the near future.

In simulating hypothetical reductions of defence spending, the effects of reducing South Korea's defence spending on its growth are generally positive for the period 1980-2000. As shown in the simulation results, the diversion of resources released from defence to other

civilian sectors increases GDP and promotes growth. The adjusted GDP were larger than the actual GDP in all scenarios. Therefore, it is concluded that defence spending hampered growth by crowding-out the civilian economy in South Korea for the period 1980-2000 as shown in Chapter VI. The reallocation of resources released from defence to the civilian sector could have helped South Korea's growth and thus produced a peace dividend for this period.

APPENDICES

APPENDICES

Appendix II-1[1].

As the result of simple correlation test between the two Koreas' defence spending, the defence spending between the two nations are significantly correlated at 0.53 in the Pearson test and 0.59 in the Spearman's rho test. Through these correlation tests, a possibility of the arms race between South and North Korea can be found.

Table II-1A. Pearson Correlations

		SME	NME
SME	Pearson Correlation	1	.528**
	Sig. (2-tailed)	.	.001
	N	37	37
NME	Pearson Correlation	.528**	1
	Sig. (2-tailed)	.001	.
	N	37	37

**. Correlations is significant at the 0.01 level.

Note: SME is South Korea's defence spending and NME is North Korea's defence spending.

1 Roman number denotes the chapter.

Table II-1B. Nonparametric Correlations

		SME	NME
SME	Spearman's rho Sig. (2-tailed) N	1.000 . 37	.587** .000 37
NME	Spearman's rho Sig. (2-tailed) N	.587** .000 37	1.000 . 37

**. Correlations is significant at the 0.01 level.

Note: SME is South Korea's defence spending and NME is North Korea's defence spending.

Appendix II-2.

As the result of simple correlation test between defence and growth in South Korea, the relationship between the two variables is non-significant in both the Pearson and Spearman's rho tests.

Table II-2A. Pearson Correlations

		GROWTH	DEFENCE
GROWTH	Pearson Correlation	1	-.216
	Sig. (2-tailed)	.	.200
	N	37	37
DEFENCE	Pearson Correlation	-.216	1
	Sig. (2-tailed)	.200	.
	N	37	37

**. Correlations is significant at the 0.01 level.

Table II-2B. Nonparametric Correlations

		GROWTH	DEFENCE
GROWTH	Spearman's rho	1.000	-.213
	Sig. (2-tailed)	.	.206
	N	37	37
DEFENCE	Spearman's rho	-.213	1.000
	Sig. (2-tailed)	.206	.
	N	37	37

**. Correlations is significant at the 0.01 level.

Appendix IV-1.

The empirical results of log-linear model in Table IV-1A show the asymmetric arms race between South and North Korea led by the US-South alliance. The R^2 s are high compared with a simple linear model, but the signs of coefficients are different from the expectations presented in Chapter IV. Fatigue coefficients are not negative but positive, and inter-state conflict factor has a negative effect on South Korea's defence spending. Hence, it provides very different results from the linear model, but still shows South Korea's leadership in the arms race with North Korea.

Table IV-1A. Regression Results of Log-linear Model (1963-2000)

Dependent	Coefficients of independent variables					Statistical values		
Dependent variable	Threat	Fatigue	Conflict	US Aid	Grievance	R^2	F-value	DW
(1) MND								
South	0.15 (2.38)**	0.90 (14.25)***	-0.096 (2.27)**	-3.2E-05 (-0.24)	-0.35 (-0.83)	0.99	891.18	1.34
North	-0.09 (-1.65)	0.96 (10.63)***	0.09 (1.23)		1.08 (2.19)**	0.87	73.94	2.08
(2) SIPRI								
South	0.14 (1.80)*	0.95 (14.38)***	0.04 (1.36)	1.25E-04 (1.15)	-0.56 (-1.55)	0.99	1372.5	1.00
North	-6.2E-03 (-0.09)	0.90 (8.65)***	0.05 (1.15)		0.75 (2.66)**	0.95	192.34	1.35

Notes: 1.Threat factor in North is the coefficient of the total defence spending of the US-South Korea alliance.

2. Figures in parentheses in the coefficients of independent variables are t -statistics.

***.01 level of significance; **.05 level of significance; *.10 level of significance

Appendix IV-2.

Table IV-2A shows the military expenditure data of each institution, including the Korean Ministry of Defense (MND), the Stockholm International Peace Research Institute (SIPRI), the International Institute for Strategic Studies (IISS) and the US Department of State (ACDA).

Table IV-2A. Comparison of Military Expenditure Data (US$ Million in 1995 constant price)

Year	Military Expenditures of South Korea				Military Expenditures of North Korea				US Military Aid
	MND	SIPRI	IISS	ACDA	MND	SIPRI	IISS	ACDA	
1963-1964	540	661	-	-	1061	368	-	-	1001
1964-1965	475	621	-	-	1174	394	-	-	825
1965-1966	508	657	-	-	1170	459	-	-	1101
1966-1967	630	797	-	-	1154	455	-	-	771
1967-1968	711	887	-	-	1983	610	-	-	655
1968-1969	861	1049	-	-	2472	826	-	-	938
1969-1970	1039	1211	-	-	2349	918	-	-	1031
1970-1971	1099	1249	636	-	2511	978	746	-	1286
1971-1972	1301	1476	785	-	3354	965	1180	-	1019
1972-1973	1470	1840	815	2330	2959	619	615	1535	1297
1973-1974	1442	2052	909	2147	2760	614	862	1877	547

(*Cont.*) Table IV-2A.

Year	Military Expenditures of South Korea				Military Expenditures of North Korea				US Military Aid
	MND	SIPRI	IISS	ACDA	MND	SIPRI	IISS	ACDA	
1974-1975	2008	2345	1066	2627	3625	766	1070	2041	513
1975-1976	2411	2835	1373	3054	4522	918	1070	1609	488
1976-1977	3600	4104	2865	4296	4399	1014	1220	2220	698
1977-1978	4545	4882	3438	4834	4455	1044	1390	1862	535
1978-1979	5693	6068	2407	5715	5284	1155	1432	1952	433
1979-1980	6003	5935	6150	5322	5799	1262	1668	1967	192
1980-1981	6689	6669	6609	5964	5858	1350	1807	4470	161
1981-1982	6783	6914	8404	6453	5295	1362	2043	5039	59
1982-1983	6703	7200	7583	6742	5004	1468	2336	5217	63
1983-1984	6470	7497	9880	6911	5039	1599	2396	5417	-111
1984-1985	6261	7690	8417	6979	4823	1730	2663	5617	-38
1985-1986	6198	8311	8592	7419	4647	1783	5675	5839	-3
1986-1987	6278	8928	9754	7978	5136	1801	5382	6038	-98
1987-1988	7434	9747	10954	8152	5567	1799	5870	6260	-256
1988-1989	9375	10594	12050	8762	5502	1756	5481	6482	-260
1989-1990	10649	11261	12153	9658	5398	1845	5602	6660	-353
1990-1991	11666	11675	12677	10622	4280	1961	5434	6593	-194

(*Cont.*) Table IV-2A.

Year	Military Expenditures of South Korea				Military Expenditures of North Korea				US Military Aid
	MND	SIPRI	IISS	ACDA	MND	SIPRI	IISS	ACDA	
1991-1992	12638	12648	12146	10003	5166	2030	5328	5175	-274
1992-1993	13130	13140	13731	10850	4819	2083	5087	5966	-299
1993-1994	13002	13011	11645	11470	4842	2133	5305	5485	-333
1994-1995	13625	13624	12764	12090	4783	2190	5412	5692	-366
1995-1996	14424	14410	14359	12000	5932	2353	5232	6000	-400
1996-1997	14245	15187	16172	13842	5559	2259	5559	5894	-425
1997-1998	12930	15554	14732	-	2238	1670	2238	-	-456
1998-1999	10923	15015	10461	-	1952	1327*	2086	-	-275
1999-2000	13104	14608	12088	-	1929	1364*	2100	-	-432

Note: Asterisk * is 1998 constant price.

Appendix IV-3.

Table IV-3A compares the numbers of military personnel and tactical aircraft between South and North Korea for the period 1963-2000.

Table IV-3A. Number of Military Personnel and Tactical Aircraft

Year	South Korea		North Korea	
	Military Personnel	Tactical Aircraft	Military Personnel	Tactical Aircraft
1963-1964	627000	128	375000	500
1964-1965	600000	128	411000	500
1965-1966	604000	200	411000	500
1966-1967	571600	200	411000	500
1967-1968	612000	230	412000	500
1968-1969	620000	230	433500	620
1969-1970	620000	250	466100	700
1970-1971	645000	250	467300	700
1971-1972	634250	276	466700	685
1972-1973	634750	276	468200	708
1973-1974	633500	245	504700	748
1974-1975	625000	265	562000	818
1975-1976	625000	337	567000	907
1976-1977	635000	351	567000	910
1977-1978	635000	499	570000	910
1978-1979	642000	464	612000	1065
1979-1980	619000	442	692000	1006
1980-1981	600600	562	700000	1106
1981-1982	601600	543	768000	1171
1982-1983	601600	672	782000	1160
1983-1984	622000	686	784000	1290
1984-1985	622000	693	784000	1292
1985-1986	598000	700	784000	1496
1986-1987	601000	710	838000	1550
1987-1988	629000	729	838000	1648
1988-1989	629000	731	870000	1572
1989-1990	650000	670	980000	1378
1990-1991	750000	654	990000	1500
1991-1992	750000	590	995000	1550
1992-1993	633000	590	1010000	1550
1993-1994	633000	650	1030000	1555
1994-1995	633000	690	1030000	1595
1995-1996	633000	636	1040000	1446
1996-1997	660000	636	1055000	1422
1997-1998	672000	706	1055000	1417
1998-1999	672000	706	1082000	1421
1999-2000	683000	752	1082000	1510

Source: The International Institute for Strategic Studies, *The Military Balance* 1963-2001.

Appendix VI-1.

Table VI-1A shows the list of data statistics related to the defence-growth relationship in South Korea for the period 1963-2000.

Table VI-1A. List of Series and Data Statistics

Year	Δ gdp	Δ s	Δ m	Δ lab	Δ nge	Δpcgdp	Δtb	Δusaid	Δnklag	Δexch	infla	hc	ct	ic	dum
1963-64	1503	620	-114	208	6.1	44	-413	1.2	89	-8.9	28.4	30.0	0.24	0	0
1964-65	337	-4	-65	135	1.3	-1	558	5.9	113	574.3	32.9	30.6	0.24	0	0
1965-66	536	-35	33	414	-0.6	7	163	-6.9	-4	39.7	6.4	32.3	0.26	0	0
1966-67	2020	802	122	213	-7.7	57	-494	6.9	-16	-44.1	14.0	28.2	0.31	0	0
1967-68	1591	56	81	299	1.7	40	-364	-3.7	829	-18.5	16.1	30.8	0.37	0	0
1968-69	3159	1061	150	437	1.5	90	-971	7.2	489	-24.7	15.9	29.5	0.41	1	0
1969-70	4841	1692	178	224	1.9	138	-330	-13.4	-123	32.3	14.6	26.2	0.45	0	0
1970-71	2838	-323	60	332	-0.6	71	-170	-7	162	-11.8	18.4	26.9	0.38	0	0
1971-72	6983	561	202	329	-0.4	195	-661	4.4	843	134.6	13.9	28.3	0.31	0	0
1972-73	-162	394	169	433	-0.3	-24	1715	-2.6	-395	28.1	17.4	29.0	0.29	0	0
1973-74	3973	2753	-28	563	-1.3	98	268	4.1	-199	-83.3	14.1	28.1	0.29	0	0
1974-75	13869	1919	566	479	1.2	380	-4861	-10	865	151.1	30.8	26.5	0.5	1	0
1975-76	3228	-578	403	271	-1.6	66	850	3	897	-117.7	26.0	23.9	0.42	1	0

(*Cont.*) Table VI-1A.

Year	Δ gdp	Δ s	Δ m	Δ lab	Δ nge	Δpcgdp	Δtb	Δusaid	Δnklag	Δexch	infla	hc	ct	ic	dum
1976-77	11854	6289	1189	720	-3.8	306	4201	-19.4	-123	-78.4	22.4	23.8	0.44	1	0
1977-78	16243	6708	945	400	-1.9	416	804	-7.2	56	-77.2	16.2	21.4	0.8	0	0
1978-79	15710	6717	1148	600	-0.9	391	-2364	-3.5	829	-78.9	23.4	22.0	0.75	0	0
1979-80	17829	3683	310	190	3.5	434	-5872	-0.6	515	-85.1	20.1	25.9	0.7	1	0
1980-81	-4333	-7244	686	81	-2.2	-162	-1382	-5.7	59	234.3	24.9	43.3	0.74	1	-1
1981-82	11146	-414	94	340	0.8	-55	2052	-3.5	-563	-45.1	17.6	59.3	0.77	0	0
1982-83	-5805	2311	-80	356	-2	20	3603	-3.9	-291	8.9	6.7	54.9	0.97	0	0
1983-84	5124	5494	-233	126	0.4	120	1685	-0.8	35	19.5	5.2	53.5	1.06	1	0
1984-85	2357	4512	-209	-76	0.9	103	425	-1.4	-216	-6.9	5.5	51.6	1.23	0	0
1985-86	683	1600	-63	541	0.6	-62	741	-1.1	-176	4.6	4.6	49.6	1.51	0	0
1986-87	5887	5209	80	535	-0.7	141	7352	0.1	489	-67.3	4.6	47.5	1.68	0	0
1987-88	39447	16606	1156	849	0.9	728	6690	0.1	431	-126	5.0	46.1	1.77	1	0
1988-89	62342	30489	1941	515	1.3	1607	5039	-1.6	-65	-172	6.7	44.5	1.84	1	0
1989-90	25692	4264	1274	691	4.4	696	-11627	-2	-104	-41	5.3	44.4	1.89	0	0
1990-91	50399	21863	1017	525	1.4	1083	-8652	0.8	-1118	8.3	9.9	44.9	1.87	0	0
1991-92	35018	9168	972	592	0.8	534	-6840	-0.6	886	18.4	10.9	45.9	1.93	0	0
1992-93	27554	9148	492	356	0.8	686	4910	1.6	-347	7.9	7.6	50.7	2.08	0	0

(*Cont.*) Table VI-1A.

Year	Δ gdp	Δ s	Δ m	Δ lab	Δ nge	Δpcgdp	Δtb	Δusaid	Δnklag	Δexch	infla	hc	ct	ic	dum
1993-94	15490	6076	-128	295	1.1	340	5241	-0.7	23	-1.9	7.0	55.4	2.3	0	0
1994-95	45075	13400	623	577	-1.5	930	-4963	-0.2	-59	-38	7.7	63.1	2.58	1	0
1995-96	45224	14656	799	527	4.4	817	-4574	-0.2	1149	-27.7	7.1	74.2	2.71	0	0
1996-97	-10421	-10191	-179	385	-0.2	-237	-13032	-0.1	-373	60.1	3.9	78.9	2.79	0	0
1997-98	-30843	-11575	-1315	289	0.1	-731	14255	0.1	-3321	558.7	3.1	85.8	2.69	0	-1
1998-99	-66204	-20855	-2007	-1112	1.8	-1582	45875	0	-3457	-216	5.3	84.4	2.52	0	-1
1999-00	60173	15644	2181	287	0.3	1210	-17453	-0.4	-157	-126	-1.6	84.4	2.46	1	0

Notes: Δ gdp= real growth of gross domestic product (GDP) (US$ Million in 1995 constant price); Δ s= real growth of domestic savings (US$ Million in 1995 constant price); Δ m= real growth of defence spending (US$ Million in 1995 constant price); Δ tb= real growth of trade balance (US$ Million in 1995 constant price); Δ lab= size of employed labour forces (first difference) (thousands); hc= human capital investment (advance rate of students to high school)(%); ct= civilian R&D expenditures to GDP (%); Δ nge= share of non-military government expenditures in total government expenditures (first differnce); infla= inflation rate (%); Δexch= real exchange rate (US$); Δpcgdp = real growth of per capita GDP (US$); Δusaid= share of US grant in the total defence spending of US-South Korean alliance (first difference); Δnklag= real growth of North Korean defence spending in the previous year (US$ Million in 1995 constant price); dum= impulse dummy variable for economic crises in 1980 and 1998; ic= dummy variable for Inter-Korean conflicts for the period 1963-2000.

Appendix VII-1.

Table VII-1A shows the list of data statistics used for measuring the possible effect of defence reductions in South Korea for the period 1980-2000.

Table VII-1A. List of Series and Data Statistics

Year	inv	m	tb	labour	hc	ct	sd	pes
1980-81	26302	6689	-9590	13683	43.3	0.74	6.4	21.5
1981-82	25888	6783	-7538	14023	59.3	0.77	6.0	18.9
1982-83	28199	6703	-3935	14379	54.9	0.97	6.2	17.5
1983-84	33693	6470	-2250	14505	53.5	1.06	6.5	17.2
1984-85	38205	6261	-1825	14429	51.6	1.23	6.4	15.3
1985-86	39805	6198	-1084	14970	49.6	1.51	6.8	16.1
1986-87	45014	6278	6268	15505	47.5	1.68	7.9	16.5
1987-88	61620	7434	12958	16354	46.1	1.77	8.2	19.4
1988-89	92109	9375	17997	16869	44.5	1.84	7.8	14.6
1989-90	96373	10649	6370	17560	44.4	1.89	8.9	14.9
1990-91	118236	11666	-2282	18085	44.9	1.87	8.9	14.1

(*Cont.*) Table VII-1A.

Year	inv	m	tb	labour	hc	ct	sd	pes
1991-92	127404	12638	-9122	18677	45.9	1.93	10.2	16.4
1992-93	136552	13130	-4212	19033	50.7	2.08	9.7	18.6
1993-94	142628	13002	1029	19328	55.4	2.30	9.2	20.7
1994-95	156028	13625	-3934	19905	63.1	2.58	9.0	23.1
1995-96	170684	14424	-8508	20432	74.2	2.71	8.1	22.3
1996-97	160493	14245	-21540	20817	78.9	2.79	8.6	22.4
1997-98	148918	12930	-7285	21106	85.8	2.69	9.2	25.5
1998-99	128063	10923	38590	19994	84.4	2.52	9.8	30.3
1999-00	143707	13104	21137	20281	84.4	2.46	11.4	29.2

Notes: inv= real civilian investment (US$ million; 1995 constant price); m= real military expenditures (US$ million;1995 constant price); tb= balance of trade (US$ million; 1995 constant price); labour= size of employed labour force (thousands); hc= human capital investment (advance rate of students to high school) (%); ct= civilian R&D expenditures to GDP (%); sd= share of social development expenditures in total government budget (%); pes= share of public and economic services expenditures in total government budget (%)

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