AN EMPIRICAL ANALYSIS OF DEFENCE SPENDING AND ECONOMIC GROWTH IN TURKEY AND GREECE

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To the memory of my father

ABSTRACT

This thesis explores the relationship between defence expenditure and economic growth in the case of Turkey with Greece used as a basis for comparison.

The thesis starts with a review of relevant literature and a survey of the Turkish defence economy including Turkey's newly-developing defence industry (Chapters 2 and 3). Chapter 4 empirically estimates Turkish defence-growth relationships using a supply-side model. Both externality effects and the size effects of defence expenditure are estimated for Turkey. Lags and human capital variables are introduced into a Feder type supply-side model. Chapter 5 uses an alternative model (Deger model) to test the relationships. In this Chapter, the relationship is investigated using 2SLS and 3SLS simultaneous equation methods and also some results from cointegrated regression are provided, together with Granger causality tests for Turkey. Chapter 6 applies the analysis to Greece. It uses supply-side (Feder type) and demand and supply-side (Deger type) models to analyse Greek defence-growth relationships. Firstly, Chapter 6 provides a review of the Greek defence economy, then the relationship is estimated using both a supply-side Feder model and Deger type demand and supply-side multi-equation model. Finally, Chapter 7, assesses the effects of Turkish and Greek disaggregated defence expenditure on economic growth using an error correction mechanism.

This thesis concludes that the effect of defence expenditure differs among the countries. The thesis shows a positive impact of defence spending on Turkish economic growth but the effect is not clear for Greece.

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A version of Chapter 7 was presented at the International Conference on "The Arms Trade, Security and Conflict", June 11-12th, 1999, Middlesex University London.

CHAPTER 1

CHAPTER 1

INTRODUCTION

1.1. Objectives of the Thesis

Defence expenditure is important in the government budgets of all countries and is a major user of scarce resources. Although defence expenditure has been decreasing in recent years, most parts of the world still have high defence expenditures implying the sacrifice of alternative civil expenditures (*e.g.* schools, hospitals). Total world defence expenditure was estimated at US $864 billion in 1995 (US ACDA 1996). On average, 2.8 per cent of GNP and over 13 per cent of all central government expenditure are spent on defence in the developing world (US ACDA, 1996) and these are countries facing major problems of poverty, starvation, ill-health, lack of education and poor housing. Moreover, some countries continue to spend a huge amount on defence each year, apparently for security considerations. Turkey and Greece are examples of such countries. Their military burdens remain the highest in NATO, namely, 5.74% of GDP for Greece and 4.42% for Turkey compared to NATO's average of 3.5% for the last decade (Dunne *et al.* 1998). For these reasons defence expenditure and its economic effects needed to be carefully and critically evaluated.

An important and controversial area for defence economists is the relationship between defence spending and economic growth. Until 1973, it is difficult to find any study on defence-growth relationships. The most important contribution was made by Benoit (1973). After Benoit's work many studies were carried out in the literature. However, there is no consensus to whether defence spending has a negative effect or a positive effect on a nations' economic growth.

1.2. The Central Hypothesis

This study explores the defence-growth relationship for Turkey. It is hypothesised that Turkish defence spending should have a positive impact on its economic growth. Turkey is an example of a developing country with a substantial defence burden. Turkey has achieved considerably high economic growth over the last four decades at a time when its defence expenditures have also shown an increasing trend during the time. Military spending has some apparent economic benefits for a nation's development. In Turkey, almost every man apparently benefited from compulsory military service. For example, technology training given during military service turns conscripts into qualified personnel able to contribute to the economic development of the country; the Armed Forces also organise literacy courses for their personnel. Further benefits of military expenditure result from the production of medical drugs in the military plants, from the treatment of civilians in military hospitals, from mapping services and from the military contributing to the development of communications, transport and infra-structure (*e.g.* roads; bridges; telecommunications: all of which create a national market). These are all examples of possible ways through which defence spending contributes to the Turkish economy. This thesis undertakes an in-depth analysis of the defence-growth relationship using time-series data for Turkey.

Greece is included in the thesis to provide a comparative study. Greece is also a member of NATO; it is a developing nation with a high defence burden; it is in a potential conflict situation with Turkey; and both are Mediterranean countries. Thus, Greece provides a comparative country case study to test the robustness and reliability of any defence-growth relationships estimated for Turkey.

In addition to the central study of the defence-growth relationships for Turkey, this thesis addresses several subsidiary research questions:

1. Does the newly-developing defence industry of Turkey help to lower its arms imports?
2. What is size effect of defence expenditure in Turkey?
3. Are there externalities from defence to the rest of the Turkish economy?
4. Is there a causal relation between Turkey's defence spending and economic growth?
5. Do disaggregated defence expenditures (*i.e.* equipment, personnel) have different impacts on Turkey's economic growth?
6. Do the effects of defence spending differ among countries? Comparisons will be made with Greece. Questions will be asked about the impact of Greek defence spending on its economic growth and the size effect of defence expenditure in Greece compared with Turkey (*e.g.* do the size effects differ and why?).

This thesis will analyse the relationship between defence expenditure and economic growth in the case of Turkey reinforced by comparisons with Greece. To analyse defence-growth relationships, the previous empirical evidence on defence-growth studies is critically reviewed and Turkey's military industrial sector is described and evaluated. The impacts of defence spending are empirically estimated for Turkey and then compared with Greece.

This study differs from other comparable studies in that:

1. It evaluates the Turkish defence industry, its armed forces and the trends in Turkish defence expenditure over the period 1955-1996 (*i.e.* Turkey's military-industrial complex);

2. It makes an original contribution to the literature through an empirical case study. There has been no rigorous empirical study relating to economic growth and defence spending in Turkey. The reliability and robustness of the results for Turkey are then tested using Greece as a comparative case study.

This study uses financial data mainly from the International Monetary Fund (IMF)/ International Financial Statistics (IFS), the Organisation for Economic Cooperation and Development (OECD), the Stockholm International Peace Research Institute (SIPRI), the State Institute of Statistics (SIS) Turkey, the State Planning Organisation (SPO) Turkey, and the Ministry of Finance of Turkey.

1.3. Plan of the Thesis

This study is primarily focussed on Turkish economic growth and defence spending between 1955 and1996. The thesis is organised as follows. Chapter 2 assesses the existing literature on defence expenditure and economic growth. This Chapter starts by reviewing defence-economic growth relationships from Benoit's (1973) path breaking study, followed by the studies using supply side models, demand and supply side models and finally, the studies using Granger causality are reviewed. Data sources are also assessed in this Chapter which concludes with a summary and assessment.

Chapter 3 examines the Turkish armed forces, the new-developing Turkish industry and its modernisation and the trend of Turkish defence expenditure. Turkey is an important country in the region. This Chapter briefly reviews the history of the Republic of Turkey and presents some historical data; it also analyses Turkey's defence industry and its development.

Chapter 4 provides empirical time series evidence for Turkey. The relationship between Turkish defence expenditure and economic growth is estimated using an augmented Feder model with the addition of human capital. There are some novel results of this analysis. Firstly, a labour force data set was constructed: this allows us to obtain a clearer picture of defence-growth relationships. Secondly, both level and first differences of the variable are regressed to avoid spurious regression. Thirdly, human capital and lags are introduced into the Feder model.

Chapter 5 is also an empirical analysis of defence-growth relationships for Turkey but using an alternative model. The model is based on Deger (1986a, 1986b) which applies simultaneous equation methods. Some results from cointegration analysis are presented and this Chapter also provides a causal analysis of Turkish defence-growth relationships for the period 1924 to 1996.

Using the analysis and results for Turkey, Chapter 6 applies the models to test for a similar relationship in Greece. This Chapter is comparative: the empirical model used in Chapters 4 and 5 is applied to Greek data. Firstly, a defence-growth trade-off for Greece is estimated with a supply-side (Feder type) model using OLS estimation for the period 1958-1994; and secondly, a Deger type (demand and supply side) model is tested using the Greek data. This Chapter also briefly reviews the defence economy of Greece. The results suggest that the effect of defence spending differs between the two countries.

In Chapter 7, the relationship between defence expenditure and economic growth is analysed using disaggregated defence expenditure data for Turkey; and then comparisons are made with Greece. This Chapter uses recent econometric techniques of error correction mechanisms. The Chapter mainly considers the effects of equipment and non-equipment defence spending. The evidence showed that the effects of equipment and non-equipment defence spending are different and the results also differ between the short-run and long-run. Finally, Chapter 8 presents some concluding remarks and proposals for further research.

This thesis makes a major contribution to the defence economics literature it should also be of interest to public sector economists and practitioners of government spending as well as development economists. It is of interest to public economists because defence expenditure is an important proportion of the government budgets of all countries. It is of interest to practitioners because they are in need of more case studies about the possible economic effects of defence expenditure. It is of interest to development economists because defence has an important role in the development of countries: it is a user of scarce resources in poor nations. This thesis should also be of interest to applied economists who are concerned with the relationships between defence spending and economic growth.

It is important to understand how defence expenditure affects economic growth and whether these effects differ among countries. This is an important topic for theoretical and empirical work in the defence economics discipline. A starting point for the analysis requires a review of the relevant literature.

CHAPTER 2

CHAPTER 2

REVIEW OF THE LITERATURE AND THE DATA

2.1. Introduction: overview

The aim of this Chapter is to review existing studies of defence-growth relationships and critically analyse data problems and give the data sources used in this thesis. To explain the relationship between defence spending and economic growth, demand side and supply side studies were used. Some of the models included both demand side and supply side considerations. The majority of demand side models in the literature have found a negative effect of defence spending on growth. On the other hand, supply side models might have a positive effect of defence spending on economic growth through spin-off and externalities. However most supply side models reviewed had no significant effects on growth (Sandler & Hartley 1995). Furthermore, some studies applied Granger causality tests (Chowdhury 1991, Jeording 1986). The findings of these studies are inconclusive. While some studies found defence is endogenous relative to economic growth, other studies found no causal relationships (Jeording, 1986; Chowdhury, 1991; Madden & Haslehurst, 1995).

Both demand side and supply side models use ordinary least squares or ordinary ridge regression or a three-stage least squares estimation. For empirical study, it is very important to use appropriate data. There are three alternative methods for defence-growth empirical estimations: they are time series or longitudinal data, cross sectional data at a point of time or pooled time series and cross sectional data (Gujarati 1992). When a study focuses on only one country, time series data are most appropriate (Sandler & Hartley 1995).

This Chapter is organised as follows. Firstly, Benoit's (1973; 1978) original contributions are critically analysed (section 2.2); then supply side (Feder type) models and existing studies are reviewed in section 2.3. Section 2.4 is devoted to demand and supply side (Deger type) models. In section 2.5, the studies using Granger causality are reviewed. After the conclusions from the literature review (section 2.6), section 2.7 discusses data problems and provides the data sources used in this thesis. Finally, section 2.8. concludes the Chapter.

2.2. Benoit (1973 & 1978)

The first comprehensive and pioneering study of defence-growth relationships came from Benoit in 1973. He used a large sample of 44 less developed countries(LDCs) between 1950 and 1965. There were also some specific country studies such as India, Mexico, South Korea, Argentina, Israel and United Arab Republic but the main country study was India. **He showed that defence spending has a surprising positive effect on economic growth.** Benoit's 1978 paper supported these arguments. He considered the direction of Granger causality (between economic growth and defence spending) in his work and found that causation goes from defence to growth. He considered foreign aid but ignored labour. The very important point from the study is that if government reduced the defence budget, then the money may not always go to investment: instead consumption or social wages may increase. For this reason, the opportunity cost of defence spending can be very low (Benoit 1978). Benoit calculated that if the share of defence in GDP increased one per cent, civilian growth will increase 0.25 per cent, therefore the net effect of defence spending is positive and defence helps growth (Benoit 1973).

Benoit's statistical method and his correlation analysis have been criticised by many scholars. The equation was:

$$g=a_0+a_1m+a_2Z \qquad \textbf{(2.1)}$$

In this model g denotes growth rates, m shows the defence burden (M/Y) and Z is a vector of other exogenous variables and a_1 is positive coefficient and often significant which represents a positive effect of defence spending on economic growth. However, according to Deger(1986), only two direct effects (aggregate demand stimulation and spin-off) of defence spending were considered, the indirect effects were ignored. If negative resource allocation effects were considered, the results might have reversed because the defence sector diverts resources away from other sectors to defence (Deger, 1986). Deger and Smith(1986) found that defence spending stimulated growth, and this is the positive direct effect; on the other side, the higher defence spending reduces savings rates then reduces investment then growth and this is negative indirect effect. The net effect is argued to be negative based on Deger's empirical findings (Deger 1986).

Benoit's works was also criticised by Smith especially his estimation method and sample countries. The sample of 44 LDCs was at very different stages of development, from Turkey and Spain to Burma and Ceylon, and also the rate of growth of GDP is an insignificant indicator of the rate of development. The most serious weakness with Benoit's study was the statistical method used. He did not use an explicit theoretical economic model (Smith 1980). Another important criticism came from Ball's (1983) descriptive paper. He asserted that Benoit used an imperfect method to study defence-growth relationships (Ball 1983). Frederikson and Looney extended Benoit's work in 1983. They used the same sample of countries and the same time period, but the sample countries were divided into two groups as relatively poor countries and others. They found a negative defence effect for poor countries and positive for relatively rich countries, and they showed that Benoit's sample was inadequate (Frederikson & Looney 1983). When Benoit's sample and the time period are examined, it can be seen, Benoit's estimates of correlation coefficient for defence spending and growth were fragile (Grobar & Porter 1983). In spite of some weaknesses, Benoit's work remains a starting point for defence-growth relationships. The next section reviews the literature on supply-side models.

2.3. Supply Side (Feder Type) Studies[1]

Feder (1983) developed a model to analyse the impact of the export sector on economic growth. Feder's model divides the economy into two sectors. One is an advanced sector export (X) and the other is a domestically oriented sector (non-export sector). There are positive externalities from an advanced sector to the rest of the economy. Ram (1986), and Biswas and Ram (1986) firstly applied this model to the study of defence spending and economic growth in a cross-section of 58 LDC's over the period 1960-1977. Since then many other scholars have employed the Feder model for defence-growth association (Atesoglu and Mueller, 1990; Alexander, 1990, 1995; Huang and Mintz, 1990; 1991; Adams, Behrman and Boldin, 1991; Ward *et al.* 1991; Ward and Davis, 1992; Biswas, 1993; Mueller and Atesoglu, 1993; Ward, Davis and Chan, 1993; DeRouen, 1994; Macnair *et al.* 1995; Mintz and Stevanson, 1995; Ward, Davis and Lofdahl, 1995).

1 The model will be extensively explained in Chapter 4

Firstly, it is assumed that the economy consists of two sectors namely, a civilian sector (C) and a defence sector (M). There are externalities from a defence sector to civilian sector. From the production function the main inputs of the sectors are capital (K) and labour (L). Subscripts refer to each sector:

$$M=M(K_m,L_m) \quad \textbf{(2.2)}$$

$$C=C(K_c,\ L_c,\ M) \quad \textbf{(2.3)}$$

The main point in this model is that it allows externalities from sector "M" to sector "C" and it considers factor productivity differentials. This type of model offers much for the empirical study of defence-growth relationships (Deger and Sen, 1995). It considers externalities between sectors and may explain both the size effect of defence expenditure and the externality effect as well as factor productivity differentials. At the same time, the model needs relatively less data which are generally a major problem for many developing countries. The other advantage of this model is that it describes the supply constraints which are important for developing countries such as Turkey. Skilled worker and investment are a major constraint for developing countries. The next section reviews some important supply side models[2].

Biswas and Ram (1986) paper was the first comprehensive paper analysing defence-growth relationships using Feder type supply side model. The purpose of the paper was to decide whether defence sectors generate any externalities to the civilian sector and whether relative productivity differs significantly across defence and civilian sectors. The Feder model extended two sectors (defence and civilian) using data for the period 1960-70 and 1970-77

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[2] The other important supply side (Feder type) studies are provided in Appendix 2.1.

with a large sample of LDCs and the sample countries were separated into low income and middle income countries, because they thought that the effect of defence spending depended on a country's income. In contrast to the Ram(1986) study, the government sector was replaced with the defence sector. It is assumed there are two sectors in the economy: they are the defence (M) and the civilian sectors (C). It is further assumed there are only two inputs for each sector, labour(L) and capital(K). Marginal productivity of labour and capital may differ across the two sectors and there is an externality effect from the defence sector to the civilian sector. For two sectors the production equations are: $C = C(L_c, K_c, M)$ and $M = M(L_m, K_m)$ where the lowercase subscripts (c, m) show sectoral inputs. Total labour and capital inputs are:

$$L = L_c + L_m \qquad \textbf{(2.4)}$$

$$K = K_c + K_m \qquad \textbf{(2.5)}$$

The final forms of the model:

$$\dot{Y} = \alpha \frac{I}{Y} + \beta(\dot{L}) + \left(\frac{\delta}{1+\delta} + C_m \right) \dot{M} \frac{M}{Y} \qquad \textbf{(2.6)}$$

With separate externality effects:

$$\dot{Y} = \alpha \frac{I}{Y} + \beta(\dot{L}) + \left(\frac{\delta}{1+\delta} - \theta \right) \dot{M} \frac{M}{Y} + \theta \dot{M} \qquad \textbf{(2.7)}$$

Where, the dot represents rate of growth for labour, output and defence burden, I/Y is ratio of investment to the total output. M/Y is ratio of defence spending to the total output. α is the elasticity of output with respect to I/Y and β is the same for labour. C_m shows the externality effect of defence output on the civilian sector and δ denotes the relative factor productivity difference between the two sectors. Using the second equation, the externality effect can be estimated separately. After the estimation, they concluded that defence spending has no effect on growth. In the words of Biswas and Ram, "*military expenditures neither help nor hurt economic growth in the LDCs to any significant extent*"(Biswas and Ram 1986 pp: 370). The results did not show significant factor productivity differences across the defence and civilian sectors and externality effects, because the study used a large sample and the sample countries were not homogeneous. Even though they divided the countries into low income and middle income, the countries still might have large differences, so giving possibly misleading results (see Table 2.1).

Table 2.1. Empirical Results of Biswas and Ram (1986) Study

Variables		I/Y	$\dot{L}$	$\dot{M}$(M/Y)	$\dot{M}$	R^2
1960 - 1970	Full sample	0.19** (4.39)	1.15** (4.03)	0.55 (1.03)	-0.01 (-0.44)	0.45
	Low income LDCs	0.19* (1.85)	1.95** (2.96)	0.69 (1.10)	0.05 (0.06)	0.52
	Middle income LDCs	0.15** (2.79)	0.96** (3.00)	-3.41 (-0.79)	-0.01 (-0.01)	0.38
1960 - 1970	Full sample	0.21** (4.61)	0.94** (2.97)	0.78 (1.04)	0.02 (0.87)	0.48
	Low income LDCs	0.02 (0.17)	2.96** (2.49)	0.53 (1.17)	-0.01 (0.06)	0.36
	Middle income LDCs	0.27** (4.79)	0.71** (2.23)	2.78 (0.55)	0.05 (1.46)	0.51

Note:The dot represents rate of growth for labour, output and defence burden, I/Y is ratio of investment to the total output, M/Y is ratio of defence spending to the total output. δ denotes the relative factor productivity difference between two sectors. t statistics are in parentheses.
* Significant at the 10% level
** Significant at the 5% level

Alexander's (1990) paper was the most elaborate representation of the Feder-Ram model with four sectors, namely, a defence sector, a non-defence sector, an export sector and a private sector (Sandler & Hartley 1995). The author assumed that the sectors are mutually "exclusive" and "exhaustive" with respect to output. Factor productivity varies across sectors. The government sector provides positive externalities for all other sectors. The sectors G (government sector, X (export sector) and D (defence sector) all generate externality effects directly on N (rest of the economy) and G also generates externality effects on D and X. The production function can be written as:

$$G=G(K_g, L_g) \tag{2.8}$$

$$D=D(K_d, L_d, G) \tag{2.9}$$

$$X=X(K_x, L_x) \tag{2.10}$$

$$N=N(K_n, L_n, G, D, X) \tag{2.11}$$

where lower cases indicate sector inputs (*eg*, K_x indicates capital employed in export sector). Total output Y is:

$$Y=G+X+D+N \tag{2.12}$$

and the statistical form of the equation is:

$$\frac{\dot{Y}}{Y}=\alpha_1\frac{I}{Y}+\alpha_2\frac{\dot{L}}{L}+\alpha_3\frac{\dot{G}}{G}\frac{G}{Y}+\alpha_4\frac{\dot{X}}{X}\frac{X}{Y}+\alpha_5\frac{\dot{D}}{D}\frac{D}{D} \tag{2.13}$$

Where $\dot{Y}/Y$ is the real economic growth rate, I/Y is investment ratio, $\dot{L}/L$ is labour force growth rate, $(\dot{G}/G)(G/Y)$ is government sector growth rate which is multiplied by government/GDP ratio; $(\dot{X}/X)(X/Y)$ is an export growth rate which is multiplied by export/GDP ratio; and $(\dot{D}/D)(D/D)$ is defence spending growth rate which is multiplied by the defence burden. The results showed that government and export sector variables have a positive and statistically significant impact on economic growth but the effect for the defence variable was insignificant (see Table 2.2). Therefore, Alexander concluded that the effect of defence spending is neutral on the rest of the economy. Also, the externality effect of the defence sector was not significant. On the other hand, the non-defence public sector can provide positive externalities for the other three sectors. The study was criticised by Ram(1995) because the model does not include any external effect of defence on exports or of exports on defence or of defence on the government sector (Ram 1995). Macnair *et al.*(1995) also criticised Alexander's work under five criteria. It is best in their own words; "*...first he never established the stationarity of the macroeconomic aggregates due to limited degrees of freedom, second Alexander did not test among alternatives pooling techniques to ascertain the most appropriate error structure, third he did not account for any allies defence spillins that could have an impact on the supply side, fourth Alexander pooled over a rather diverse group of developed nations. Fifth his results that investment was a negative and insignificant influence on growth is counter-intuitive and against most therotical paradigms...*" (Macnair *et. al.* 1995, pp:848).

Table 2.2. Empirical Results of Alexander (1990) Study

	I/Y	$\dot{L}/L$	$(\dot{G}/G)(G/Y)$	$(\dot{X}/X)(X/Y)$	$(\dot{D}/D)(D/Y)$	DW
Coefficient	-0.05	0.90***	0.31*	0.32***	-0.37	1.79
t statistics	-0.97	4.08	2.00	10.07	-0.77	

Where $\dot{Y}/Y$ is real economic growth rate. I/Y is investment ratio, $\dot{L}/L$ is labour force growth rate $(\dot{G}/G)(G/Y)$ is government sector growth rate is multiplied by government/GDP ratio, $(\dot{G}/G)(G/Y)$ is an export growth rate is multiplied by export/GDP ratio and $(\dot{D}/D)(D/D)$ is defence spending growth rate is multiplied by defence burden
* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

Huang and Mintz (1990) examined defence-growth relationships using US data for the period of 1952-88. They mainly focussed on the multi-collinearity problem. To avoid that problem, the authors employed ridge regression estimation method in the model. It included three sectors (defence, public and civilian sectors). Using the ridge regression method improved the interpretation of results. However, their findings showed defence spending has no significant effect on economic growth (see Table 2.3).

Table 2.3. Empirical Results of Huang and Mintz (1990) Study

		I/Y	$\dot{L}/L$	$N\dot{M}/Y$	$\dot{M}/M$	Adjusted R^2
OLS estimates	Coefficient	0.46	0.80*	1.50*	0.32	0.68
	standard errors	0.32	0.33	0.58	0.23	
ORR estimates	Coefficient	0.51**	0.70**	1.36**	0.32	0.64
	standard errors	0.19	0.19	0.53	0.21	

Where I/Y is investment ratio, $\dot{L}/L$ is labour force growth rate, $N\dot{M}/Y$ is non-defence government sector GDP ratio, $\dot{M}/Y$ is defence sector GDP ratio.
* Significant at the 5% level
** The estimate to standard error ratio exceeds 2.50

Ward, Davis, Penubarti, Rajmira, and Cochran (1991) paper is case study of defence-growth relationships for India using time series data for 1950-87 with two sector model. India is one of the a few countries in developing worlds that produces most of its own military equipment. However, the production is mostly undertaken by the government. India spends around 3.5 per cent of its GNP on defence. The authors analysed Indian defence-growth relationships under the Feder-Ram model. It includes two sectors as (C) civilian sector and (G) government sector:

$$C=F(K_c, L_c, G) \quad \textbf{(2.14)}$$

$$G=G(K_g, L_g) \quad \textbf{(2.15)}$$

Where K is capital and L is labour and lower case refer to the civilian and government sectors, respectively. In the above equation G shows externalities on the civilian sector. The final form of the model was:

$$\dot{Y}=\alpha_0+\alpha_1 I+\beta\frac{Y}{L}\dot{L}+\left(\frac{\delta_m}{1+\delta_m}-\theta_m\right)\dot{M}+\theta_m\frac{\dot{M}}{G}Y+\left(\frac{\delta_n}{1+\delta_n}-\theta_n\right)\dot{N}+\theta_n\frac{\dot{N}}{G}+e \qquad \textbf{(2.16)}$$

In this equation, α_0 is constant and α_1I is investment share, the third part of the equation denotes the changes in labour, fourth part is the size effect of defence spending, the fifth part is the size effect of non-defence government spending and final part is the externality effect of non-defence spending. The model provides the identification of size effects, externality effect and the relative marginal productivity of defence and non-defence government spending programs. The results of the empirical case study were a positive impact of defence spending on growth, a negative impact of labour, a positive size effect of defence spending, a negative the size effect of non-government spending and a negative externality effect for defence spending (equation 2.16). The factor productivity effect for defence spending was negative. This is an important case study from the developing country (see Table 2.4).

Table 2.4. Empirical Results of Ward *et al.* (1991) Study

Parameter	Estimate	Parabolic error
I	0.19	0.00
$(Y/L)\dot{L}$	-0.12	0.01
$\dot{M}$ (size)	1.04	0.33
$(\dot{M}/S)Y$ (externality)	-0.88	0.04
$\dot{N}$ (size)	-3.21	0.86
$(\dot{N}/S)Y$ (externality)	0.77	0.01

Where I is investment function. $(Y/L)L$ denotes the changes in labour, $\dot{M}$ is the size effect of defence spending, and $(\dot{M}/S)Y$ is the externality effect of defence spending. $\dot{N}$ is the size effect of non-defence government spending and $(\dot{N}/S)Y$ is the externality effect of non-defence spending.

Ward and Davis (1992) analysed economic growth and defence spending using US data for 1945-90. Time series estimation method was employed on the three sector Feder-Ram model. They did some simulations predicting future US defence expenditure. The three sector model included civilian, government and defence sectors. The model considers externality and productivity effects. The government sector spreads externalities to the civilian sector. Ward and Davis growth equation is:

$$\frac{\dot{Y}}{Y}=\alpha\frac{I}{Y}+\beta\frac{\dot{L}}{L}+\left(\frac{\delta_m}{1+\delta_m}-\theta_m\right)\frac{\dot{M}}{Y}+\theta_m\frac{\dot{M}}{G}+\left(\frac{\delta_g}{1+\delta_g}-\theta_g\right)\frac{\dot{G}}{Y}+\theta_n\frac{\dot{N}}{G} \qquad \textbf{(2.17)}$$

Y represents national income, I is investment, L is labour, θ is externality of government (G) and civilian (C) sector on growth and the factor productivity differential is δ. The model was applied to the US. The results of the OLS estimates of equation showed that defence spending has negative size effect on GNP but, on the other hand, defence spending has a positive externality effect. Overall, the effect of defence spending is negative on economic growth because the size of the positive externalities of defence spending is very small (see Table 2.5).

Table 2.5. Empirical Results of Ward and Davis (1992) Study

	Investment	Labour	Size effect of		Externality effects of	
			Defence	Non-defence	Defence	Non-defence
Coefficient	0.69*	0.63*	-2.97*	6.99**	0.73**	-1.27**
t statistics	2.20	2.05	-2.40	4.69	2.99	-4.40

* Significant at the 10% level
** Significant at the 5% level

Mueller and Atesoglu (1993) discussed defence spending and economic growth under the effect of technological change. The research methodology is based on the multi-sectoral neoclassical production function approach. The study includes two sectors (defence and civilian) with technological aspects. Single equation estimates derived that defence sector provides externalities to the civilian sector. Using US data the study covers 1948-90. It is assumed that the civilian sector may benefit from favourable spillovers from the defence sector like technological inventions. The aggregate production functions are:

$$D=A(t).F(L_d,K_d) \qquad \textbf{(2.18)}$$

$$C=B(t).G(L_c,K_c,D) \qquad \textbf{(2.19)}$$

In the equation, D represents defence sector output, C is civilian output and A(t) and B(t) give Hicks neutral technical change in the respective sectors. F and G are the marginal product of labour and capital in two sectors. L and K are labour input and capital input sectors, respectively. Then total output (Q) will be Q=D+C. Technical change of the defence sector may not be the same as in the civilian sector. However, it is assumed that they are proportional to each other according to $A(t)/B(t)=1-\varphi$, where φ is the technological change proportionality factor. The final form of estimation equation is:

$$\frac{dQ}{Q}=\lambda+\varepsilon_l\frac{dL}{L}+\varepsilon_k\frac{dK}{K}+\varepsilon_d\frac{dD}{D}+\theta\lambda\frac{D}{Q} \qquad \textbf{(2.20)}$$

where dQ/Q, dK/K and dL/L are economic growth, capital growth and employment growth, respectively; θ is a constant and λ is the average rate of technological progress. The elasticities(ε_l, ε_k, ε_d,) are:

$$\varepsilon_1=e^{\lambda t}G_1\frac{L}{Q} \qquad \textbf{(2.21)}$$

$$\varepsilon_k=e^{\lambda t}G_k\frac{K}{Q} \qquad \textbf{(2.22)}$$

$$\varepsilon_d=(\theta+e^{\lambda t}G_d)\frac{D}{Q} \qquad \textbf{(2.23)}$$

where $e^{\lambda t}$ represents technological change function.

With consideration of technological change, the empirical results showed that defence spending has a significant positive effect on the economic growth. On the other hand, the externality effect of defence spending on economic growth was insignificant. Positive effect occurs due to difference in marginal productivity of labour and capital in civilian and defence sectors ($\delta\neq0$) and the differences of technological change ($\varphi\neq0$) in the two sectors may create positive effects (see Table 2.6).

Table 2.6. Empirical Results of Atesoglu and Mueller (1993) Study

	Investment	Labour	Defence size	Defence externality	R^2	DW
Coefficient	0.65**	0.37**	1.08**	-0.03	0.80	1.89
t statistics	7.44	3.11	3.93	-1.05		

* Significant at the 10% level
** Significant at the 5% level

Macnair, Murdoch, Pi and Sandler (1995) paper employed multiple observations in a pooled cross section, time series for 10 NATO countries. They exclude the export sector because they assumed an export sector is not so different from other sectors for developed countries. The study, of course, considered externalities which arise from the non-defence government sector and defence sector and also defence spill-ins from allies to civilian sectors. The production function used is:

$$N=N(K_n, L_n) \quad \textbf{(2.24)}$$

$$D=D(K_d, L_d, N, \tilde{D}) \quad \textbf{(2.25)}$$

$$C=C(K_c, L_c, N, D, \tilde{D}) \quad \textbf{(2.26)}$$

where, N denotes non-defence government sector output, D is defence sector, $\tilde{D}$ is defence spilling from a nation's allies and C is civilian output. Defence spill-in is measured as the sum of its allies real defence spending so that total output will be Y=N+D+C. The study was very comprehensive in that they employed a variety of error component specifications that included fixed effects, one way random effects and two way random effects. The results of the study showed that defence spending has a positive impact on economic growth. On the other hand, defence spill-in had a small negative influence (see Table 2.7).

Table 2.7. Empirical Results of Macnair *et al.* (1995) Study

	Investment	Labour	Defence	Non-defence	Defence spillins	Adjusted R^2
Coefficient	0.14**	0.40	0.64**	0.58*	-0.04**	0.13
t statistics	6.22	1.07	3.39	1.94	-2.75	

* Significant at the 10% level
** Significant at the 5% level

Overall evaluation: The bulk of the supply side studies mainly showed that defence had no significant impact on economic growth or a small positive impact. These findings are consistent despite the different sample size, different time periods and different estimating procedures. When the externality effect is considered, the majority of studies found positive externalities from defence. The main advantage of this model is that it describes the supply constraints which are important for developing countries such as Turkey. The findings of these studies are summarised in Table 2.8.

Table 2.8. Summary of Previous Studies Using Feder Models

Author(s)	Sample Period	Method	Effect of	Sign
Biswas & Ram (1986)	1960-70 &1970-77, 58 LDCs	Two sectors, OLS	defence size	(0)
			externality	(0)
Alexander (1990)	1974-1985 9 DCs	Four sectors, OLS	defence size	(0)
			externality	(?)
Huang & Mintz (1990)	1952-1988 US	Three sectors OLS & ORR	defence size	(0)
			externality	(?)
Ward *et al.* (1991)	1950-1987 India	Three sectors NLS	defence size	(+)
			externality	(-)
Ward & Davis (1992)	1945-1990 US	Three sectors OLS	defence size	(-)
			externality	(+)
Mueller & Atesoglu (1993)	1948-1990 US	Two sectors with technological change, OLS	defence size	(+)
			externality	(-)
Macnair *et al.* (1995)	1951-1988, 10 NATO countries	Three sectors, pooled	defence size	(+)
			externality	(-)

2.4. Demand and Supply Side (Deger Type) Studies

Defence spending may have growth promoting effects through supply side factors (such as technology spin-off, positive externalities from an infrastructure, human capital etc.). Also defence spending may affect economic growth (positive or negative) through demand side factors (such as the crowding-out of investment, exports, health spending or infrastructural improvement, *etc.*). Therefore, when one analyses defence-growth relationships, both supply side and demand side factors of economic growth should be considered. Supply side models tend to have positive impact of defence spending on economic growth, while demand side factors tend to have negative effects through crowding out of investment. To obtain more accurate answers, investigation of defence-growth relationships should include both demand side and supply side influences (Sandler and Hartley, 1995).

In the defence-growth literature, a few studies comprised demand and supply factors of economic growth. They all estimate very similar multi-equation models and hypothesised possible positive direct effect of defence spending on growth through Keynesian demand stimulation and other spin-off effects, and negative indirect effect through reducing savings or investment. They all include either three or four equations as growth, savings or investment ratio, trade balance ratio and defence burden using either three stage least squares (3SLS) or two stage least squares (2SLS) method.

Deger and Sen (1983), Deger and Smith (1983)and Deger (1986a, 1986b) estimated defence growth relationships by 3SLS on data for 50 LDCs over the period 1965-1973. Although the four studies used the same samples and the same sample period, their empirical models were slightly different. Other than these studies, Lebovic and Ishaq (1987), Scheetz

(1991) and Roux (1996) employed multi-equation models with different sample and sample period and slightly different equations.

Deger and Sen (1983) simultaneous equation model is described by the following equations:

$$\text{GDP growth} = a_0 + a_1(\text{Investment/GDP}) + a_2(\text{Defence spending/GDP}) + a_3(\text{GDP}) + a_4(\text{Population growth}) + a_5(\text{Net foreign capital transfers}) \quad (2.27)$$

$$\text{Investment/GDP} = b_0 + b_1(\text{GDP growth}) + b_2(\text{Change on GDP}) + b_3(\text{Defence spending/GDP}) + b_4(\text{Net foreign capital transfers}) \quad (2.28)$$

$$\text{Defence spending/GDP} = c_0 + c_1(\text{GDP}) + c_2(\text{Per capita income at the PPP exchange rate minus PCI at the official rate}) + c_3(\text{Population}) + c_4(\text{Oil producer dummy}) + c_5(\text{War dummy}) \quad (2.29)$$

Defence spending may divert resources available for capital formation thus lower growth and an increase in defence burden may decrease (or increase) the amount of saving and also defence spending may have modernisation and spin-off effects. Therefore, the growth equation 2.27 includes investment shares (from any standard growth model), defence burdens (representing resource allocation and spin-off effects) and capital inflow from abroad but it does not represent human capital. Equation 2.28 for investment includes growth (due to simultaneity), increments in output (accelerator), foreign capital and defence burden representing mobilisation effect. An increase in defence spending may decrease (or increase) the amount of investable resources. In the final equation 2.29, the defence burden is determined as a function of income and population (due to public goods nature of defence spending). In the equation, the difference between per capita income at purchasing power parity and official rates (INTEG) attempts to measure the degree of integration of economic activity from the rest of the world. Deger and Sen (1983) sample of 50 countries include oil producer countries and some countries were at war. Therefore, the equation includes oil producer and war dummy variables. They concluded that defence spending has positive direct and negative indirect effects (through investment) and the overall effects of defence spending were estimated to be negative (see Table 2.9).

Table 2.9. Empirical Results of Deger and Sen (1983) Study

ΔY/Y (Growth equation)		**I/Y (Investment equation)**		**M/Y (Defence equation**	
Variables	**Coefficient**	**Variables**	**Coefficient**	**Variables**	**Coefficient**
Constant	-9.63 (-1.50)	Constant	14.17 (10.08)	Constant	3.69 (5.59)
I/Y	0.83 (1.84)	ΔY/Y	0.54 (2.75)	Y	0.18 (3.25)
M/Y	0.20 (0.98)	ΔY	0.03 (4.42)	INTEG	0.30 (-2.82)
Y	-0.13 (-0.76)	M/Y	-0.35 (-2.75)	P	0.01 (0.37)
ΔP/P	0.39 (0.63)	FC	0.33 (3.83)	D1	4.99 (5.19)
FC	-0.28 (-2.09)	-	-	D2	13.33 (15.63)

t statistics in parenthesis
ΔY/Y: Average an annual growth rate of real GDP; I/Y: Investment shares in GDP; M/Y: Defence burden; Y: Income (GDP); ΔY: Increments in national income; ΔP/P: Growth rate of population; FC:Net foreign capital transfers; INTEG: The difference between per capita income measured at PPP and official exchange rate values; P: population; D1: Dummy variable for oil producing countries with balance of payments surplus; D2: Dummy variable of war economies

Deger and Sen (1983) study is important because it analysed the two sides (demand and supply) and also employed relatively sophisticated econometric tests. Therefore, it avoided the problem of simultaneity bias. However, it has some weaknesses that the theoretical derivation of the models is not always clear and some variables seem *ad hoc* (Sandler and Hartley, 1995). Population growth is not a very good proxy for labour productivity. The estimation techniques are very sensitive to specification error. The other shortcoming from this paper is that dummy variables in the equation are very crude proxies to represent an external threat. A cross section analysis of defence growth relationship with multi-equation models provides limited evidence, because, very crude proxies are inevitable and data become less reliable due to very different economies of countries. The fifty countries used in these estimations are not homogenous.

Deger and Smith (1983) develop an econometric model to test for the effect of defence spending on economic growth. They employed the following simultaneous equation model:

$$\begin{aligned} \text{GDP growth} = {} & a_0 + a_1(\text{Saving/GDP}) + a_2(\text{Defence spending/GDP}) + \\ & a_3(\text{Population growth}) + a_4(\text{Net external capital flow/GDP}) + a_5(\text{1970 per capita income at official exchange rate}) + a_6(\text{Agricultural output growth}) \end{aligned} \tag{2.30}$$

$$\begin{aligned} \text{Saving/GDP} = {} & b_0 + b_1(\text{GDP growth}) + b_2(\text{Per capita GDP growth}) + \\ & b_3(\text{Defence spending/GDP}) + b_4(\text{Net foreign capital flows/GDP}) + b_5(\text{Inflation rate}) \end{aligned} \tag{2.31}$$

$$\begin{aligned} \text{Defence spending/GDP} = {} & c_0 + c_1(\text{PCI}) + c_2(\text{Per capita income at the PPP exchange rate minus PCI at the official rate}) + \\ & c_3(\text{Population}) + c_4(\text{Oil producer dummy}) + c_5(\text{War dummy}) \end{aligned} \tag{2.32}$$

They suggested that the econometric model should include growth, saving (not investment) and defence equations. In the growth equations (2.30), they added agricultural output growth. It reflects structural change in an economy. Population growth represents the labour force in the equation. The saving equation (2.31) contains GDP growth, due to simultaneity, per capita GDP growth, defence spending, foreign capital and inflation rates. Defence equation (2.32) is almost the same as the previous model but income (GDP) is replaced by PCI to represent effect of population growth on income. INTEG is for international integration of the economy. As the economy becomes more open to world market and relations, the difference between per capita income (PCI) and purchasing power parity (PPP) reduces. The negative coefficient suggest that a country tends to spend more on defence (Deger, 1986a). Defence is security related so the war dummy and oil producers dummies are included. Deger and Smith (1983) found very similar results. Defence spending has a small positive effect on growth through modernisation and larger negative effects through savings, but the estimated net effect is negative. Moreover, unlike Deger and Sen (1983), positive direct effect of defence spending on economic growth is statistically significant in this estimation (Table 2.10).

Table 2.10. Empirical Results of Deger and Smith (1983) Study

ΔY/Y (Growth equation)		S/Y (Saving equation)		M/Y (Defence equation)	
Variables	**Coefficient**	**Variables**	**Coefficient**	**Variables**	**Coefficient**
Constant	-8.93 (-2.43)	Constant	14.54 (9.70)	Constant	3.98 (4.53)
S/Y	0.93 (3.78)	M/Y	-0.43 (-3.16)	PCI	0.19 (2.61)
M/Y	0.35 (2.77)	ΔY/Y	0.48 (1.92)	INTEG	-0.30 (-2.09)
ΔP/P	0.49 (-1.08)	ΔPCI/PCI	0.37 (4.55)	P	-0.02 (-4.29)
FC/Y	0.59 (2.89)	FC/Y	-0.67 (-7.63)	D1	4.67 (3.65)
PCI	-0.26 (-2.44)	INF	0.07 (-0.03)	D2	11.31 (10.83)
ΔAG/AG	0.16 (1.42)	-	-	-	-
R^2	0.22	R^2	0.86	R^2	0.78

t statistics in parentheses
ΔY/Y: Average an annual growth rate of real GDP; S/Y: National saving ratio; M/Y: Defence burden; PCI: 1970 per capita income at official exchange rates; ΔPCI/PCI: Per capita GDP growth; ΔAG/AG: Average annual growth rate of agricultural product; ΔP/P: Growth rate of population; FC/Y:Net foreign capital transfers share in GDP; INF: Rate of change of aggregate price level per annum; INTEG: The difference between per capita income measured at PPP and official exchange rate values; P: population; D1: Dummy variable for oil producing countries with balance of payments surplus; D2: Dummy variable of war economies

The above two studies are very similar. They use the same 50 sample countries and the same time period, but their choices of variables are rather different. Deger and Smith (1983) added more variables into the equations and instead of investment/GNP ratio, they employed saving/GNP ratio for their second equation to assess effects of defence spending on saving. Per capita income and agricultural growth were included in the growth equation, whilst inflation rates and per capita GDP growth were added to the saving equation. The economic basis for adding agricultural growth is to represent structural change in an economy.

Deger (1986a) estimates three structural equations. The model consists of:

$$\text{GDP growth} = a_0 + a_1(\text{Saving/GDP}) + a_2(\text{Defence spending/GDP}) + a_3(\text{1970 per capita income at official exchange rate}) + a_4(\text{Net external capital flow/GDP}) \quad (2.33)$$

$$\text{Saving/GDP} = b_0 + b_1(\text{GDP growth}) + b_2(\text{Per capita GDP growth}) + b_3(\text{Defence spending/GDP}) + b_4(\text{Net foreign capital flows/GDP}) + b_5(\text{Inflation rate}) \quad (2.33)$$

$$\text{Defence spending/GDP} = c_0 + c_1(\text{Government spending/GDP}) + c_2(\text{Per capita GDP}) + c_3(\text{Per capita GDP at official exchange rate minus PPP}) + c_4(\text{Oil producer dummy}) + c_4(\text{War dummy}) \quad (2.34)$$

Deger (1986a) explained that defence spending may affect growth through aggregate demand stimulation, spin-off, allocation of resources away from potential investment and creation of new sources. Spin-off and aggregate demand stimulation are represented by the growth equation (2.33). The equation also includes saving ratios. Foreign capital inflows are included because of effects of external factors on the economy. Population is a proxy for labour force. Per capita income represents relative wealth of the sample countries. The predicted sign of this analysis is some positive effect on growth and negative effects on savings.

Savings equation (2.34) represents resource creation and allocation effect of the defence sector. In this equation, the coefficient of defence explains how defence spending influence savings. For the life cycle effects, GDP growth is added in to equation (2.34). The equation also included the inflation rate to take account of inflationary effects on resource creation.

Defence equation (2.35) is determined after extensive experimentation. It includes two dummies for oil producer countries and economies in war. Government spending, per capita income is included because of the public good nature of defence. Per capita GDP at official exchange rate minus per capita income at purchasing power parity (INTEG) are added to measure variations in economic structure and for a particular country reflects the degree of integration with the international economy.

The main difference of Deger (1986a) study from previous two studies is that in the growth equation, population growth and agricultural growth are excluded and in the defence equation, population is excluded but government spending is added. The empirical results of this study are shown in Table (2.11). The study concluded that defence spending stimulates growth through spin-off and aggregate demand effects. However, it retards economic growth because investable resources decrease when defence spending increases. Overall, the net effect of defence spending is negative. The results are as expected.

Table 2.11. Empirical Results of Deger (1986a) Study

ΔY/Y (Growth equation		S/Y (Saving equation)		M/Y (Defence equation)	
Variables	**Coefficient**	**Variables**	**Coefficient**	**Variables**	**Coefficient**
Constant	-7.47 (-2.24)	Constant	13.73 (9.26)	Constant	1.19 (2.23)
S/Y	0.79 (3.91)	ΔY/Y	0.61 (2.46)	ΔGS/GS	0.12 (2.39)
M/Y	0.25 (2.46)	ΔPCI/PCI	0.03 (4.36)	PCI	0.16 (2.82)
PCI	-0.19 (-2.21)	M/Y	-0.39 (-3.06)	D1	4.00 (3.34)
FC/Y	0.47 (2.72)	INF	-0.86 (-0.34)	D2	11.54 (10.38)
-	-	FC/Y	-0.64 (-7.60)	INTEG	-0.28 (-2.53)
R^2	0.30	R^2	0.86	R^2	0.86

t statistics in parentheses

ΔY/Y: Average annual growth rate of real GDP; S/Y: National saving ratio; M/Y: Defence burden; PCI: 1970 per capita income at official exchange rates; ΔPCI/PCI: Per capita GDP growth; FC/Y:Net foreign capital transfers share in GDP; INF: Rate of change of aggregate price level per annum; ΔGS/GS: Government expenditure as a proportion of GDP; INTEG: The difference between per capita income measured at PPP and official exchange rate values; D1: Dummy variable for oil producing countries with balance of payments surplus; D2: Dummy variable of war economies

Second study of Deger (1986b) used four equations rather than three. She isolates the balance of trade in the model as another endogenous equation, because the economies became more open and foreign trade and net capital flow from abroad became more important in the economy.

The model is (Deger 1986b):

$$\text{GDP growth} = a_0 + a_1(\text{Saving/GDP}) + a_2(\text{Defence spending/GDP}) + a_3(\text{Balance of trade}) + a_4(\text{1970 per capita income at official exchange rate}) + a_5(\text{Agricultural growth}) \quad (2.36)$$

$$\text{Saving/GDP} = b_0 + b_1(\text{Defence spending/GDP}) + b_2(\text{1970 per capita income at official rate} * \text{GDP growth}) + b_3(\text{Balance of trade}) + b_4(\text{Inflation rate}) \quad (2.37)$$

$$\textit{Balance of trade/GDP} = c_0 + c_1(\textit{Defence spending/GDP}) + c_2(\textit{GDP growth}) + c_3(\textit{Inflation rate}) + c_4(\textit{Oil producer dummy}) + c_5(\textit{War dummy}) \quad (2.38)$$

$$\textit{Defence spending/GDP} = d_0 + d_1(\textit{1970 Per capita income at official exchange rate}) + d_2(\textit{Per capita income - PPP}) + d_3(\textit{Government spending growth}) + d_4(\textit{Population}) + d_5(\textit{Oil producer dummy}) + d_6(\textit{War dummy}) \quad (2.39)$$

Although Deger (1986b) second study seems very similar to previous studies it includes four equations rather than three. The fourth equation is balance of trade. It is expected to represent foreign capital inflows and effects of defence spending on balance of payments. The predicted sign for balance of trade is negative. The equation contains the defence burden as an exogenous variable. The other variables used are GDP growth, inflation rate and two dummies. The dummies are the same as in the defence equation (oil producer and war dummies). She expected that GDP growth affects balance of trade negatively if the country follows import substituting strategies and positively, if the country follows export promoting strategies. Inflation is included in the equation (2.38) because LDCs generally have a fixed exchange rate. Therefore, the inflation rate will distort the relative price structure with the rest of the world. The defence burden variable is predicted to be negative because higher arms imports may divert resource available for civilian import which are growth promoting. However, this effect might be positive. Sophisticated imported weapons might lead to learning-by-doing as well as adopting the technology to domestic uses (training of personnel to maintain high tech weapons). These positive effects should be higher for LDC's.

Defence equation (2.39) is based on its public good nature. Almost all defence expenditures came from government budget and it is predominantly public good. Its macroeconomic effects are related to government spending. Therefore, determinants of defence expenditure could be per capita income, the government budget or level of population (Deger, 1986b). Deger (1986b) also added to her defence equation country specific dummies (eg. dummy for oil producer economies and dummy for war economies). Per capita income minus purchasing power parity (INTEG) shows international aspect of economy. Since national income per capita measured at an official exchange rate can vary significantly from that measured at purchasing power parity. The difference between the two is defined as an index measuring the degree of integration that the domestic economy has achieved with the rest of the world. The predicted sign of this variable is negative. It implies that when an economy becomes more open, it spends more on defence through armaments (Deger, 1986b; Deger and Sen, 1983). The results are shown in Table 2.12. Although saving, balance of trade and defence equations have an acceptable R^2, the growth equation has a low R^2. It suggests that the equation does not represent growth adequately.

Table 2.12. Empirical Results of Deger (1986b) Study

ΔY/Y (Growth equation)		S/Y (Saving equation)		B/Y (Balance of trade equation)		M/Y (Defence equation)	
Variab.	Coefficient	Variab.	Coefficient	Variab.	Coefficient	Variab.	Coefficient
Cons.	-4.2 (-1.56)	Cons.	12.5 (6.91)	Cons.	-2.33 (-0.86)	Cons.	1.47 (1.52)
S/Y	0.58 (3.37)	M/Y	-0.56 (-3.72)	M/Y	-2.45 (-2.88)	INTEG	-0.25 (2.52)
M/Y	0.29 (2.5)	ΔY/Y	0.74 (2.42)	ΔY/Y	1.22 (3.08)	D1	4.02 (3.42)
B/Y	-0.15 (-1.75)	ΔPCI/PCI	0.04 (3.92)	INF	0.16 (0.03)	D2	11.2 (10.2)
PCI	-0.14 (-1.75)	B/Y	0.32 (4.22)	D1	41.5 (7.08)	ΔGS/GS	0.16 (3.07)
ΔAG/AG	0.19 (1.85)	INF	-1.75 (-0.56)	D2	23.6 (0.92)	P	0.01 (1.32)
-	-	-	-	-	-	PCI	0.15 (2.80)
R^2	0.32	R^2	0.78	R^2	0.67	R^2	0.87

t statistics in parentheses
ΔY/Y: Average annual growth rate of real GDP; S/Y: National saving ratio; M/Y: Defence burden; PCI: 1970 per capita income at official exchange rates; ΔPCI/PCI: Per capita GDP growth; B/Y:Net foreign capital transfers share in GDP; INF: Rate of change of aggregate price level per annum; ΔGS/GS: Government expenditure as a proportion of GDP; INTEG: The difference between per capita income measured at PPP and official exchange rate values; D1: Dummy variable for oil producing countries with balance of payments' surplus; D2: Dummy variable of war economies; P: Population; ΔAG/AG: Growth of agricultural product; INF: Inflation rate

The above four studies used cross section data for fifty LDCs for the 1965-1973 period. A three-stage least squares (3SLS) estimation is employed. The equations show a simultaneity problem and there is high covariance among equations (Deger 1986a, 1986b). The studies found that defence spending shows positive effect on growth through spin-off and aggregate demand effect, but they show negative effects on saving and hence investment. However, the size of the negative effect is higher than the positive direct effect. Therefore, they conclude that the net effect from defence spending to the economy is negative.

Lebovic and Ishaq (1987) develop an empirical model of defence-growth relationships. They employed three equations with a sample of 20 Middle-Eastern countries for the period of 1973-1982. They used two-stage least squares(2SLS) method. This empirical model is similar to various Deger models. However, they added export growth into the growth equation and the endogenous defence equation included a security needs index (SNI) which is calculated by the authors and considers military capabilities of other nations weighted by their geographical distance from that nation. This index is also sensitive to the existence of power centres. Power centres are defined as countries' relative capability, their strength as compared to their neighbours. It considers size of armed forces and the geographical distance between their capital cities (Lebovic and Ishaq, 1987; 113). Three different proxies were employed for defence variable, namely, defence spending/GDP, arm imports/total imports and troops/population (Lebovic and Ishaq, 1987). They found that defence spending was negatively correlated to economic growth. Their empirical model is shown below (equations 2.40, 2.41, 2.42 and 2.42):

$$GDP\ growth = a_0 + a_1(Investment/GDP) + a_2(Defence\ spending/GDP) + a_3(Population\ growth) + a_4(Export\ growth) \tag{2.40}$$

$$Investment/GDP = b_0 + b_1(Defence\ spending/GDP) + b_2(Net\ capital\ inflows\ abroad/GDP) + b_3(GDP\ growth) \tag{2.41}$$

$$Defence\ spending/GDP = c_0 + c_1(Security\ needs\ index) + c_2(Non\text{-}defence\ government\ spending/GDP) + c_3(Population) + c_4(GDP\ growth) \tag{2.42}$$

The result of their study is as expected. Defence spending is strongly related to nations' basic external security needs. Although they conclude that the negative effect of defence on growth, the empirical results generally have low t statistics and the defence coefficient is insignificant in the growth equation (Table 2.13).

Table 2.13. Empirical Results of Lebovic Ishaq (1987) Study

ΔY/Y (Growth equation)		I/Y (Investment equation)		M/Y (Defence equation)	
Variables	**Coefficient**	**Variables**	**Coefficient**	**Variables**	**Coefficient**
Constant	5.57	Constant	0.25	Constant	2.99
I/Y	-2.88 (0.23)	M/Y	0.01 (3.42)	SNI	0.60 (13.10)
M/Y	-0.19 (0.45)	FC/Y	0.10 (2.74)	NGS/Y	0.39 (1.99)
ΔP/P	0.47 (0.79	ΔY	0.00 (1.30)	P	0.02 (1.77)
ΔEX/EX	0.36 (1.73)	-	-	ΔY/Y	-0.01 (0.86)

t statistics in parentheses
ΔY/Y: Average annual growth rate of real GDP; I/Y: Investment share in GDP; M/Y: Defence burden; ΔP/P: Population growth rate; FC/Y:Net foreign capital transfers share in GDP; ΔEX/EX: Growth rate of merchandise exports; ΔNGS/GS: Non-defence government expenditure as a proportion of GDP; ΔY: Absolute change in GDP from one year to another; SNI: Security needs index; P: Population.

Scheetz (1991) study used a model which is modified from Deger (1986a) and Deger and Smith (1983). The study analysed Chile, Argentina, Peru and Paraguay for the period of 1969-1987. He both employed pooled cross-sectional time series estimation and time series estimation. His model includes four equations using 3SLS estimation. The findings of this study are that both effects of defence spending (spin-off and aggregate demand effects and crowding-out of investment) are negative.

His four equation model was:

$$\begin{aligned} GDP\ growth &= a_0 + a_1(Saving/GDP) + a_2(Defence\ spending/GDP) + \\ & a_3(Balance\ of\ trade) + a_4(Agricultural\ growth) + \\ & a_5(Government\ spending\ growth) \end{aligned} \quad (2.43)$$

$$\begin{aligned} Saving/GDP &= b_0 + b_1(Defence\ spending/GDP) + b_2(GDP\ growth) + \\ & b_3(Inflation\ rate) + b_4(Government\ spending/GDP) + \\ & b_5(Level\ of\ per\ capita\ income) + \\ & b_6(Lagged\ balance\ of\ trade/GDP) \end{aligned} \quad (2.44)$$

$$\textit{Balance of trade/GDP} = c_0 + c_1(\textit{Defence spending/GDP}) + c_2(\textit{Level of per capita income}) + c_3(\textit{Lagged balance of trade}) + c_4(\textit{Inflation rate}) + c_5(\textit{International comparisons project index}) \quad \textbf{(2.45)}$$

$$\textit{Defence spending/GDP} = d_0 + d_1(\textit{Government spending/GDP}) + d_2(\textit{Dummy for military dictatorship}) + d_3(\textit{Dummy for threat}) + d_4(\textit{Lagged defence spending/GDP}) \quad \textbf{(2.46)}$$

The model is modified from Deger (1986a) and Deger and Smith (1983). In the growth equation (2.43) growth of government expenditure is included because of the dominant role of government in the sample countries and he excluded the population growth rate because of insignificant results. Saving equation (2.44) is very close to the Deger model. However, Scheetz added a government expenditure variable (net of defence spending). Balance of trade equation (2.45) is different from Deger's equation. He discovered that lagged foreign accounts variable gave very well results because of inertial effects of both the trade and the debt interests. Furthermore, Scheetz (1991) added a per capita income variable in order to capture country relative wealth effects in foreign accounts.

Like Deger, Scheetz determined defence equation (2.46) after extensive experimentation. However, his equation is radically different from Deger's equation. Due to poor statistical results, he did not use population. There are two dummy variables in Scheetz (1991) equation (2.46), one is for military dictatorship and the other is for a threat to capture tension brought about by an interstate military crisis or internal security problems. Moreover, lagged defence spending is included in the equation to capture the inertial nature of defence spending (Scheetz, 1991). This equation is more like standard models of demand for military expenditure. The results are shown in Table 2.14. Defence spending has a negative effect on the growth, the saving and the balance of trade equations. Unlike other previous studies, no positive effect of defence is found, but again the R^2 for the growth equation is very low.

Table 2.14. Empirical Results of Scheetz (1991) Study

ΔY/Y (Growth equation)		**S/Y (Saving equation)**		**B/Y (Balance of trade equation)**		**M/Y (Defence equation)**	
Variab.	Coefficient	Variab.	Coefficient	Variab.	Coefficient	Variab.	Coefficient
S/Y	0.22 (3.10)	Cons.	0.14 (6.44)	M/Y	-0.49 (-2.40)	NGS/Y	0.07 (5.24)
M/Y	-0.53 (-1.95)	ΔY/Y	0.32 (2.06)	PCI	-0.01 (-3.12)	F	0.07 (3.76)
B/Y	-0.25 (-1.62)	M/Y	-0.56 (-1.25)	$(B/Y)_{-1}$	0.45 (4.47)	TENS	0.01 (3.68)
ΔAG/AG	0.15 (4.02)	INF	0.01 (2.81)	INF	0.01 (1.87)	$(M/Y)_{-1}$	0.57 (7.75)
ΔGS/Y	0.08 (2.06)	ΔGS/Y	-0.26 (-3.71)	D75	0.04 (1.58)	-	-
-	-	PCI77	0.01 (4.95)	-	-	-	-
-	-	$(B/Y)_{-1}$	0.21 (2.08	-	-	-	-
R^2	0.26	R^2	0.51	R^2	0.53	R^2	081

t statistics in paratheses
ΔY/Y: Average annual growth rate of real GDP; S/Y: National saving ratio; M/Y: Defence burden; PCI: Level of per capita income measured in current US$ official exchange rates; PCI77: Level of per capita income, in constant US$ of 1977 official exchange rates; B/Y:Net foreign capital transfers share in GDP; INF: Rate of change of aggregate price level per annum; ΔGS/Y: Government expenditure as a proportion of GDP; ΔNGS/NGS: Non-defence government expenditure as a proportion of GDP; P: Population; ΔAG/AG: Growth of agricultural product; INF: Inflation rate; $(B/Y)_{-1}$: Lagged B/Y; $(M/Y)_{-1}$: Lagged M/Y; D75: International comparisons index using 1975 base year data; F: Dummy variable for years when a democratic government wrote the budget, one for years when a military dictatorship decided; TENS: Dummy variable, zero for peace, one for tension from imminent external defence threat of internal guerilla problem.

Roux (1996) empirically tested for the impact of defence spending on South Africa's economic growth between 1960 and 1990. The model includes four equations similar to Deger (1986a, 1986b) and Scheetz (1991). He added some exogenous variables in his equations which were different from others. They are US$/South African Rand exchange rates, annual percentage change in the Rand gold price in balance of trade equation.

The change in the real US$/Rand exchange rate is included to account for the effect on exports and imports of a change in the international purchasing power of the domestic currency. The gold price is added to reflect the importance of this commodity in a county's export performance. In the saving equation, a real prime overdraft rate is taken to exert an influence on savings decisions. In the defence equation, lagged defence spending is added to capture its inertial nature, whereby defence spending in any particular year partly reflects the commitments incurred in a previous year (Roux, 1996). The model he used is shown in equations (2.47, 2.48, 2.49 and 2.50):

$$\begin{aligned} \text{GDP growth} = {} & a_0 + a_1(\text{Saving/GDP}) + a_2(\text{Defence spending/GDP}) + a_3(\text{Balance} \\ & \text{of trade/GDP}) + a_4(\text{Government spending growth}) \end{aligned} \tag{2.47}$$

$$\begin{aligned} \text{Saving/GDP} = {} & b_0 + b_1(\text{Defence spending/GDP}) + b_2(\text{GDP growth}) \\ & + b_3(\text{Per capita income}) + b_4(\text{Balance of trade}) + \\ & b_5(\text{Inflation rate}) + b_6(\text{Non-military government} \\ & \text{expenditure} + b_7(\text{Prime overdrat rate}) \end{aligned} \tag{2.48}$$

$$\begin{aligned} \text{Balance of trade/GDP} = {} & c_0 + c_1(\text{Defence spending/GDP}) + c_2(\text{GDP} \\ & \text{growth}) + c_3(\text{Change of \$/Rand exchange} \\ & \text{rate}) + c_4(\text{Change of Rand/Gold price} + \\ & c_5(\text{Financial sanctions dummy}) \end{aligned} \tag{2.49}$$

$$\begin{aligned} \text{Defence spending/GDP} = {} & d_0 + d_1(\text{Per capita income}) + d_2(\text{Non-military} \\ & \text{government spending/GDP}) + d_3(\text{War dummy}) + \\ & d_4(\text{Lagged defence spending/GDP}) \end{aligned} \tag{2.50}$$

After the analysis, he found that there is no relationship between gross domestic savings rate and defence spending, but the balance of trade is negatively correlated to defence expenditure for South Africa between 1960-1990. The empirical results are depicted in Table 2.15. However, in the growth equation, the defence burden is negative and statistically significant.

Table 2.15. Empirical Results of Roux (1996) Study

ΔY/Y (Growth equation)		**S/Y (Saving equation)**		**B/Y (Balance of trade equation)**		**M/Y (Defence equation)**	
Variab.	Coefficient	Variab.	Coefficient	Variab.	Coefficient	Variab.	Coefficient
Cons.	15.48 (3.35)	Cons.	5.11 (0.58)	Cons.	9.71 (1.87)	Cons.	1.77 (1.83)
NGS/Y	-0.87 (-3.74)	ΔY/Y	0.58 (1.19)	ΔY/Y	-1.91 (-2.70)	$(M/Y)_{-1}$	0.72 (8.35)
M/Y	-1.51 (-2.63)	M/Y	-0.07 (-0.08)	M/Y	-1.69 (-1.44)	PCI	0.01 (-1.00)
B/Y	-0.23 (-3.13)	$(S/Y)_{-1}$	0.35 (1.93)	$(B/Y)_{-1}$	1.03 (5.88)	D	0.54 (2.93)
S/Y	0.54 (3.18)	PRI	-0.23 (1.54)	USG	0.64 (2.18)	-	-
-	-	NGS/Y	0.45 (1.21)	-	-	-	-
R^2	0.64	R^2	0.49	R^2	0.75	R^2	0.87

t statistics in parentheses

ΔY/Y: Average annual growth rate of real GDP; S/Y: National saving ratio; M/Y: Defence burden; PCI: Real per capita income; B/Y:Current account balance share in GDP; ΔNGS/NGS: Non-defence government expenditure as a proportion of GDP; USG: Economic growth rate of USA; PRI: Real prime overdraft rate; D: Dummy variable for the effects of war (or threat of war) it took value of one for the years between 1973 and 1987 and zero elsewhere; $(S/Y)_{-1}$: Lagged S/Y; $(B/Y)_{-1}$: Lagged B/Y; $(M/Y)_{-1}$: Lagged M/Y;

The findings of these studies are summarised in Table 2.16. Despite the fact that defence has positive effect on growth in all Deger studies, the effect of defence on saving is negative and the net effect is also negative because the negative effect of defence on saving is much bigger. The other studies also suggest a negative effect of defence on saving and on growth.

Table 2.16. Summary of Previous Studies Using SEMs

Author(s)	Sample Period	Method	Effect of Defence on	
Deger & Sen (1983)	50 LDCs 1965-1973	3SLS three equation	Growth Saving Net	+ - -
Deger & Smith (1983)		3SLS three equation	Growth Investment Net	+ - -
Deger (1986a)		3SLS three equation	Growth Saving Net	+ - -
Deger (1986b)		3SLS four equation	Growth Saving Balance of Trade Net	+ - - -
Lebovic & Ishaq (1987)	20 Middle East Count. 1973-1982	2SLS three equation	Growth Saving	- -
Scheetz (1991)	Chile, Argentina, Paraguay, Peru 1969-1987	3SLS four equation	Growth Saving Balance of Trade	- - -
Roux (1996)	South Africa 1960-1990	2SLS four equation	Growth Saving Balance of Trade	- ? -

2.5. Causal Analysis of Defence Expenditure and Economic Growth

This section provides a brief review of the defence-growth literature which used Granger causality tests to analyse defence-growth relationships and the exogenity of these two variables. Eight important empirical studies are reviewed. The earlier study of Jeording (1986) analysed exogenity of defence and growth variables with sample of 57 LDCs. The defence variable was expressed as share of defence spending in GNP. Jeording (1986) concluded that defence spending is not an strong exogenous variable relative to economic growth. Chowdhury (1991) applied this procedure for 55 LDCs. His test results showed a lack of consistency across different countries. While there was no causal relationship for 30 countries, a causal relationship was evident for the remaining 25 countries. These 25 countries have relatively high defence burdens and much of them experienced a war or conflict during the term[3]. However, in no cases did he find defence spending helps economic growth. Then, he concluded that the relationships between defence spending and economic growth cannot be generalised across the countries (Chowdhury, 1991). Although Kusi (1994) found no causal relationships for 62 countries out of 77, the remaining 15 countries showed a causal relationships. In seven countries, defence spending Granger causes economic growth. However, in contrast to Chowdhury (1991), in no cases did defence spending help economic growth. These 15 countries have similarities with Chowdhury's. They have a high defence burden and experience of war[4]. Furthermore, Frederikson (1991) study for causal relationship between defence spending and economic growth showed a feedback relationship. It implies that neither economic growth nor defence spending can be considered exogenous, so that OLS estimations are inconsistent.

On the other hand, in recent years, four different studies used a single country to analyse defence-growth relationships by Granger causality test. Chen (1993), using Chinese data between 1950-1991, Madden and Haslehurst (1995), using Australian quarterly data between 1959-3 and 1993-2 and Kollias (1997) using Turkish data between 1954 and 1993 found no causal relationships between defence expenditure and economic growth for these countries. In contrast to the above three studies, Assery (1996) found that defence spending Granger causes economic growth for Iraq between 1950 and 1980.

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3 Causal relationships of 25 countries in Chowdhury (1991). Defence spending causes economic growth: Argentina, Iran, Israel, Jordan, South Korea, Panama, Paraguay, Peru, Philippines, Sudan, Syria, Tanzania, Thailand, Uruguay, Venezuela. Economic growth cause defence spending: Chilli, Ghana, Haiti, Libya, Saudi Arabia, Tunisia, Uganda. Feedback: Kenya, Indonesia, Egypt,

4 Causal relationships of 15 countries in Kusi (1994). Defence spending causes economic growth: Pakistan, Indonesia, Malaysia,, Algeria, Malawi, Brazil. Economic growth cause defence spending: Israel, Jordan, Oman, Saudi Arabia, Bangladesh, Burundi, Congo. Feedback: Kuwait

The results so far suggests that exogenity of the defence variable is not a clear issue. In some cases, OLS estimation of usual single equation growth models with defence expenditure might be inconsistent (Chowdhury, 1991). However, this test should be analysed with caution, because, the Granger causality test is very sensitive to the sample period, the number of observations, data frequency, choice of lag length, structural changes over the period, stationary of variables and cointegration across the variables (Ram, 1995). Moreover, as Ram (1995) pointed out using bivariate causality tests can suffer from omitted variables, because the defence variable is generally used with other regressions in growth equations.

2.6. Conclusions

Over the last twenty years, defence-growth association have been heavily investigated. The bulk of defence-growth studies can be classified as demand side and supply side, developed countries and LDCs, considering externality in the models and the Granger causality tests. Although the majority of demand side models uncovered a negative effect of defence spending on economic growth, supply side models usually have positive effect of defence spending or have no significant effects on growth. On the demand side, except Benoit (1973 & 1978), Stewart (1991) and Landau (1994), all studies found negative effects. On the supply side, only Ward and Davis (1993) found a negative effect of defence spending on growth. The classification of developed countries and LDCs did not show a clear result, because the findings of negative and positive effects of defence spending are nearly equal. When we consider externality effects, most of the studies found positive externality effect or no externality effect of defence spending; only Macnair *et al.* (1995) study found small negative externality effect. Furthermore, some of the studies applied purely Granger causality tests which were Chowdhury (1991), Jeording (1986) and Madden and Haslehurst (1995). According to Jeording's findings causality runs from growth to defence. It shows that defence spending is a dependent variable on growth. These results break findings of all studies because the studies explicitly or implicitly assumed defence spending is independent variable. On the other hand, for over half of the sample no causality was found by Chowdhury (1991) and also no causality was found by the Madden and Haslehurst(1995) study. A summary of the literature is presented in Table 2.17.

Table 2.17. Summary of Literature on Defence Spending and Economic Growth (arranged in order of year of publication)

Year of Study	*Author(s)*	*Model Sample Period*	*Method*	*Main Conclusions*	*Sign*
1973-1978	*Benoit*	*Traditional(Ad Hoc Model 44 LDCs 1950-65*	*OLS estimations and correlations*	*Significantly positive effect of defence spending on growth*	+
1980	*Smith*	*Keynesian model of investment and demand 14 OECD countries 1954-73*	*Pooled cross-sectional time series estimations and time series estimations*	*Defence spending has a negative effect on investment*	–
1983	*Deger and Smith*	*Demand side and supply side models 50 LDCs, 1965-73*	*Three equation model, defence, savings and growth, cross sectional time series estimations 3SLS*	*Negative indirect effect of defence on growth and positive direct effect, net effect is negative*	–
1983	*Frederikson and Looney*	*Same as Benoit model and sample 1950-65*	*Linear regression equations*	*For "resource abundant" countries defence spending has positive effect but for "resource constrained" countries the effect is negative*	+ –
1983	*Lim*	*Harrod-Domar Growth model, 54 LDCs 1965-73*	*OLS estimations*	*Defence spending has a negative impact on growth*	–
1984	*Faini, Annez and Taylor*	*Demand side traditional model, 69 countries mostly LDCs, 1952-70*	*Single equation estimations, cross sectional time series*	*a generally negative effect of defence spending on growth except some developed countries*	–
1986	*Deger*	*Demand side and supply side model (Ad hoc) 50 LDCs, 1965-1973*	*Three equation model, defence savings and growth equation, cross sectional estimations (3SLS)*	*Negative indirect effect of defence on growth; positive direct effect; overall effect is negative*	–
1986	*Ram*	*Feder-Ram model, 115 countries, 1960-70 and 1970-80*	*Cross sectional time series estimations, time series estimations for each country, defence sector is not separated from government sector*	*Positive impact of government sector on growth*	+
1986	*Jeording*	*Granger causality test, 57 LDCs, 1962-77*	*Defence spending measured two different type*	*Causality runs from growth to defence spending. No evidence that defence spending Granger causes growth, defence spending potentially dependent*	?

1986	*Landau*	*Traditional models with many variables, 65 LDCs, 1960-80*	*Cross sectional time series OLS; defence measured by defence spending, GDP, growth measured by growth of per capita income*	*Defence spending has little effect on growth*	*0*
1986	*Biswas and Ram*	*Feder Ram, 58 LDCs, 1960-70 and 1970-77*	*Cross sectional time series estimations*	*No significant effect of defence spending on growth*	*0*
1987	*Lebovic and Ishaq*	*Keynesian demand model, 20 Middle Eastern LDCs 1973-82*	*Three equation model like Deger-Smith(1983), pooled cross sectional time series estimations*	*Negative effect of defence spending on growth*	–
1988	*Rasler and Thompson*	*Demand side investment models, hegemonic leaders in 19th and 20th century*	*Capital investment formation is dependent, defence burdens and economic growth are independent variables*	*Some evidence of an adverse effect of defence spending on investment*	–
1990	*Mintz and Huang*	*Demand side flexible accelerator investment model, US*	*OLS estimation of a three equation model*	*Defence spending reduces investment and hence growth*	–
1990	*Alexander*	*Feder-Ram, 9 developed countries, 1974-85*	*Four sectors model(defence, non-defence government, civilian, export) cross sectional time series estimations*	*No effect of defence spending on growth*	*0*
1990	*Atesoglu and Mueller*	*Feder-Ram model, US, 1949-89*	*Two sectors model, defence and civilian*	*Significant small positive effect of defence spending on growth*	+
1990	*Huang and Mintz*	*Feder-Ram model, US, 1952-88*	*Single equation ridge regressions, three sectors defence, non-defence government and civilian sectors*	*Defence has no effect on growth*	*0*
1991	*Huang and Mintz*	*Feder-Ram model, US, 1952-88*	*Almost the same 1990 paper but disaggregates externality and productivity considered*	*Defence has no effect on growth*	*0*
1991	*Stewart*	*Keynesian demand model, LDCs*	*Simulation based estimations*	*Defence spending is conducive to growth but non-defence spending even more conducive*	+
1991	*Chowdhury*	*Granger causality tests 55 LDCs period various by country*	*Time series estimations for each country, defence measured by defence spending/GDP*	*30 countries no causality, 15 countries defence negative effects on growth, 7 countries economic growth causes defence spending, 3 countries bidirectional causality*	*?*

1991	Scheetz	Deger type demand and supply side models, Chile, Argentina, Peru, Paraguay, 1969-87	Time series estimations, pooled cross sectional time series estimations	Defence has a negative impact on investment	–
1991	Adams, Behrman and Boldin	Feder-Ram Model, LDCs, 1974-86	Cross sectional time series estimations, three sector (defence, non-defence, export)	Defence has no effect on growth but export has positive effect	0
1991	Ward et al	Feder-Ram Model, India 1950-87	Three sector model (defence spending, non-defence governmental spending and private sector. Non linear time series estimation	Defence spending has a positive effect on growth	+
1992	Ward and Davis	Feder-Ram model, US 1948-90	Three sector model, time series estimation, separate externality and productivity effects	Defence spending has a negative effect on growth in spite of positive externality effect	-
1993	Biswas	Feder-Ram and traditional models, 74 LDCs 1981-89	Three sector model	Defence spending has positive significant effect on economic growth	+
1993	Chen	Granger causality tests, China, 1950-1991	The study used unit root and cointegartionn methodology	No causal relationship between defence spending and economic growth	?
1993	Mueller and Atesoglu	Feder-Ram model with technological change US 1948-90	Two sectors defence and civilian with technological change aspect, single equation estimates	Small and significant positive effect on growth, no defence spending externality effect	+
1994	Kusi	Granger causality tests, 77 LDCs, 1985-1990	Defence spending measured as share of defence spending in GDP	62 countries, no causal relationship, 7 countries, defence causes economic growth, 7 countries economic growth causes defence spending and 1country, feedback	- + ?
1994	Landau	Traditional (Ad hoc)growth model 71 LDCs 1969-89	Defence variable measure as defence spending/GDP, cross section regressions	Defence spending has initial positive effect but the effects turns negative at higher levels of defence burden, 47 countries had no significant effect	+
1995	Madden and Haslehurst	Granger causality tests like Chowdhury, Australia	Defence variable measured as defence spending/GDP	No causal relationship between defence spending and economic growth	?
1995	Macnair et al	Extended Feder-Ram model, 10 NATO allies 1951-88	Pooled annual data , spilling from allies included	Defence spending has a positive effect on growth	+

1995	*Chletsos-Kollias*	*Demand side (Ad hoc) Greece, 1974-1990*	*Disaggregated defence data used, three equations Total consumption, total investment and defence burden equations,*	*Defence has an positive impact on growth*	+
1996	*Roux*	*Demand and supply side Deger type model, South Africa, 1960-1990*	*Time series 2SLS four equation as growth, savings, balance of trade and defence equations*	*Negative direct effect of defence on growth. No effect of savings and balance of trade*	-
1996	*Asseery*	*Granger causality tests, Iraq, 1950-1980*	*unit root tests employed*	*Defence spending causes economic growth*	-
1997	*Kollias*	*Granger causality test, Turkey, 1954-1993*	*Cointegration and unit root methodology were employed*	*No causal relationships are found*	?
1997	*Antonakis*	*Demand and supply side Deger model, Greece, 1960- 1990*	*Time series, 3SLS estimation, three equation, growth equation, saving equation and defence equation*	*Negative direct effect of defence on growth, positive indirect effect. Net effect is negative*	-
1997	*Antonakis*	*Feder type, Greece, 1958-1991*	*Single equation estimates, time series, two sector, defence and civilian*	*Military expenditure had a negative impact on growth*	-
1998	*Dunne-Vouges*	*Granger causality tests, South Africa, 1964-1995*	*VAR methodology*	*Defence spending causes economic growth*	-
1998	*Dunne-Nikolaidou*	*Demand and supply side Deger model, Greece, 1960-1996*	*Time series estimation (2SLS) and (3SLS) four equations, growth, saving, balance of trade and defence equation*	*Positive direct effcet of defence on growth, negative indirect effect. Net effect is positive*	+

2.7. DATA

2.7.1. Data Problems

Reliable data are crucial elements of econometric studies. However, reliable data are a major problem when studying LDCs. Not do only defence expenditure data have problems but also general economic data may not be reliable. Series usually do not group for time series data, and deflators are not very exact due to high inflation. It makes for high residuals and low R^2 (Scheetz, 1991). Turkey has been living with high inflation for long time. This is one econometric difficulty when studying Turkey. However, there is no other possibility for empirically discussing its defence-growth associations.

Most of the defence-growth studies rely on cross-section analysis and their sample periods are relatively short. There is a lack of empirical evidence from single country using time series estimation. A country such as Turkey, from developing world with a high defence burden might help to explain these relationships. The major problem in the econometric study is data availability and its reliability. This problem is even bigger in the cross-nation analysis because of problems of comparability (Cohen and Ward, 1996: Ch. 21). Scheetz (1996) showed that for a given US $, level of defence spending, expenditure levels between one international sources and another can frequently differ by as much as 300% (Scheetz, 1996: Ch. 22). Blackaby and Ohlsen (1987) analysed the problem of defence spending data and they showed that ACDA and SIPRI data differ significantly in pricing and presentation. Their finding is that out of the 150 countries in the World, only about 25 countries have a "good" statistical series for defence spending and even 25 countries' series are not very accurate (Blackaby and Ohlsen, 1987). However, NATO figures are relatively reliable.

Fontanel (1987) mentioned limitations of exchange rates when comparative information about defence spending is expressed in US $. This limitations make ACDA data less reliable for Turkey. Fontanel (1987) indicated four important problems which seriously undermine the credibility of defence spending data. They are:

a) The very large domestic sector that is not connected with international trade and broadly independent of exchange rate trends.

b) Changes in interest rate differentials and sudden capital movements attribute to international specifications.

c) The fact that some exchange rates are set arbitrarily mostly by countries with planned economies but also by other countries that exercise a more or less strict control over foreign exchange.

d) The poor credibility of official exchange rate to adjust prices in different currencies for purposes of international comparisons because they do not reflect the currencies international purchasing power" (Fontanel, 1987: 29-30).

Purchasing Power Parity (PPP) is not an answer for cross-nation study of defence economy. Since the pattern of defence spending and in particular the pattern of relative prices in a defence sector can be very different from that of other kinds of expenditure. This is particularly the case when there is any form of conscription by which military manpower is obtained at very low rates of pay (Blackaby, 1987). Smith (1996) suggests that in the case of defence spending US ACDA and SIPRI data are better than other sources.

Defence expenditure data are not usually very accurate for a number of reasons such as: significant amounts of security expenditure never enter the accounts or budgets of developing countries, problems of conversions, extra budgetary accounts, highly budget categories, military assistance and foreign exchange manipulation. These make cross-nation studies more inaccurate. Although single country analysis does not solve all the above data problems of defence spending, it has potential for better explanations.

2.7.2. Data Sources

There are a few main data sources for defence expenditure with its own characteristics. The military expenditure data are as follows. *Military Balance* (MB) is published by the International Institute for Strategic Studies. It is useful for compact information for a particular country and for a particular year (Deger, 1986). However, when time series data or historical data are needed, the data are rather inadequate. Some of the defence expenditure data are estimated and then not updated.

The IMF publish defence expenditure data in *Government Finance Statistics Yearbook* (GFS). The data are taken directly from the government submission, and its definition of defence expenditure is very narrow. It includes only shares of Ministry of National Defence in general budget for Turkey. The data are rarely used in econometric studies (Candemir, 1995).

The other comprehensive military data source is US Arms Control and Disarmaments Agency (ACDA). Its publication of *World Military Expenditures and Arms Transfers* (WMEAT) does not give local currency figures. It gives only constant and current US dollar figures. The base year of constant dollar series changes in every yearbook. Each book provides data for 10 years. It is difficult to construct a long enough time series data set. Furthermore, converting national currency to US $ involves a long complicated procedure with national and US GDP deflators, and exchange rates. Therefore, national currency in value term are not directly obtainable from ACDA figures. Despite the fact that the ACDA figures are very useful for cross sectional studies, they are limited for time series analysis.

Turkey's own records are another data source for the study. Recently, defence expenditure in the general government budget was published from 1924-1996 by the Ministry of Finance. The data are same as with IMF-GFS data, so it has the same problems. It is very narrow. It does not include many of defence related expenditures such as Defence Industry Support Fund (DISF). In recent years, the fund has transferred considerable amounts of money to the defence industry.

The Stockholm International Peace Research Institute (SIPRI) also publishes defence expenditure data and it uses open sources when calculating defence expenditure data. The NATO definition is used as a guideline for all countries. It supplies very reliable data for time series analysis and publishes military expenditure data for its member countries. For the NATO countries, the NATO and SIPRI figures are same. Table (2.18) and Figure (2.1) show comparative military expenditure trends among different data sources. ACDA data are not included because they use US$ and not national currency, and converting to national currency is not easy due to its long procedures. However, its value for Turkey is not so different from SIPRI or NATO data. ACDA also uses NATO definitions of defence expenditure for Turkey. **For these reasons, this study uses SIPRI data (or NATO data) for military expenditure.**

Table 2.18. Turkish Defence Expenditure among Different Data Sources

Years	IISS (1)	NATO/SIPRI (2)	GFS/MOD (3)	Turkey Total (4)
1981	2142	2080	1539	1937
1982	1645	2319	1278	1641
1983	1825	2289	1514	1953
1984	1615	2223	1458	1909
1985	1558	2236	1358	1808
1986	1648	2493	1493	1988
1987	1728	2477	1454	2042
1988	1710	2232	1318	1907
1989	1303	2404	1515	2234
1990	1670	2953	1696	2611
1991	1986	3165	1844	2984
1992	2275	3440	2078	3388
1993	2424	3796	2135	2984

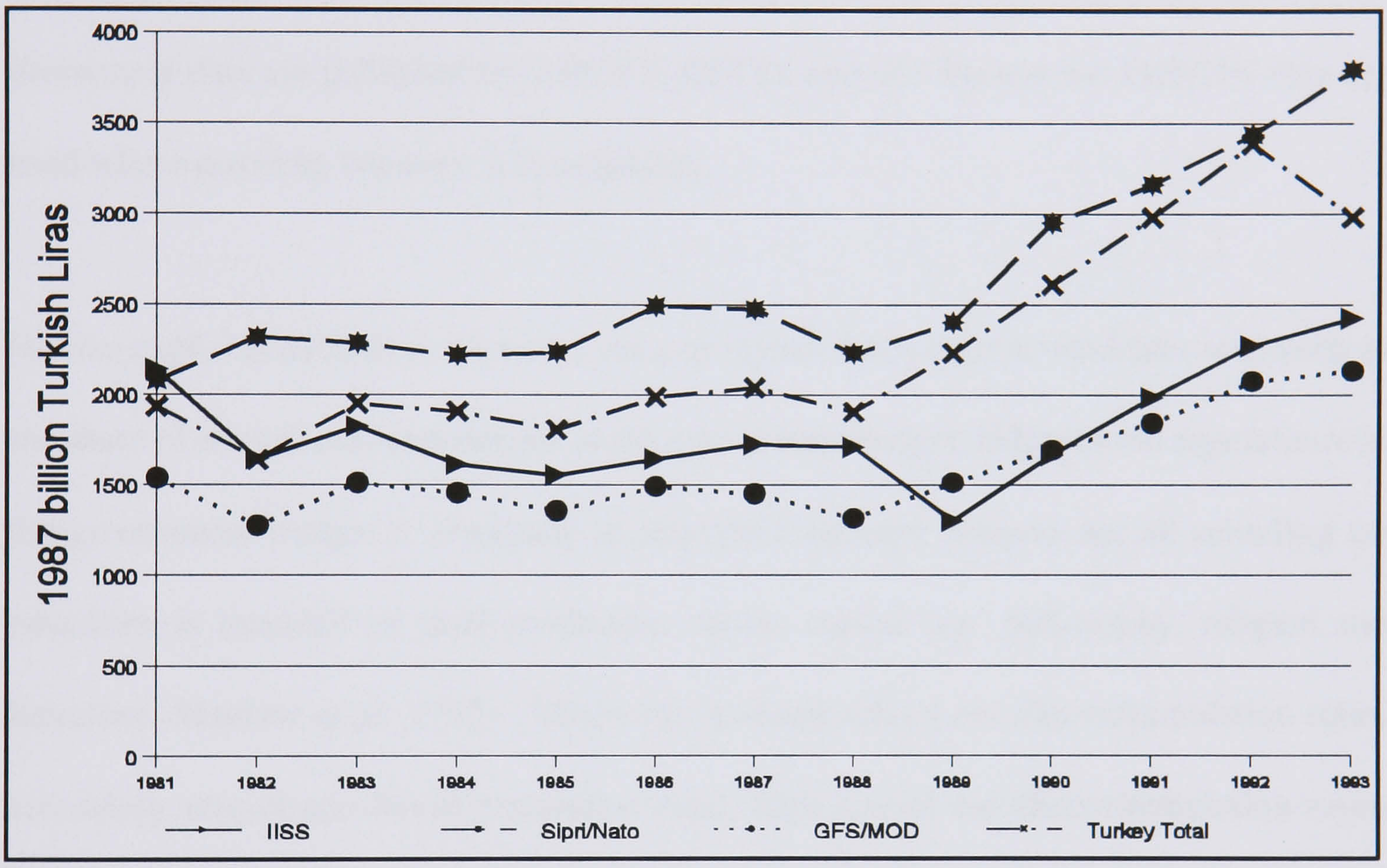
Sources: IISS, Military Balance (various years), NATO Review (various years), SIPRI yearbook 1995, IMF-GFS (various years), Ministry of National Defence Turkey (1993, 1995) Values are with 1987 Constant Turkish Billion Liras.

Notations:

1. These data were taken from IISS Military Balance (various years)
2. These data are from NATO publications (NATO Review) and SIPRI yearbooks. They have exactly the same values for Turkey.
3. Turkish Ministry of Defence budget figures and also IMF, Government Finance Statistics Yearbooks publishes same data for defence expenditure.
4. Turkey's total security defence and spending. They were taken from Ministry of Finance Turkey (1993, 1995). It include ministry of defence budget, gendarmerie force budget, coast guard budget, security forces budget and ministry of interior budget figures.

In Table (2.18) and Figure (2.1). IISS and GFS/MOD values show lower trends because their defence expenditure definitions are very narrow. Data for Turkey were taken from the Ministry of Finance in Turkey. They include total security and defence expenditures (i.e. Ministry of Defence budget, gendarmerie force budget, coast guard budget, security forces budget and Ministry of Interior budget figures), but exclude some important components of defence spending. The SIPRI and NATO (they are same for Turkey) figures better explain Turkish defence expenditures, since they are a more accurate measure of all defence items. For these reasons, the study applied SIPRI or NATO data.

Figure 2.1 Trends of Turkish Defence Expenditure among Different Data Sources



2.7.2.1. The Turkish Data

The data for defence expenditure in Chapters 4 and 5 are taken from SIPRI yearbooks but for the causal analysis in Chapter 5, the data for defence burden and economic growth between 1924-1996 came from Ministry of Defence, Turkey; and the disaggregated defence data in Chapter 7 are taken from various issues of NATO Review. Other than military expenditure, in Chapter 4, the study needs gross national product (GNP), gross fixed investment, educational expenditure and labour force data. These data are published by IMF International Finance Statistics (IFS), the Organisation for Economic Development and

Cooperation (OECD), State Institute of Statistics (SIS) Turkey and Ministry of Finance Turkey. Although the International Labour Office (ILO) publishes labour force data. sufficient data are not available for Turkey. Therefore, labour force data are obtained from OECD Labour Force Statistics from 1960 to 1994. The data between 1955-1959 are not available from OECD nor SIS Turkey, so it is constructed from population using a labour force/population ratio. Population data were taken from SIS Turkey. GNP and gross fixed investment data are published by IMF/IFS, OECD, and SIS Turkey but IMF/IFS data are used where possible, because of its reliability.

Human capital is difficult to measure. As a proxy the study used several data sets, such as the share of educational expenditure in the government budget. Educational expenditure in the government budget is obviously an imperfect measure because not all spending on education is intended to yield productive human capital (*eg*. philosophy, religion and literature: Mankiw *et al.* 1992). Moreover, primary school enrollment/population ratio, secondary school enrollment/population ratio, high school enrollment/population ratio, primary school enrollment/labour force ratio primary school enrollment/labour force ratio, secondary school enrollment/labour force ratio. high school enrollment/labour force ratio, armed forces/labour force and an armed forces/labour force ratio are considered as alternative proxies. The data for the human capital are taken from the Ministry of Finance, SIS Turkey and NATO. respectively.

The data for the study are from 1955 to 1996. Before 1949. SIPRI military data are not available and gross fixed investment data are available from 1948 and accurate human capital data from 1954. All financial data were millions of Turkish Liras in current prices which are deflated to millions of 1985 Turkish Liras using both IMF/IFS GNP deflator and GNP deflators of SIS Turkey. The IMF/IFS deflator was only available from 1960. For earlier years, the GNP deflator of SIS Turkey is used. Due to a long period of high inflation for Turkey, deflators are not exact. To obtain the most accurate data, OECD, SPO (State Planning Organisation, Turkey) and United Nations data are considered[5].

The data used in Chapter 5 (different from data sources of Chapter 4) are taken from the following sources. Balance of trade and government consumption was taken from various IMF/IFS yearbooks. Inflation and exchange rate data came from various publications of SIS Turkey. Share of Greek defence spending in GDP and average NATO defence burden of members of NATO data were taken from various SIPRI yearbooks. Share of variables for GRE and NATO are not very accurate proxies for this estimation. Sandler and Hartley (1995) suggest that defence expenditure for spill-in and threat should consist of the level of defence expenditures not per capita defence expenditures nor the share of defence expenditures in GNP (Sandler and Hartley, 1995; 60-61). However, converting into a common currency using exchange rate might make the variables less representative. GRE and NATO variables needed to be converted Turkish currency, but the high level of inflation and fixed exchange rate until 1980 makes these conversion meaningless[6]. All financial data were deflated to 1985 million Turkish liras using GNP deflators of IMF/IFS and SIS Turkey[7].

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5 A more detailed account of data set are given in the Appendix 4.1.

6 The series are converted to Turkish currency but it did not give significant results.

7 The data series used for estimation are presented in the Appendix 5.1.

2.7.2.2. The Greek Data

Greece provides comparative material, enabling tests of the robustness of the results for Turkey. The data used for Greece came from two main sources. First, the International Monetary Fund (IMF), International Financial Statistics (IFS) Yearbooks (various issues). Second, the SIPRI yearbooks. GNP (gross national products), GNP deflator, investment, saving (it is calculated from national accounts), a balance of trade (exports of goods and services minus imports of goods and service in the national accounts), inflation rates government consumption, export and population data were taken from IMF/IFS yearbooks. Defence expenditure data came from various SIPRI yearbooks. For alternative estimations, limited labour force data were taken from OECD historical statistics.

All financial data were deflated to 1990 billion Greek Drachmas using GNP deflators of IMF/IFS[8]. Share of Turkish defence spending in GDP and average NATO defence burdens of members of NATO data were taken from various SIPRI yearbooks. Although share of variables for TUR and NATO are not very accurate proxies for this estimation, but there are no other possible proxies. Converting into a common currency using the exchange rate may give inaccurate values due to a long period of fixed exchange rate policy. For disaggregated defence expenditure in Chapter 7, the data are taken from various issues of NATO Review.

2.8. Summary and Conclusions

This Chapter has reviewed the empirical literature on defence-growth relationships and data and data problems. From the literature, it is difficult to say whether defence spending has

8 The data series used for estimation are presented in the Appendix 6.4

a negative effect or a positive effect on economic growth. The relationship between defence spending and economic growth is still a controversial issue. More research needs to be done in this area. Furthermore, data also needs special attention. The above studies showed that the effects of defence spending differ among countries. Cross-sectional studies give limited evidence for the defence-growth trade-off. This study focuses on Turkey, with Greece included to provide a comparative study. Turkey spends a higher proportion of their GDP to defence. Turkey has registered a high economic growth during the last two decades. Defence spending should have an important effect on Turkish economic growth. This study then hypothesised that Turkish defence spending should have a positive impact on Turkish economic growth. After reviewing the Turkish economy, defence expenditure and defence industry, the next Chapters will empirically analyse the effect of Turkish defence spending on its economic growth. The empirical work follows the literature review in examining the applicability of supply side models (Feder), and of demand and supply side models (Deger) to test hypotheses about the defence-growth relationship for Turkey. A similar study of Greece is used to assess the reliability and robustness of the results for Turkey.

CHAPTER 3

CHAPTER 3

TURKISH DEFENCE EXPENDITURE, ARMED FORCES AND DEFENCE INDUSTRY

3.1. Introduction

The purpose of this Chapter is to examine the Turkish armed forces, its new developing Turkish defence industry and its modernisation, and the trend of Turkish defence expenditure. The period of study covers the last four decades (1950-1996) which have seen important developments in defence related issues as well as in Turkish economic growth. Also, a brief history of the Turkish republic era is presented. **A distinguishing feature of Turkey is its relatively high defence burden compared with other European NATO states.**

Turkey is an important country in the region with a population of over 60 million people, containing a land area of 779,000 square miles and with geo-strategic position. Turkey is located between Europe and Middle East as well as sharing a boundary with the former Soviet Union (now Georgia and Armenia), Iran, Iraq Syria, Greece and Bulgaria. Although Turkey has a high defence burden, the level is modest when it is compared with its neighbouring countries. Turkey is a member NATO (North Atlantic Treaty Organisation) and OECD (Organisation for Economic Development and Cooperation), and it has relatively powerful military forces. Turkish armed forces ranked seventh in the world and it has the largest armed force in NATO Europe. Economically, Turkey has relatively low level of economic development in comparison with the western industrialised countries. However, Turkey has achieved high rates of economic growth during the republic era and it has a developed industrial sector. After 1980, Turkey turned to export-based growth and the Turkish economy registered high economic growth between 1980-1993.

The rest of this Chapter proceeds as follows: Section 3.2.1 provides the background to the Turkish development process. Section 3.2.2 gives general macroeconomic indicators for Turkey. Section 3.2.3 presents Turkish defence expenditure, its trends and importance in Turkish economy. In section 3.2.4 Turkish armed forces are analysed. Turkish defence industry and its modernisation are considered in section 3.2.5. Section 3.3 summarises the main findings and draws some conclusions.

3.2. Turkish Defence Expenditure, Armed Forces and Defence Industry

3.2.1. Background

In order to understand the current economic situation of Turkey, it is useful to look at the country's recent history. After World War I, the Ottoman Empire lost control of its territory and the new republic of Turkey was established in 1923. Turkey initiated a series of radical changes in its social, political and economic systems. The undisputed leader of this transformation was Ataturk. He was the first president after the country became a republic in 1923. Ataturk influenced Turkey's development until he died in 1938. From the establishment of a republic, Turkey pursued a policy of industrialisation within a closed economy (inward looking economic strategy) and reliance on government intervention until 1980. After the military takeover in September 1980, Turkey has been following an outward looking economic strategy. The Turkish development period can be divided into a number of sub-periods, namely, 1923-1939, 1939-1945, 1945-1950, 1950-1960, 1960-

1980 and after 1980.

From 1923 to 1939, the Turkish economy focussed on investment in heavy industries and capital intensive industrial projects. This was called the Industrial Planning Term. It was influenced by the Soviet Union. In this period a high economic growth rate was achieved (an average 6.5 % per annum for 1924-1939. The period 1939-1945 was World War II years. The Turkish economy was affected through being involved in the war. 1945-1950 was the transitional five years from mono-party to democracy. Between 1939-1950, the annual growth rate of Turkish economy had been very low, even negative, the only exception was 1946 with 31.9 % growth rate. The next period (1950-1960) was a period of inflation and of rapid growth in Turkish exports and agricultural production. There was a short term liberalisation attempt between 1950-1953. The inward-oriented approach was formalised under the first two five-year plans (1963-1972). In the 1960's and early 1970's, the Turkish economy experienced import substituting industrialisation. In 1974, the oil price shock and military intervention in Cyprus had affected Turkish development, then in the late 1970s, the Turkish economy faced crisis. The economic crisis was accompanied by political crisis. By 1980, a dramatic change had begun in the Turkish economy. In the previous year, the real gross national product had fallen for the first time in a decade and the annual inflation rate had been about 116 %. Although the new government of 1980 had initiated a major program of economic reforms, the reforms had been carried out after the military coup. The substantial change of Turkish development after 1980 was that it turned to export-based growth. The Turkish economy registered high growth rates between 1980 and 1993 (an annual average of 5.2 %).

3.2.2. Economic Indicators

Turkey's general economic trends should be outlined so providing the economic background for this study. Table 3.1 shows general macro economic variables. The data are shown on the Table 3.1 with ten year intervals between 1950 and 1980, then between 1980 and 1990 with 5 years intervals and annual data after 1990. Population has a high growth rate. Between 1950-1994, Turkey's population increased three-fold at an average of 2.4% per annum. The inflation rate was very high especially after the late 1970s although there was a decreasing trend between 1981 and 1984. The unemployment rate shows little variation over the years, but, in 1970, the rate peaked at 12%. The growth rate of GNP (Gross National Product) between 1950-1994 was an average of 5.4 % annually. Although the average rate is rather high, there were dramatic fluctuation in the growth rates. There was also an increasing trend of per capita GNP, although 1994 showed a decline which was due to an economic stabilisation programme starting in April 1994. The investment/GNP ratio also shows a slight upward trend during the period. Central government budget shares in a gross national product suggest a major expansion of government activity in the economy after 1980. The remaining data are an export share in GNP. The export sector grew rapidly after 1980 with exports becoming an important sector in the economy after 1980.

Table 3.1. Main Economic Indicators of Turkey (1950-1996)

Indicators	1950	1960	1970	1980	1985	1990	1994	1995	1996
Population (million)	20.8	27.5	35.3	44.4	50.3	56.1	61.2	62.2	63.2
Annual Inflation rate (%)	-9.4	5.0	8.3	101.6	44.9	60.3	106.3	89.1	80.4
Unemployment rate (%)	-	0.1	12.0	7.8	6.9	8.3	8.4	7.2	6.3
Annual real growth rate of GNP* (%)	11.4	10.9	7.0	-1.2	5.1	9.1	-7.4	8.0	7.1
Per capita GNP (US $ current)	242	522	539	1539	1204	2687	2161	2788	2944
Per-capita GNP (1987 thousand Turkish Liras)	520.4	724.5	775.9	1144.8	1272.0	1508.0	1503.1	1606	1691.9
Investment/ GNP (%)	10.4	13.1	20.9	16.7	22.5	25.7	24.5	24.0	25.0
Central Gov. Budget./GNP (%)	13.8	11.5	16.7	21.6	19.5	12.2	24.6	21.7	26.3
Export/GNP (%)	7.1	3.4	4.4	5.0	14.9	11.9	13.6	12.6	12.5

* Calculated using 1985 constant Turkish Liras

Sources: OECD Economic Surveys Turkey and OECD Labour Force Statistics, IMF/IFS, Ministry of Finance Turkey, SIS (1996), Ozmucur (1996), SPO (1997)

3.2.3. Turkish Defence Expenditure

Turkish defence expenditure has been around 4.8 % of GNP over the last four decades and an average of 21.7 % of central government outlays goes to defence spending. Typically, Turkey has allocated a considerably higher percentage of its GNP to defence expenditure. At the same time Turkey's growth rate (1950-1994) has been around 5.4 % per annum. Turkey was a member of NATO from 1952. Often, the defence burden in Turkey has been greater than the NATO average, although it has a relatively low stage of development. Table 3.2 shows indicators of Turkish defence expenditure between 1950 and 1994 with annual data. The growth rate of military expenditure has averaged 6.2 % per annum, while the growth rate of GNP has averaged 5.4 % per annum. Table 3.2 also shows the long term defence burden and ME/CGB (military expenditure/central government budget): they are an average of 4.7 % and 21.7 % per annum, respectively. There are other sources of military expenditure outside the central government budget in recent years. The most important one is the Defence Industry Support Fund (DISF). The DISF has had considerable amount of its own budget since 1986 which was part of the central government budget before that year. Therefore, the share of military expenditure in the central government in Table 3.2 does not include the DISF budget. It shows a decline in the ratio after 1986. Figure 3.1 shows long term Turkish economic growth and its defence burden.

Table 3.2 Selected Indicators of Turkish Defence Expenditure

Years	ΔME (%)	ΔGNP (%)	ME/ GNP (%)	ME/ CGB (%)	Years	ΔME (%)	ΔGNP (%)	ME/ GNP (%)	ME/ CGB (%)
1950	7.3	9.4	5.8	27.0	***1973***	2.0	4.9	3.9	20.7
1951	11.1	12.8	5.3	27.2	***1974***	-2.6	3.3	3.7	21.8
1952	4.5	11.9	5.1	26.5	***1975***	69.6	8.1	5.6	20.1
1953	11.0	11.2	4.9	31.0	***1976***	13.7	9.0	6.0	19.2
1954	8.0	-3.0	5.5	34.8	***1977***	-2.1	3.0	5.7	17.2
1955	9.5	7.9	5.1	37.8	***1978***	-6.6	1.2	5.1	15.0
1956	-3.3	3.2	4.8	31.2	***1979***	-18.1	-0.5	4.2	15.3
1957	-2.3	7.8	4.2	29.1	***1980***	-2.5	-2.8	4.1	19.0
1958	-5.9	4.5	3.8	30.9	***1981***	18.8	4.8	4.8	17.9
1959	28.2	4.1	4.5	29.5	***1982***	12.5	3.1	5.1	18.0
1960	-6.6	3.4	4.7	27.1	***1983***	-3.1	4.2	4.8	16.3
1961	12.8	2.0	5.1	22.1	***1984***	-3.9	7.1	4.4	16.1
1962	-6.0	6.2	4.9	28.8	***1985***	6.9	4.3	4.4	15.4
1963	5.9	9.7	4.7	25.6	***1986***	15.5	6.8	4.7	17.9
1964	-4.6	4.1	4.8	24.8	***1987***	-4.2	9.8	4.2	16.0
1965	11.0	3.1	5.0	24.1	***1988***	-7.6	1.5	3.8	15.1
1966	4.6	12.0	4.4	23.1	***1989***	13.7	1.6	4.2	17.1
1967	2.2	4.2	4.5	22.1	***1990***	25.4	9.4	4.8	17.9
1968	12.3	4.1	4.6	22.9	***1991***	7.2	0.4	5.2	16.8
1969	-5.9	4.3	4.3	20.2	***1992***	9.4	6.4	5.3	18.5
1970	5.1	4.4	4.2	18.2	***1993***	13.1	7.6	5.4	13.2
1971	15.1	7.0	4.4	19.1	***1994***	-8.4	-5.1	5.2	15.0
1972	1.7	9.2	4.1	19.2	***1995***	1.1	8.0	8.0	17.4
					1996	6.9	7.1	7.1	17.6

Sources: SIS (1994), Ministry of Finance (1993, 1995), SIPRI yearbooks, US ACDA, SPO, (1997), NATO Review, Spring 1998.

Notes:

•ME: Military expenditure with 1987 constant Turkish billion liras

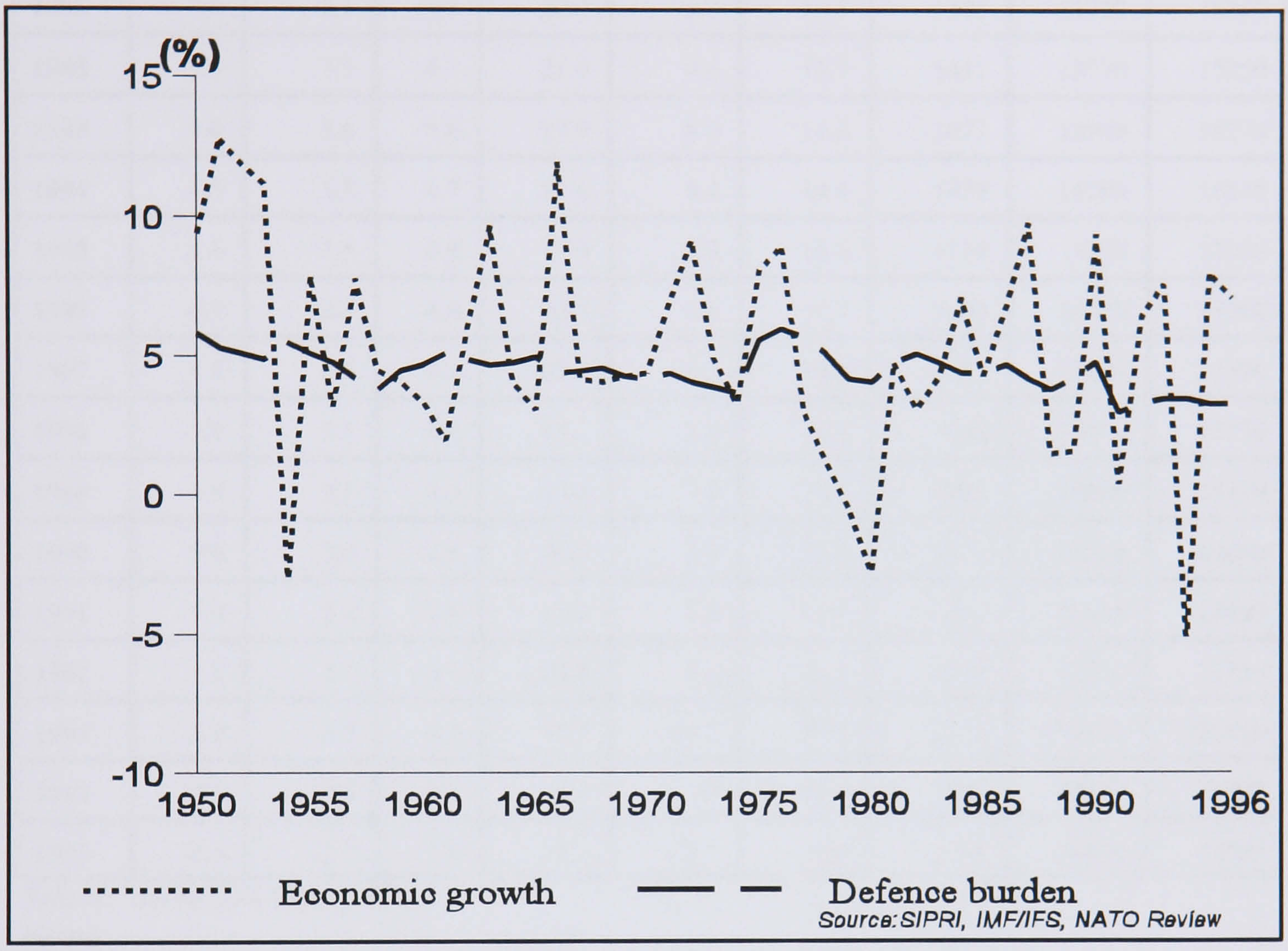
•ΔME: Growth rate of military expenditure

•ΔGNP: Real growth rate of gross national product

•ME/GNP: Share of military expenditure in the GNP

•ME/CGB: Share of military expenditure in the central government budget

Figure 3.1. Trends of Turkish Defence Burden and Economic Growth



Sources: SIPRI, IMF/IFS, NATO Review

When the Turkish burden is compared with NATO, the burden is always higher than other European NATO countries. However, when NATO includes North America, the results are rather different due to a large US defence burden (Table 3.3 and Figure 3.2). The other perspective of defence expenditure is its share in the central government budget. The ratio is much higher than in NATO countries. On the other hand, the per capita military expenditure of Turkey is very low when compared to NATO countries (Table 3.3).

Table 3.3 Defence Burden for Turkey and NATO

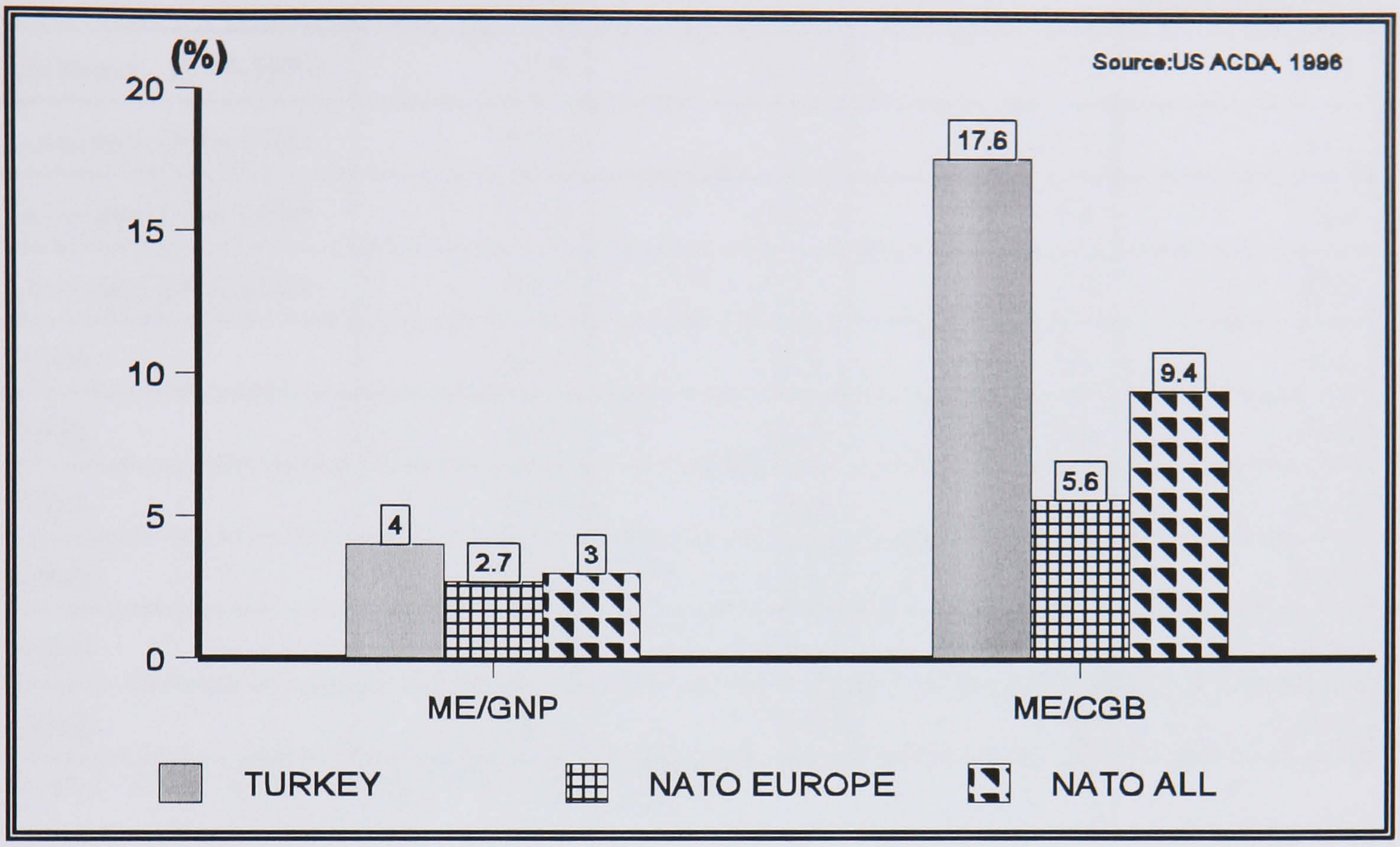
	ME/GNP(%)			ME/CGB (%)			PCME		
Year	T	NE	NA1	T	NE	NA1	T	NE	NA
1981	5.0	3.5	4.3	20.0	8.7	13.7	1381	13760	16260
1982	5.3	3.5	4.7	21.6	8.6	14.7	1411	13770	15950
1983	5.0	3.6	4.8	19.9	8.6	14.3	1427	13940	16270
1984	4.5	3.5	4.7	17.6	8.4	14.4	1473	14200	16840
1985	4.6	3.5	4.8	17.9	8.3	14.6	1518	14500	17200
1986	4.9	3.4	4.8	22.5	8.1	14.7	1600	14830	17560
1987	4.4	3.3	4.7	19.4	8.2	14.6	1682	15170	17950
1988	3.9	3.1	4.4	17.7	8.0	14.2	1702	15660	18520
1989	4.4	3.1	4.3	18.4	7.8	13.8	1692	16060	18910
1990	5.0	3.0	4.1	20.3	7.7	13.2	1819	16370	19080
1991	5.4	2.9	3.8	17.9	7.2	11.5	1790	15810	18490
1992	3.8	2.7	3.7	18.8	6.5	11.2	2618	18350	21310
1993	3.9	2.7	3.5	15.8	6.1	10.6	2775	18160	21320
1994	4.0	2.5	3.3	17.4	5.9	10.0	2597	18530	21790
1995	4.0	2.7	3.0	17.6	5.6	9.4	2714	18830	22090

Source: US ACDA 1994, 1996

Notes:

- ME/GNP represents share of military expenditures in gross national product
- ME/CGB is share of military expenditure in central government budget
- PCME is per capita military expenditure with 1991 constant US $
- T represents Turkey
- NE represents NATO Europe
- NA represents all NATO

Figure 3.2. Comparative Defence Burden and Defence Spending Share in Central Government Budget for Turkey and NATO (1995)



Source: US ACDA

Another aspect of the defence budget is its distribution among personnel, equipment, infrastructure and other expenditures. Table 3.4 shows the distribution of military expenditure by category. An average of 50% of defence expenditure per annum goes to personnel expenditure(1990-1994); 23.7% to equipment; 3% to infrastructures; 22.5% to other operational expenditures. The important point is that half of the Turkish defence expenditure goes to personnel expenditures. This ratio is not so different from other NATO nations.

Table 3.4 Distribution of Turkish Defence Expenditure by Category

Years	Personnel Expenditure (%)	Equipment Expenditure (%)	Infrastructure Expenditure (%)	Other Operational Expenditure (%)
Average 1975-1979	47.6	19.2	7.3	23.7
Average 1980-1984	45.3	9.1	13.2	30.1
Average 1985-1989	37.1	18.2	5.4	38.4
Average 1990-1994	50.1	23.7	3.0	22.5
1991	48.5	22.7	2.8	26.0
1992	48.7	24.8	3.5	23.0
1993	54.5	22.9	2.9	19.7
1994	51.0	29.3	2.6	17.1
1995	50.9	29.7	2.5	16.9
1996	46.2	30.8	3.0	19.9

Source : NATO Review January 1996, Spring 1998

3.2.3. The Turkish Armed Forces

It has been claimed that the Turkish armed forces are the best organised, best disciplined and largest surviving establishment in the country (Birand, 1991; Chletsos & Kollias, 1995) . Turkey has one of the largest armed forces in the world. It ranked seventh in 1991 (US ACDA 1994), and it is the largest armed force in NATO Europe (811,000; 1994). Military and civilian personnel in the army as a percentage of the labour force is about 4.2 % (1990-1994), and the rate is always well above the NATO average (2.2% :Table 3.5). Turkey supplies (an annual average for 1990-1994) 23% of the Europe NATO armed forces and 14% of the total NATO military personnel. Despite the fact that NATO countries began to decrease the size of their armies, there has not been such a decline in the Turkish army. The Turkish army always has been large from the establishment of the republic. Military service is compulsory and its length has been changing from time to time. In 1995, military service was 18 months. There was a short term intention of 15 months military service a few years ago but due to the increasing threat from the separatist Kurdish Worker's Party (PKK) and the dispute with Greece, the period was extended to 18 months. Candidates for military service are all 20-year-old men. Due to the high growth of population, the number of candidates increases from time to time. In 1973-1974, in 1988-1989 and in 1992-1993, the size of the army was decreased by shortening the duration of military service for a specific period of time.

According to the International Institute for Strategic Studies, 393,000 (345,000 conscripts) military personnel were in land forces, 57,000 (29,000 conscripts) were in air forces; while 54,000 (37,000 conscripts) were in the navy. Besides, there are gendarmerie and national guard (70,000). Conscripts comprise 82% of all personnel in Turkey, and there is a low share of volunteers in the army (IISS Military Balance 1994). The share of volunteers are much higher in the air forces and the navy, because, these two forces need more skilled personnel and the skilled personnel are mostly available from volunteers.

Table 3.5 Military Personnel in Turkey and NATO

	1975	1980	1985	1990	1993	1994	1995	1996
Military Personnel								
Turkey (000)	584	717	814	769	686	811	805	818
NATO (Europe)(000)	-	3504	3603	3510	2994	3082	3010	2976
NATO (Total)(000)	-	5636	5930	5778	4885	4871	4700	4617
Turkey/NATO Europe(%)	-	20.5	22.6	21.9	22.9	26.3	26.7	27.4
Turkey/ NATO total (%)	-	12.7	1.37	13.3	14.0	16.6	17.1	17.7
Military and Civilian Personnel as % of Labour Forces								
Turkey	3.8	4.5	4.8	4.1	3.7	4.2	4.0	3.9
NATO (Europe)	-	2.8	2.8	2.6	2.1	2.1	2.1	2.0
NATO (total)	-	2.8	2.7	2.5	2.1	2.0	1.9	1.9

Source: NATO Review, January 1996

The Turkish armed forces with major weapons can be listed as below. The figures for 1994 are (IISS Military Balance 1994/1995):

4,919 Main battle tanks

3,360 Armoured vehicle

2,397 Artillery systems

21 Frigate and destroyers

15 Submarines

555 Combat aircraft

It can be seen from above that the Turkish armed forces are supported with substantial conventional weapons. Turkey has always been among the countries which have a large number of military personnel and because of continued internal and external threats, a reduction is not expected in the near future.

3.2.5. The Turkish Defence Industry and its Modernisation

This section surveys Turkish defence industry during the republic era. The republic started domestic production of various defence weapons and equipments with the support of the state. There were some military facilities in Turkey before the republic. These were reorganised under the General Directorate of Military Factories (Askeri Fabrikalar Umum Mudurlugu) immediately after the war of independence in 1921. Then, the factories were transformed into a state enterprise known as the General Directorate of Mechanical and Chemical Industry (Makina Kimya Endustrisi MKE) in 1950 (Akgul, 1988). The General Directorate is now one of the largest defence industry establishments in Turkey. There was dramatic advancements in the field of aeronautics (Erdem, 1991). The Kayseri Aircraft Factory opened in 1932 and it produced Curtis Hawk fighters with American co-operation and other aircraft factories were established in Istanbul and Ankara (Akgul, 1988). However, World War II broke out.

There was an increasing flow of American military aid to Turkey when Turkey entered NATO in 1952 after the Korean war (Table 3.6). The USA supplied all kinds of war material, including M-47 and M-48 tanks, M-113 APCs, guns, howitzers, ships and transport aircraft (Akgul, 1988). It caused a recession in the Turkish defence industry. Therefore, the defence industry field had not shown any improvement. After 1960, import substitution policy affected the defence industry but this policy became more important after the Turkish intervention in Cyprus in 1974. The USA imposed an arms embargo on Turkey[9] and the most important consequences of that embargo was that Turkey planned to expand

9 The embargo ended in 1979

its defence industry (Ayres, 1983). The main goal of arm production in Turkey was import substitution of military equipment, hence military independence.

Table 3.6. US Military Assistance to Turkey

Year	(1)	(2)	(2/1)	Year	(1)	(2)	(2/1)
1950	489	378	77.20	1970	1221	387	31.69
1951	504	540	107.00	1971	1436	436	30.34
1952	530	588	110.43	1972	1509	438	29.00
1953	585	510	87.99	1973	1600	449	28.04
1954	598	1045	174.95	1974	1793	322	17.96
1955	638	69	10.80	1975	2870	162	5.66
1956	588	574	97.58	1976	3295	181	5.49
1957	548	267	48.78	1977	3172	170	5.35
1958	533	440	82.71	1978	2906	221	7.62
1959	633	593	93.65	1979	2578	205	7.94
1960	698	381	54.54	1980	2442	208	8.53
1961	786	418	53.16	1981	3014	229	7.60
1962	822	512	62.32	1982	3296	344	10.44
1963	860	491	57.07	1983	3083	333	10.81
1964	920	323	35.05	1984	2997	570	19.01
1965	964	384	39.82	1985	3178	539	16.97
1966	968	379	39.15	1986	3572	465	13.01
1967	1042	463	44.45	1987	3411	358	10.49
1968	1166	408	35.02	1988	2975	344	11.56
1969	1128	403	35.70	1989	2826	335	11.85

Sources: Avramides (1995)

Notes:

- (1) Real value of Turkish military expenditures in $US, constant 1980 prices
- (2) Real value of US military assistance to Turkey in millions SU at 1980 prices
- (2/1) The percentage ratio of real military aid to real Turkish defence expenditure

In the late 1970s, the national defence industry was accelerated and various foundations were established to support the defence industry (*eg.* Air Force Foundation, Land Force

Foundation and Navy Foundation)[10] and substantial funds flowed to those foundations. With the help of such foundations, groups such as Aselsan (Military Electronic Industry), Aspilsan (Military Battery Industry), Isbir (Generators for military), were established but their industrial activities remained at a limited level (Erdem, 1991). The end of the 1970s, economic instability in Turkey slowed down the improvement of the national defence industry until the military take-over of 12 September 1980. Immediately after the military take-over, a comprehensive defence industry modernisation plan was prepared, including the plan to produce Turkey's own aircraft. Defence Industry Support Fund (DISF) was established to provide continuous and stable financial support for arms production. Revenue of this fund was mainly composed of taxes levied on alcoholic beverages, cigarettes, on the interest income of depositors and corporation taxes. Table 3.7 shows that there were important differences between revenue and expenditures because in 1988 and 1989, 30%, in 1990, 50% and in 1991 30% of the fund's revenue was transferred to the general budget under the prime minister's assent.

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10 These funds were merged in 1987 under the name of the Turkish Armed Forces Foundations

Table 3.7. Defence Industry Support Fund Expenditures and Revenues

Years	Current Prices (billion TL)		Constant Prices (1987 billion TL)	
	Revenue	Expenditure	Revenue	Expenditure
1986	179.5	40.5	241.6	56.2
1987	360.8	69.3	360.8	69.3
1988	677.4	378.0	390.1	217.6
1989	1,463.2	615.8	896.2	377.2
1990	2,456.6	2,133.8	1,532.5	1,331.1
1991	1,595.8	2.551.7	961.3	1,537.1
1992	7,930.0	6,895.0	4,662.0	4,053.5

Source: Ministry of Finance (1993), SIS (1994)

Furthermore, the Defence Industries Development and Administration (DIDA) was established in 1985 and it was restructured as the Under Secretariat for Defence Industry (UDI) within the Ministry of National Defence in 1989. This new independent body for the development of Turkish defence industry monitors the implementation of decisions taken by the Defence Industry Supreme Board of Co-ordination and the Defence Industry Executive Committee. The major finance of the UDI is DISF. Some UDI projects are depicted in Table 3.8, showing examples of local production in air and land systems (see also Table 3.9).

Table 3.8. UDI Projects in Turkey

Project	Local Producer	Licenser	Date of Contract
Armoured infantry fighting vehicle project	NUROL	FMC (USA)	1989
F-16 Electronic warfare project	KAVALA, MIKES	LORAL (USA)	1989
HF-SSB Radio communications systems project	HAS, CIHAN, ELIT	MARCONI (UK)	1990
Basic trainer aircraft	Turkish Aerospace Industry	AGUSTA (Italy)	1990
Multiple launch rocket system (MLRS)	ENKA, MKEK	LTV (USA)	1990
Mobile radar complex project	HEMA electronics	AYDIN (USA) THOMSONS (France)	1990
Light transfer aircraft project	Turkish Aerospace Industry	CASA (Spain)	1990
Helicopter project		SIKORSKY (USA)	1992
Unmanned air vehicles	Turkish Aerospace Industry	AAI (USA) General Atomics (USA)	1992

Source: Senesen (1993)
Notes:
•Nurol, Kavala, Mikes, Has, Cihan, Elit, Enka and Hema are private companies
•Turkish Aerospace Industry (TAI) is state joint venture
•MKEK is state enterprise

Some military projects of UDI are under negotiation and they include low level defence systems, 35 mm anti craft fire control systems, MCM vessels, coast guard vessels, advanced technology, industrial park and aviation centre, and airport construction (Senesen, 1993; Erdem, 1991).

After 1985, a large number of firms entered the defence industries and new partnerships with foreign companies were established. Growing interest in arms production in Turkey can be observed from the increasing number of the arms producers. There were eight firms among the largest 100 industrial establishments in 1994 and 30 firms among the largest 500 firms (Ozmucur, 1996). The private sector has been encouraged to invest in defence industries. The leading arms producers companies are shown in Table 3.9 and the major sectors are described below.

Table 3.9. Leading Arms Producers in Turkey

Company	Year founded	Ownership	Major activity
Aselsan	1976	Armed forces	military communications, electronics for F-16s
Asil Celik	1974	State	barrel and bullet steel production
Coskunoz	1973	Private	hydraulic and mech. presses, automotive space parts
FMC-NUROL	1992	Joint venture	armoured (combat) infantry fighting vehicles
ISBIR Electric	1977	Armed forces	diesel generators for military purposes
MARCONI (MKAS)	1988	Joint venture	HF-SSB radio communications
Mercedes Benz	1967	Joint venture	tactical vehicles
MKEK	1950	State	artillery, small arms ammunition, anti tank rocket launchers, machine guns
MKEK-Av Fisek	1930	State	ammunition
MKEK- Barutsan	1989	State	explosives, propellants
NUROL	1982	Joint venture	enclosed weapon systems
Otokar	1963	Joint venture	Land Rover chassis, diesel engines
Petlas	1976	Armed forces	tyres
Roketsan	1989	Joint venture	propellants and rocket motors
SGS-Profilo	1988	Joint venture	mobile telephones
STFA-Savoronik	1986	Joint venture	fire control and secure systems
Tusas TAI	1984	Joint venture	F-16 aircraft
Tusas TEI	1985	Joint venture	F-110 engine components for F-16
Teletas	1984	State	communications, electronics
Testas	1976	Private	electronic components
Manas	1976	Joint venture	heavy trucks for military purposes
Taskizak Naval Yard	1941	Navy	shipbuilding
Golcuk Naval Yard	1924	Navy	shipbuilding

Sources: Bartzokas (1992), Karasapan (1987), Ozmucur (1996), Senesen (1993)

3.2.5.1. The Aerospace Industry

The rapid development in the aerospace industry occurred after the military government decided to modernise the Turkish defence industry in the early 1980s. It aimed to produce F-16 fighter aircraft for the Turkish air force and for export. For this reason, Tusas Aerospace Industry Inc. (TAI) was established as a joint venture with US General Dynamics (now Lockheed) (42 %) and US General Electric (7 %). Tusas has a 49 % share with the remaining 2 % held by the Turkish armed forces foundation. TAI was the organisational model for subsequent arms production in Turkey (Senesen, 1993). TAI completed the initial production order of 152 F-16 aircraft and started to produce a second production order for 80 F-16 aircraft. Another development in this sector was Tusas Engine Industries (TEI) which was established to produce engines for F-16s in January 1985 (Senesen, 1993). This is also a joint venture with General Electric (49%) and Tusas (49%) and a smaller share holder, namely, the Turkish Armed Forces Foundation. The first export sale of two F-16 aircraft from Turkey was realised in 1994 to Egypt. Although Turkey has attempted to export F-16 fighter to Lebanon, Kuwait, Malaysia and the Philippines, no exports had been achieved by 1995 (Senesen, 1995); but exports are unlikely without a government subsidy, because of high costs (Candemir, 1995). In recent years, a contract was signed to produce light transport aircraft and trainers in collaboration with CASA of Spain and Agusto of Italy, respectively (Senesen, 1993).

3.2.5.2 The shipbuilding Industry

The shipbuilding industry is not new in Turkey. There are two important naval yards, namely, the Taskizak Naval Yard and the Golcuk Naval Yard. The Taskizak Yard was founded in 1455 and built the first submarine for the Ottoman navy in 1886, but after World

War I, it ceased and then reactivated as a naval yard in 1941. The Yard now employs 4000 people and builds landing ships, patrol boats and transports of up to 10,000 tons. The Golcuk Yard was founded in 1924 and it builds ships up to 30.000 tons including frigates and submarines and employs 6,000 people (Karasapan 1987). Both Yards are owned by the Turkish Navy. Before the collaboration with German shipyards, the Turkish navy received second hand US warships, but, after the late 1970s, Turkey's warships were German designed (mainly Blohm & Voss, HDW and Lürssen Werft) and built either at the Taskizak or Golcuk Naval Yard with technical assistance from the parent yards in Germany. The Turkish Navy also bought frigate, submarines and fast attack craft (FAC) from Germany (Senesen, 1993).

3.2.5.3. The Information Technology and the Electronics Industry

In the area of information technology and the electronics industry, the most important development was the establishment of Military Electronic Industry Inc. in 1975 (Aselsan). The Armed Forces Foundation owns most of the shares. It employs about 300 people and produces tactical communication equipment, encryption equipment, scrambler and digital message devices with licences from Philips (the Netherlands), Litton (USA) and Teledyne. It also produces some of the F-16 aircraft electronic equipments. Aselsan ranks 77th among the largest 100 firms in Turkey. The other two firms in this area are Teletas (communications) and the Turkish Electronic Industry (Testas). The state owned Teletas produces communications products. Testas was established in 1976 to produce electronic components and related equipments (Karasapan, 1987).

3.2.5.5. Ordnance, Explosive, Ammunition and Weapons Industry

Ordnance, explosive, ammunition and weapons are mainly manufactured by the Machinery and Chemical Industries Establishment (MKEK) founded in 1950. It is a state-owned enterprise. MKEK has now 20 factories and 20,000 employees. Their production is varied. Mainly it produces small arms, ammunition, ordnance for the air force, air to ground rockets under the US licence, 105 mm tank guns under licence from the Royal Ordnance Factories (UK), 20 mm automatic weapons, and 35 mm guns with the licence from Oerlikon (Switzerland). It also has a gas mask factory which has been modernised. In 1990, MKEK started to produce a modern artillery rocket system, namely, MLRS (US). Some of the ammunition products of MKEK are exported mainly to NATO allies (Karasapan, 1987). Although the Turkish authorities are committed to modernising the oldest state enterprise there has been little development in this area (Senesen 1993). Turkey has attempted to develop and modernise its military vehicles and tanks. To produce tactical vehicles, Turkey's largest cooperation Koc established a plant called OTOKAR under licence from Land Rover (UK), and German MAN corporation opened a factory with Ercan Holding which produces heavy trucks for the army. Also, a joint venture of Turk Mercedes manufactures a range of wheeled military vehicles. The other development is Turkey's M-47 tanks converted into recovery and bridge laying vehicles and M-48 tanks have been modernised (Karasapan, 1987). FMC-NUROL has produced armoured infantry fighting vehicles. The employment in the sector is not clearly known, because, many of the arms firms produce civilian goods at the same time. However, the trade union in the military sector (Harb-Is) has 41,500 members. Table 3.10. shows the main arms firms and their employment. Although the Table is not very comprehensive due to lack of data, it gives some employment data.

Table 3.10. Main Arms Firms and Their Employment

Firms	Employment
MKE (20 factories)	20,000
Golcuk Shipyard	6,000
Taskizak Shipyard	4,000
Aselsan (military electronics industy)	3,000
TAI (F-16 fighter aircraft)	2,300
MAN (military truck)	1,500
Ibrahim Ors (small military equipment)	300
Total	**37,100**

Sources:Akgul (1988). Karasapan (1987). Senesen (1993)

In spite of the rapid development in the Turkish defence industry in the past decade, Turkey still imports most of its military equipment and its exports are very low (Table 3.11). Therefore, the costs of arm imports are important burdens on the Turkish economy. One third of Turkey's defence budget is allocated for arms imports (US, ACDA).

Table 3.11. Turkey's Arm Imports and Exports

Year	AI	AE	AI/ TI (%)	AE/TE (%)	BAT (million US$)
1985	685	164	4.4	1.5	-521
1986	934	0	6.3	0.0	-934
1987	1553	13	8.5	0.1	-1540
1988	1373	12	7.7	0.1	-1361
1989	1438	24	7.6	0.2	-1414
1990	1379	11	5.4	0.1	-1368
1991	1326	33	5.7	0.2	-1293
1992	1076	22	4.4	0.1	-1.054
1993	1258	21	4.1	0.1	-1237
1994	1128	31	4.7	0.2	-1097
1995	700	60	2.0	0.3	-640

Source: US ACDA 1994
- AI is Arm Imports (Constant 1995 million US $)
- AE is Arm Exports (Constant 1995 million US $)
- AI/TI is Arm Imports/ Total Imports (%)
- AE/TE is Arm Exports/ Total Exports (%)
- BAT is Balance of Arms Trade (Arms Exports-Arms Imports; Constant 1995 million US$)

In conclusion, despite the fact that there have not been any important development in the Turkish defence industry until 1980, considerable development occurred in the 1980s. There are several arguments for and against the defence industry and its modernisation. Ayres (1983) pointed out that Turkish arms production attempts are not so different from an imports substitution policy. He argued that arms production in Turkey might be more expensive than importing the complete system and export potential would be very limited. Military dependence is maintained due to licenced production (Ayres, 1983). Critics claim that the official expected spillover effects from the defence industry are over-estimated (such as technology transfer, quality control and technical manpower and management, accelerated growth of Turkish economy, and the creation of new employment potential: Erdem, 1991). Bartzokas (1992) mentioned that the modernisation plan was only partly successful in Turkey in the aerospace industry and some technology has transferred. The planned participation of local firms was achieved (Bartzokas, 1992). In the Turkish defence industry, the level of research and development activities seems very low (Senesen, 1993). Innovation will be limited. Although there are some disadvantages of Turkey's defence industry, the industry will be an important part of the Turkish industrial sector and production. However, it is too early to expect large volumes of exports during the early stages of arms industry development.

3.3. Summary and Conclusions

This Chapter has studied the Turkish economy, Turkish defence expenditure, Turkish armed forces and Turkish defence industry and its modernisation. It showed that the military sector is important in the Turkish economy. The main findings can be summarised as follows.

Firstly, during the republic era, Turkey pursued a policy of industrialisation within a closed economy and reliance on government intervention, but after 1980, Turkish development turned to export-based growth. In macroeconomic aspects, Turkey between 1950-1994, experienced high population growth, high inflation and modest unemployment. The growth rate of Turkish economy has shown dramatic fluctuations over time, although the average rate is rather high. While the share of investment in GNP presents a slight increasing trend, the share of central government budget in GNP and the share of exports in GNP exhibited a major expansion during the period.

Secondly, Turkey has allocated a considerably higher percentage of its GNP to defence expenditure and also its share of defence spending in the central government budget is very high. At the same time, the annual growth rate of Turkish economy between 1950-1994 averaged 5.4 %.

Thirdly, Turkey has one of the largest armed forces in the world and the size of army does not show any decreasing trends although many countries have started to decrease the size of their armies. In Turkey, military service is compulsory and the share of conscripts in the army is very high. The Turkish army is not only very large but also it is supported with substantial conventional weapons.

Finally, as one of the major arms importers, Turkey started to build its own defence industry after 1980. The main goal for establishing its defence industry was import substitution of military equipment, hence, military independence. However, military dependence is maintained due to licenced production. Turkey now produces its own fighter aircraft (F-16), and also the shipbuilding and military electronics industries have developed considerably. Many local firms started to produce military equipment. However, there is no evidence so far to support the defence industry creating lower arms imports and a large volume of exports.

This Chapter has provided background material on the economy and the military-industrial complex of Turkey. The following Chapters address the central research question of the relationship (if any) between defence spending and growth in Turkey.

CHAPTER 4

CHAPTER 4

DEFENCE-GROWTH RELATIONSHIPS USING A SUPPLY SIDE (FEDER TYPE) MODEL: TIME SERIES EVIDENCE FOR TURKEY

4.1. Introduction

The previous two Chapters surveyed the empirical defence-growth literature, the Turkish economy and its defence economy. This Chapter analyses the nature of the connection between economic growth and defence spending in Turkey. There are several reasons for choosing a case study of Turkey. First, Turkey consistently allocated substantially high budgets to its defence sector as compared with other NATO countries. Second, Turkey's growth rate of GNP during the republic era is considerably high. Third, Turkey started to produce its own military equipment after 1980. Finally, Turkey has one of the largest armies in the world. The impact of defence spending on economic growth has been studied recently with a Feder type externality model by a number of scholars. Among others, Ward *et al.* (1991), Ward and Davis (1992) and Ward *et al.* (1993) have examined a single country from the developing world. The studies showed that more single country analysis was needed. The remainder of this thesis contributes to reducing this deficiency through a country study of Turkey.

This Chapter presents empirical time series analysis for Turkey between 1955 and 1994 using OLS (ordinary least squares) estimation. The relationship between Turkish defence expenditure and economic growth is estimated with an augmented Feder model with the addition of human capital and lags introduced into the Feder model. The evidence shows that there is a positive effect of defence spending on economic growth for Turkey while externalities from the defence sector to the rest of economy are negative, and the addition of human capital into the Feder model improved the empirical results.

The remainder of the Chapter is organised as follows. Section (4.2) briefly discusses the cost and benefits of defence expenditure. Section (4.3) justifies estimation of the defence-growth relationships for Turkey. Section (4.4) provides an augmented Feder type model and also theoretical expectations of the model are given. Section (4.5) is devoted to empirical analysis with two parts. The first part (4.5.1) describes specifications of estimation and variables, and in the second part, the results of the estimations are discussed (4.5.2). Finally, section (4.6) summarizes the main finding of this Chapter and draws some conclusions.

4.2. The Costs and Benefits of Defence Spending

Defence expenditures have both costs and benefits to the economy. The costs of defence expenditure are mainly emphasised as opportunity costs. Ram (1993) outlined the opportunity costs of defence spending under the eight headings. They are:

(i) the diversion of research from alternative uses;

(ii) reductions in private consumption;

(iii) reductions in private and public spending and investment;

(iv) the diversion of public expenditure from education and health;

(v) reductions in public research and development outlays;

(vi) adverse effects on the balance of payment position of LDCs;

(vii) the diversion of skilled manpower from civilian use.

Defence spending also has negative externalities on economic growth, such as adverse effects on the environment together with inflationary finance, waste and inefficiency from defence procurement policy (Ram, 1993; Sandler and Hartley, 1995). Deger (1986) focussed on the negative resource allocation effect. According to Deger (1986) and Deger and Smith (1983), private investment is the primary determinant of future economic growth and increased defence spending entails higher taxes and government borrowing in the capital market and it causes lower investment. In their study they concluded that " the negative effect of military expenditure on saving (investment) outweighs the positive modernisation and technological effect on the growth rate" (Deger and Smith, 1983: 352). Crowding out of investment is also argued by other scholars (Lim, 1983; Faini *et al.* 1984; Lebovic and Ishaq, 1987). Lebovic and Ishaq (1987) emphasised some negative effects of defence spending, such as balance of payments difficulties; increased defence spending may create inflation; the pricing system can be damaged by defence procurement and skilled workers may shift from the civilian sector to the defence sector (Lebovic and Ishaq, 1987). Although Smith (1980) found a roughly one to one trade-off between a country's defence expenditures and investment for developed countries, Rasler and Thompson (1988) showed that this trade-off can substantially differ for different countries, because the countries may have different security concerns and different military-industrial complexes. The productivity of a defence sector may also differ between countries.

On the other hand, defence spending has potential benefits. Defence activities may have a growth promoting influence. The positive effect of defence expenditure was firstly and widely explained by Benoit (1973). Education, nutrition, training, infrastructure and other human capital augmented activities induce externalities. The immediate direct impact of a rise in defence spending is likely to be higher demand, production and employment (Chan, 1985). Atesoglu and Mueller (1990) summarised the benefits of defence spending as spillovers of technological advance and skilled labour. They are available due to government spending on defence sector research and training (Atesoglu and Mueller, 1990). In general, the benefits of defence spending can be summarised as follows:

(i) If countries are experiencing under-employment, defence expenditures may have a stimulative effect. For these stimulative benefits, the economy should be in disequilibrium (Sandler and Hartley, 1995).

(ii) Some of the defence expenditure goes to infrastructures. It can enhance economic growth. Many roads, bridges, mapping services, communications networks, airports, waterworks, dams are built for military purposes, but many of these are used for civilian purposes as well. These create positive impacts and are important benefits of defence outlays for the rest of economy. Mainly LDC's can experience these benefits (Ram, 1993).

(iii) Countries can experience direct and indirect technological effects from the defence sector. Defence sectors spend a considerable amount of money for research and development (R&D). Many of the technological achievements of the military may be used for civilian purposes, but these benefits are more likely to apply to arms producing countries.

(iv) Human capital is another area where there is a substantial positive externality of defence spending on the rest of the economy. The organisation of literacy courses, the treatment of civilians in military hospitals, skill and training and nutrition are other contributions of the military to the economy (Sandler and Hartley, 1995).

(v) Defence expenditure can indirectly support growth by providing internal and external security.

(vi) Direct use of military for civilian purposes can enhance economic growth: for example the use of army personnel and equipment in special situations caused by natural disasters like earthquakes, famines, fires and floods (Ram, 1993).

In conclusion, defence outlays can be growth promoting or growth inhibiting. The net impact of defence spending is dependent on the magnitude of costs and benefits of the defence sector. Therefore, the effect of defence spending is an empirical issue rather than a theoretical issue (Alexander, 1990). A number of studies mostly using Neo-classical or Keynesian models have investigated defence-growth relationships (see Chapter 2).

4.3. Why Single Country Analysis?

It is important to emphasise the need for single country analysis. The vast majority of studies have employed cross-sectional type methodologies using the Feder model. Despite the fact that cross-sectional analysis is useful for comparative analysis, the implicit restriction of identical parameters for the sample countries is unreasonable and therefore, it is difficult to interpret the estimates (Ram, 1995). In the literature there is lack of country studies. To find robust evidence for defence-growth association, cross country studies should be supported with individual country studies (Ram, 1995). Cross country studies provide limited evidence for defence growth association for the following reasons:

(a) Countries differ. In Benoit's (1973) work, the sample countries were at different stages of development, from Turkey and Spain to Burma and Ceylon. It is obvious that the reactions to military expenditure may vary across these countries. While some countries have a negative effect of defence expenditure, the others may have positive effect (or no effect), since the countries may not have common structural characteristics (Deger, 1986). Frederikson and Looney (1983) tried to sort out this problem by dividing Benoit's sample as resource-constrained and resource-abundant countries. In the Deger (1986) study, the countries were divided into four quartiles (countries with low growth, medium low growth, medium high growth and high growth) while Biswas and Ram (1986) distinguished between low income countries and high income countries. Single country analysis avoids these kinds of problems and gives relatively reliable results.

b) It is important to find whether a change in defence expenditures causes a change in economic growth, and if so, how that change in defence expenditure causes a change in economic growth. For this cause-effect relationship, cross sectional methodology gives little evidence. For example, findings of positive relationship between defence spending and economic growth cannot explain whether high economic growth causes high defence spending or high defence spending causes high economic growth. Also cross sectional analysis cannot provide knowledge that the observed change in economic growth is partly contributed by current level of defence spending as opposed to the lagged effect of previous levels in this spending (Chan, 1985).

c) Choosing cross country sample periods needs careful attention due to very different economic situations. While some of the sample countries are in recession, the others may be in high levels of growth (Ram, 1995). It is difficult to find countries at the same time in the same economic conjuncture. Although time series studies might have similar problems, choosing a sample period for a single country is rather less problematic.

d) The Feder model considers both externality effect and direct effect of defence spending. However, the externality effect can be seen after a lag and it may vary across the sample countries. Therefore, cross section methodology gives limited evidence for this kind of model (Deger and Sen, 1995).

e) Cross section data with Feder type model assumed that labour elasticity, the marginal product of capital in the civilian sector, the marginal external effect of defence on the rest of economy and defence-civilian sector relative factor productivity differences are identical across the sample countries (Ram, 1995). There is a strong presumption that these parameters may differ across the countries. Even if the selected sample countries are at the same stage of development, labour productivity may differ significantly, although the rate of return to capital is rather similar (Ram, 1995).

f) Each country has its own currency unit. When one wants to estimate effect of defence spending with Feder model using cross sectional methodology, converting national currencies to common currency is needed. In order to do this, US $ is generally used as a common currency using exchange rate and sometimes both exchange rate and GNP deflators, but exchange rates cannot reflect average price levels among countries. In LDCs, exchange rate is usually fixed or overestimated. Therefore, the rate is not altered quickly (Deger, 1986). The other method for common unit is purchasing power parity (PPP). Deger (1986; p. 51) showed that PPP also might not provide suitable data for the analysis. The problem of converting to a common unit is higher problem when one studying LDCs than in the developed world (Deger, 1986).

Although the previous section outlined some advantages of single country analysis, time series analysis also has some shortcomings. Firstly, it is generally difficult to find accurate and long enough data. Second, a major problem is the business cycle of a country's economy. Thirdly, it is not easy to generalise the results. The results are usually country specific not in general. Fourthly, many of the series may be non-stationary. Finally, structural breaks and changes over time makes estimation difficult. However, due to lack of individual country studies and some shortcomings from cross-sectional studies, time series analysis for a single country should be fruitful. The Turkish case will provide evidence for defence-growth relationships. This study is different from other similar studies in that:

(i) Defence-growth relationship is tested for Turkey using Feder type model and also the study uses more recent and reliable data. Unlike previous studies, the study uses labour force data instead of the proxy of population.

(ii) The study helps to reduce the lack of country studies on defence-growth relationships, and it is important to identify robust results in this controversial area.

(iii) Human capital is incorporated into the Feder model.

(iv) Lags are introduced into the Feder model with a lagged dependent variable and a lagged human capital variable.

4.4. The Externality Model

Feder (1983) developed a model to analyse the impact of the export sector on economic growth. Feder's model divides the economy into two sectors. One is an advanced sector (export, X) and the other is a domestically oriented sector (non-export sector). There are positive externalities from an advanced sector to the rest of the economy. Ram (1986), and Biswas and Ram (1986) firstly applied this model to the study of defence spending in a cross-section of 58 LDC's over the period 1960-1977: since then many other scholars have employed the Feder model for defence-growth association (Atesoglu and Mueller, 1990; Alexander, 1990, 1995; Huang and Mintz, 1990; 1991; Adams, Behrman and Boldin, 1991; Ward *et al.* 1991; Ward and Davis, 1992; Biswas, 1993; Mueller and Atesoglu, 1993; Ward, Davis and Chan, 1993; DeRouen, 1994; Macnair *et al.* 1995; Mintz and Stevanson, 1995; Ward, Davis and Lofdahl, 1995). The model in this study was extracted from Ward *et al.* (1991).

Firstly, it is assumed that the economy consists of two sectors namely, a base sector (B) and a mutually exclusive and exhaustive sector (E). There are externalities from exclusive and an exhaustive sector to base sector. From the production function the main inputs of the sectors are capital (K) and labour (L). Subscripts refer to each sector:

$$E=E(K_e,L_e) \quad \textbf{(4.1)}$$

$$B=B(K_b,\ L_b,\ E) \quad \textbf{(4.2)}$$

The main point in this model is that it considers externalities from sector "E" to sector "B" and it considers factor productivity differentials. The main weakness of Feder type model is that it assumes that the production function only consists of physical capital and labour. The model implicitly assumed there is no human capital. Physical capital is important in the production function but human capital is crucial, since an increase in the human capital causes higher output. Kendrick (1976) estimates that over half of the total US capital stock in 1969 was human capital (Mankiw *et al.* 1992). Therefore, estimation of economic growth without human capital might lead to incorrect conclusions. Human capital includes native ability and talent as well as education and acquired skills. In other words, human capital is the value of the income-earning potential embodied in individuals. Human capital is produced through formal education and training through skill acquisition, certification and job experience either on-or off-the-job. Raising the level of human capital requires investment in the form of teachers, libraries and student time and buildings. The average worker in the industrialised countries is much more productive than the average worker in the developing countries, because they have far more education and training (Dorbousche and Fischer, 1990). As an example, although Germany's and Japan's physical capital stocks were almost destroyed during the Second World War, they have recovered rapidly in part because they retained highly educated and skilled populations (Abel and Bernanke, 1992). Recent research on economic growth has emphasised that human capital is at least as important as physical capital in explaining economic growth and the growth rate is positively related to human capital (Barro, 1991). Mankiw *et al.* (1992) showed that human capital is an omitted variable in growth models, and inclusion of human capital provided improved empirical results even though imperfect proxies have to be used for human capital (Mankiw *et al.* (1992). Azerides and Dranen (1990) argued that no country was able to grow quickly during the post-war period without a highly literate labour force. Addition of human capital to the Feder model will provide a better explanation of economic growth as well as reflecting the economic impact of the defence sector (*e.g.* via training of military personnel).

When human capital is incorporated into the Feder model, the production function will be Y=f(K, L, H) and the sectors will be:

$$E=E(K_e,L_e,H_e) \tag{4.3}$$

$$B=B(K_b,\ L_b,\ H_b,\ E) \tag{4.4}$$

where H represents human capital. When equation (A4.3) and (A4.4) are totally differentiated we obtain:

$$\dot{B}=\frac{\partial B}{\partial K_b}\dot{K}_b+\frac{\partial B}{\partial L_b}\dot{L}_b+\frac{\partial B}{\partial H_b}\dot{H}_b+\frac{\partial B}{\partial E}\dot{E} \tag{4.5}$$

$$\dot{E}=\frac{\partial E}{\partial K_e}\dot{K}_e+\frac{\partial E}{\partial L_e}\dot{L}_e+\frac{\partial E}{\partial H_e}\dot{H}_e \tag{4.6}$$

where subscripts denotes sectors, a "dot" shows the time derivative (B=dB/dt) and ∂ is partial differentiation.

To simplify let:

$$B_k=\partial B/\partial K_b \tag{4.7}$$

$$B_l=\partial B/\partial L_b \tag{4.8}$$

$$B_h=\partial B/\partial H_b \tag{4.9}$$

$$B_e=\partial B/\partial E \tag{4.10}$$

$$E_k=\partial E/\partial K_e \tag{4.11}$$

$$E_l = \partial E / \partial L_e \quad (4.12)$$

$$E_h = \partial E / \partial H_e \quad (4.13)$$

Thus:

$$\dot{E} = E_k \dot{K}_e + E_l \dot{L}_e + E_h \dot{H}_e \quad (4.14)$$

$$\dot{B} = B_k \dot{K}_b + B_l \dot{L}_b + B_h \dot{H}_b + B_e \dot{E} \quad (4.15)$$

From Feder (1983), Ram (1986) and Biswas and Ram (1986) factor productivity differential is δ, then:

$$\frac{E_k}{B_k} = \frac{E_l}{B_l} = \frac{E_h}{B_h} = 1 + \delta \quad (4.16)$$

When it is arranged:

$$E_k = B_k (1 + \delta) \quad (4.17)$$

$$E_l = B_l (1 + \delta) \quad (4.18)$$

$$E_h = B_h (1 + \delta) \quad (4.19)$$

Equation (4.14) can be rewritten using equation (4.17), (4.18) and (4.19):

$$\dot{E} = B_k (1 + \delta) \dot{K}_e + B_l (1 + \delta) \dot{L}_e + B_h (1 + \delta) \dot{H}_e \quad (4.20)$$

$$\dot{B} = B_k \dot{K}_b + B_l \dot{L}_b + B_h \dot{H}_b + B_e \dot{E} \quad (4.21)$$

Since:

$$Y = B + E \quad (4.22)$$

$$\dot{Y}=\dot{B}+\dot{E} \tag{4.23}$$

Y is total output and a dot over it denotes its time derivative

Thus:

$$\dot{Y}=B_k\dot{K}_b+B_l\dot{L}_b+B_h\dot{H}_b+B_e\dot{E}+(1+\delta)B_k\dot{K}_e+(1+\delta)B_l\dot{L}_e+(1+\delta)B_h\dot{H}_e \tag{4.24}$$

Expanding to:

$$\dot{Y}=B_k\dot{K}_b+B_l\dot{L}_b+B_h\dot{H}_b+B_e\dot{E}+\delta B_k\dot{K}_e+B_k\dot{K}_e+\delta B_l\dot{L}_e+B_l\dot{L}_e+\delta B_h\dot{H}_e+B_h\dot{H}_e \tag{4.25}$$

$$\dot{Y}=B_k\dot{K}_b+B_l\dot{L}_b+B_h\dot{H}_b+B_k\dot{K}_e+B_l\dot{L}_e+B_h\dot{H}_e+B_e\dot{E}+\delta B_k\dot{K}_e+\delta B_l\dot{L}_e+\delta B_h\dot{H}_e \tag{4.26}$$

$$\dot{Y}=B_k(\dot{K}_b+\dot{K}_e)+B_l(\dot{L}_b+\dot{L}_e)+B_h(\dot{H}_b+\dot{H}_e)+\delta(B_k\dot{K}_e+B_l\dot{L}_e+B_h\dot{H}_e)+B_e\dot{E} \tag{4.27}$$

To simplify:

$$\dot{K}=I=\dot{K}_b+\dot{K}_e \tag{4.28}$$

$$\dot{L}=\dot{L}_b+\dot{L}_e \tag{4.29}$$

$$\dot{H}=\dot{H}_b+\dot{H}_e \tag{4.30}$$

where L is total labour input H is human capital and I is investment, then:

$$\dot{Y}=B_kI+B_l\dot{L}+B_h\dot{H}+\delta(B_k\dot{K}_e+B_l\dot{L}_e+B_h\dot{H}_e)+B_e\dot{E} \tag{4.31}$$

From equation (4.16) we can get:

$$B_k=\frac{E_k}{(1+\delta)} \tag{4.32}$$

$$B_l=\frac{E_l}{(1+\delta)} \tag{4.33}$$

$$B_h=\frac{E_h}{(1+\delta)} \tag{4.34}$$

$$B_k\dot{I}_e + B_l\dot{L}_e + B_h\dot{H}_e = \frac{E_k}{1+\delta}\dot{K}_e + \frac{E_l}{1+\delta}\dot{L}_e + \frac{E_h}{1+\delta}\dot{H}_e \quad (4.35)$$

$$= \frac{E_k\dot{K}_e + E_l\dot{L}_e + E_h\dot{H}_e}{1+\delta} \quad (4.36)$$

$$= \frac{1}{1+\delta} E_k\dot{K}_e + E_l\dot{L}_e + E_h\dot{H}_e \quad (4.37)$$

$$= \frac{\dot{E}}{1+\delta} \quad (4.38)$$

Then the equation will be:

$$\dot{Y} = B_k\dot{I} + B_l\dot{L} + B_h\dot{H} + \frac{\delta}{1+\delta}\dot{E} + B_e\dot{E} \quad (4.39)$$

$$\dot{Y} = B_k\dot{I} + B_l\dot{L} + B_h\dot{H} + \left(\frac{\delta}{1+\delta} + B_e\right)\dot{E} \quad (4.40)$$

Assuming that B_k is a constant α to be estimated and marginal productivity in each sector is proportional to total output per skilled worker $B_l = \beta(Y/L)$ and B_h is a constant γ to be estimated then:

$$\dot{Y} = \alpha\dot{I} + \beta\frac{Y}{L}\dot{L} + \gamma\dot{H} + \left(\frac{\delta}{1+\delta} + B_e\right)\dot{E} \quad (4.41)$$

and also assumed B_e is constant and sector "E" affects the sector "B" with a constant elasticity. The equation will be:

$$B_e = \theta\frac{B}{E} \quad (4.42)$$

$$B_e = \theta\frac{BY}{EY} \quad (4.43)$$

from equation (4.22) we know that:

$$B=Y-E \tag{4.44}$$

$$\frac{B}{Y}=\frac{Y}{Y}-\frac{E}{Y} \tag{4.45}$$

$$\frac{B}{Y}=1-\frac{E}{Y} \tag{4.46}$$

then:

$$B_e=\theta\left(\frac{1-(E/Y)}{EY}\right) \tag{4.47}$$

$$B_e=\frac{\theta-\theta(E/Y)}{E/Y} \tag{4.48}$$

$$=\frac{\theta}{E/Y}-\frac{\theta(E/Y)}{E/Y} \tag{4.49}$$

$$=\frac{\theta}{E/Y}-\theta \tag{4.50}$$

When equation (4.50) is put into the equation (4.41):

$$\dot{Y}=\alpha I+\beta\frac{Y}{L}\dot{L}+\gamma\dot{H}+\left(\frac{\delta}{1+\delta}+\frac{\theta}{E/Y}-\theta\right)\dot{E} \tag{4.51}$$

$$\dot{Y}=\alpha I+\beta\frac{Y}{L}\dot{L}+\gamma\dot{H}+\left(\frac{\delta}{1+\delta}-\theta\right)\dot{E}+\frac{\theta}{E/Y}\dot{E} \tag{4.52}$$

$$\dot{Y}=\alpha I+\beta\frac{Y}{L}\dot{L}+\gamma\dot{H}+\left(\frac{\delta}{1+\delta}-\theta\right)\dot{E}+\theta\frac{\dot{E}}{E}Y \tag{4.53}$$

This shows two sector model, if we accept exclusive and an exhaustive sector as military sector, the equation will be:

$$\dot{Y}=\alpha I+\beta\frac{Y}{L}\dot{L}+\gamma\dot{H}+\left(\frac{\delta}{1+\delta}-\theta\right)\dot{M}+\theta\frac{\dot{M}}{M}Y \qquad \textbf{(4.54)}$$

When equation is divided to Y (for growth rate of output):

$$\frac{\dot{Y}}{Y}=\alpha\frac{I}{Y}+\beta\frac{\dot{L}}{L}+\gamma\frac{\dot{H}}{Y}+\left(\frac{\delta}{1+\delta}-\theta\right)\frac{\dot{M}}{Y}+\theta\frac{\dot{M}}{M} \qquad \textbf{(4.55)}$$

and from equation (4.41):

$$\frac{\dot{Y}}{Y}=\alpha\frac{I}{Y}+\beta\frac{\dot{L}}{L}+\gamma\frac{\dot{H}}{Y}+\left(\frac{\delta}{1+\delta}+B_m\right)\frac{\dot{M}}{Y} \qquad \textbf{(4.56)}$$

The final form of the extended Feder model is shown in equation (4.55)and (4.56). It is different from other previous studies in that human capital is isolated in the model. On the right side, the third parameter $\left(\gamma\frac{\dot{H}}{Y}\right)$ of the equation is expected to show the effect of human capital on economic growth. However, empirical evidence needs to prove the reliability of this model. In these equations (4.55; 4.56), growth of productivity is a function of physical capital $\left(\alpha\frac{I}{Y}\right)$ and human capital $\left(\gamma\frac{\dot{H}}{Y}\right)$, changes in labour $\left(\beta\frac{\dot{L}}{L}\right)$; the total effect of defence expenditure $\left(\left(\frac{\delta}{1+\delta}+B_m\right)\frac{\dot{M}}{Y}\right)$; the size effect of defence spending $\left(\left(\frac{\delta}{1+\delta}-\theta\right)\frac{\dot{M}}{Y}\right)$;and the externality effect of defence spending $\left(\theta\frac{\dot{M}}{M}\right)$. Furthermore, equation (4.55) may show the relative marginal productivity of defence spending (δ) on economic growth, as compared to the rest of the economy.

4.5. Predictions

The following six predictions were derived from the model:

Prediction 1: $\alpha > 0$

Investment (accumulation of capital) should have a positive effect on Turkish economic growth. Turkey achieved a high economic growth rate between 1955 and 1994. Investment should be one of the important components of the Turkish economic growth. It is well known that the accumulation of capital is a crucial element of growth. However, diminishing returns imply that growth cannot go on forever just by adding to the capital stock (Barro and Grilli, 1994). There is no reason to expect that all investment will pay off in either the short term or long term. It is a possible drain as well as a boost to economic productivity. However, for developing countries, the effect should be positive and there is evidence that private investment has a greater impact on economic growth than public investment (Khan and Reinhard, 1991). Instead of aggregate investment, disaggregated investment might better explain the effect of investment on the Turkish economic growth. The study predicted that Turkish economic growth has benefited greatly from its investment.

Prediction 2: $\beta > 0$

The labour force is expected to have a strong positive relationship on Turkish economic growth. Turkey has achieved considerably higher rate of economic growth between 1955 and 1994. The labour force should have contributed to Turkish economic growth over that period during which there has been a major shift of economic activity from agriculture into the industrial sector and services.

Prediction 3: $\gamma > 0$

In the Turkish economic growth, accumulation of human capital should have positive effect. After the 1950s, there has been a rapid educational improvement. The growth of the Turkish economy might be positively influenced by the improvement in human capital.

Prediction 4: $\left(\frac{\delta}{1+\delta}+C_m\right)$ ⟩0 and $\left(\frac{\delta}{1+\delta}-\theta\right)$ ⟩0

The size effect and total effect of defence spending is assumed to have a positive impact on economic growth. In the literature, the effect of defence spending seems ambiguous. Ward *et al.* (1991) and Ward *et al.* (1993) found a positive impact of defence for India and Taiwan, respectively (see Chapter 2). Turkey's defence expenditure is predicted to have positive effect on Turkish economic growth.

Prediction 5: $\theta<0$

The study offers no expectations about whether externalities from the defence sector to rest of the economy are negative or positive. It should have some negative impacts because Turkey is a major arm importer country and it does not have a very substantial military-industrial complex, so that there should be some adverse effect on the balance of payments. Inflationary finance of defence and inefficient defence procurement policy due to mostly one buyer and one seller might be other negative externalities from defence sector. Although Turkey is a major arm importer country, adverse effect on balance of payment should not be very high because Turkey has benefited from a high proportion of military assistance from US until recent years. However, the inflationary effect of defence spending and inefficient defence procurement policy may apply for Turkey. On the other hand, positive externalities from the defence sector to rest of Turkish economy can be as follows: an infrastructure such as roads, ports, and communications channels, and human capital through education and training of individuals by the military. These effects should be high in Turkey, since almost every man benefited from compulsory military service. Technological training given during military service turns conscripts into qualified (and disciplined) personnel able to contribute to the development of the country. Furthermore, organisation of literacy courses, the production of medical drugs in the military plant, the treatment of civilians in military hospitals and mappings service can be cited as other contributions of defence to the Turkish economy (Benoit, 1973; 1978).

Prediction 6: $\delta \langle 0$

It is expected that the civilian sector is likely to be more productive than the defence sector. The civilian sector mostly applies competitive market disciplines and hence, it is likely to be more efficient. Defence procurement policy is generally inefficient (*e.g.* cost-plus contracts; preferential purchasing; monopolies).

4.6. Empirical Tests and Results

4.6.1. Specifications[11]

For this study, with original Feder model, two more augmented model are employed on the Turkish data. The econometric form of models used are:

(i) Two sector Feder model (total effect):

$$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\left(\frac{\delta}{1+\delta}+C_m\right)\frac{\Delta M}{Y}+\varepsilon \qquad \textbf{(4.57)}$$

[11] The data problems and data sources are explained in Chapter 2 and detailed data are given in Appendix 4.1.

With separate externality effect and factor productivity differentials of defence expenditure:

$$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\left(\frac{\delta}{1+\delta}-\theta\right)\frac{\Delta M}{Y}+\theta\frac{\Delta M}{M}+\varepsilon \qquad \textbf{(4.58)}$$

(ii) with human capital (total effect):

$$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\gamma\frac{HI}{Y}+\left(\frac{\delta}{1+\delta}+C_m\right)\frac{\Delta M}{Y}+\varepsilon \qquad \textbf{(4.59)}$$

With separate externality effect and factor productivity differentials of defence expenditure:

$$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\gamma\frac{HI}{Y}+\left(\frac{\delta}{1+\delta}-\theta\right)\frac{\Delta M}{Y}+\theta\frac{\Delta M}{M}+\varepsilon \qquad \textbf{(4.60)}$$

The variables used in the estimation were measured as follows:

$\Delta Y/Y$ (growth): Dependent variable of the model is measured as the annual rate of growth of output. In order to do this, the difference between current value of the real GNP and previous year real GNP is divided by the previous years real GNP.

$\Delta L/L$ (labour force): growth rate of labour force. Turkey's employed labour force is used. The growth rate is calculated as explained above.

I/Y (investment): Investment to GNP ratio. Real gross fixed capital of Turkey is related to previous year's real GNP.

HI/Y (human capital): The current years real educational expenditure is divided by the previous year's real GNP. It is difficult to measure human capital. As a proxy, educational expenditure in the general budget was used. Each year's expenditure is used to reflect investment in human capital.

ΔM/Y (defence size and total effect): The difference of real military expenditure between current and previous years are divided by the previous year real GNP.

ΔM/M (defence externality): Real growth rate of defence expenditure. It is calculated as in the above variables.

In the equations 4.57 and 4.59, the total effect of defence spending can be estimated and equations 4.58 and 4.60 provide both effects of defence size and defence externality. Owing to multicollinearity concerns in equations 4.58 and 4.60, initially, equations 4.57 and 4.59 are estimated.

4.6.2. Estimation Results

Table (4.1) presents empirical results from the estimation of equation (4.57) using ordinary least squares (OLS) estimation. In this estimation, labour force and defence variables give statistically significant results and both are positive, but, the coefficient of investment is statistically insignificant. The next section will critically analyse the insignificant coefficient of investment. Although DW test statistics is acceptable, the R^2 is very low for time series analysis. More estimations will follow to improve the R^2.

Table 4.1 Estimates of Equation (4.57)

Dependent variable: Economic growth		
Independent variables	Coefficient	t statistics
Constant	-0.01	-0.36
Investment	0.21	0.97
Labour force	1.09**	2.30
Defence total	4.66**	3.25
Diagnostic Statistics		
R^2 0.39		$\bar{R}^2$ 0.36
RSS 0.0852		DW 1.96
F stat. (3, 36) 7.7354 probability: 0.0004		
Lagrange Multiplier Test		
Serial Correlation χ^2 (2)	0.76829	probability : 0.6810
Normality χ^2 (2)	3.763	probability : 0.1524
Heteroscedasticity χ^2 (6)	2.3481	probability : 0.8851
Functional form χ^2 (9)	3.7006	probability : 0.9300

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

The estimation with a separate externality effect and factor productivity differential is shown in the Table 4.2 (estimates of equation 4.58). The results are similar to Table 4.1. However, although the size effect of defence spending is positive, the externality effect of defence spending is negative and they are statistically significant. The coefficient of the defence size variable became very high after regressing the separate size and externality effects of defence spending. It occurred because there is very high collinearity between two defence variables. However, this regression still explains the positive size and negative externality effect of defence spending. In this estimation, it is also possible to calculate the factor productivity differential among sectors which is negative ($\delta = -1.042$). It means that the civilian sector is more productive than the defence sector, probably. because defence is less subject to market disciplines. In Table (4.2), again the coefficient of investment is insignificant. It is surprising that the country has achieved a high growth without a contribution from investment. Therefore. the investment variable needs more consideration. The problem will be considered later, but even at this stage, the insignificance of investment raises doubts about the empirical results and leads to concern over dynamic specification problems (hence the need to explore whether the results are robust over different dynamic structures). The R^2 is still low for this estimation but it is higher than previous estimation. Inclusion of the defence externality variable improved the "fit" a little.

Table 4.2 Estimates of Equation (4.58)

Dependent variable: Economic growth		
Independent variables	Coefficient	t statistics
Constant	-0.01	-0.32
Investment	0.18	0.93
Labour force	1.22**	2.72
Defence size	25.52***	2.93
Defence externality	-0.86**	-2.43
Factor productivity Differential	-1.042	
Diagnostic Statistics		
R^2 : 0.48	$\bar{R}^2$: 0.44	
RSS : 0.0730	DW : 1.98	
F stat. (4, 35) : 8.0592	probability : 0.0001	
Lagrange Multiplier Test		
Serial Correlation χ^2 (2)	0.059876	probability : 0.9705
Normality χ^2 (2)	3.1081	probability : 0.2114
Heteroscedasticity χ^2 (8)	2.5649	probability : 0.9586
Functional form χ^2 (14)	6.2226	probability : 0.9606

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

In Tables (4.3) and (4.4), similar results are presented with the addition of human capital into the Feder model using equation (4.59) and equation (4.60), respectively. It is not easy to proxy human capital. One empirical study used the secondary school enrollment rate multiplied by the working age population (Mankiw *et al.* 1992). Another study employed the secondary school enrollment/population ratio (Ghatak *et al.* 1994). Barro and Martin (1995) used different measures for human capital such as educational attainment, life expectancy, public spending on education, primary schooling and secondary schooling. They concluded that human capital has a direct impact on economic growth (Barro and

Martin, 1995). This study used several proxies. Other than shares of educational expenditure in the central government budget, primary school enrollment/population ratio, secondary school enrollment/population ratio, high school enrollment/population ratio, primary school enrollment/labour force ratio primary school enrollment/labour force ratio, secondary school enrollment/labour force ratio, high school enrollment/labour force ratio, armed forces/labour force and armed forces/labour force ratios were regressed, but they did not provide accurate results. Educational expenditure in the government budget gave better results for explaining human capital-growth relationships as well as defence-growth relationships, because it has a better series and it is financial data. These data are more consistent with the Feder model. Therefore, the study preferred using the share of educational expenditure in the central government budget.[12] The empirical results are presented in Tables 4.3.and 4.4.

12 The regression results of different proxies of human capital are given in Appendix 4.3 (Table A4.3.4)

Table 4.3 Estimates of Equation (4.59)

Dependent variable: Economic growth		
Independent variables	Coefficient	t statistics
Constant	-0.02	-0.44
Investment	0.20	0.93
Labour force	1.10**	2.28
Human capital	0.14	0.25
Defence size	4.61***	3.12

Diagnostic Statistics	
R^2 : 0.39	$\bar{R}^2$: 0.34
RSS : 0.0851	DW : 1.95
F stat. (4, 35) 5.6672	Probability : 0.0013

Lagrange Multiplier Test		
Serial Correlation χ^2 (2)	0.95705	probability : 0.6197
Normality χ^2 (2)	3.849	probability : 0.1459
Heteroscedasticity χ^2 (8)	3.6678	probability : 0.8858
Functional form χ^2 (14)	9.0283	probability : 0.8292

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

The addition of human capital did not improve the estimation results. In the Table (4.3) and (4.4), human capital and investment variables are statistically insignificant, while labour and defence variables are statistically significant. The sign of labour and defence size are positive but the defence externality effect is negative, and the factor productivity differential is again negative.

Table 4.4. Estimates of Equation (4.60)

Dependent variable: Economic growth		
Independent variables	Coefficient	t statistics
Constant	-0.02	-0.37
Investment	0.18	0.84
Labour force	1.22**	2.68
Human capital	0.11	0.20
Defence size	25.43***	2.87
Defence externality	-0.86**	-2.38
Factor productivity differential	-1.052	
Diagnostic Statistics		
R^2 0.48		$\bar{R}^2$ 0.46
RSS : 0.0729		DW 1.97
F stat. (5, 34) 6.2789	probability : 0.0003	

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

The results shown in Tables (4.2) to (4.4) were surprising. While labour and defence variables are as predicted, the investment and human capital variable are statistically insignificant. It is surprising that a developing country like Turkey with a relatively high growth rate has not benefited from its physical and human capital. Turkey would not achieve a high economic growth without the help of investment (physical capital) and /or human capital. Data on investment might be a problem. Therefore, the investment variable was proxied by four different data sets but all data sets gave similar insignificant results[13]. Also, different proxies are employed for the human capital variable, but they did not give

[13] Regression results is provided in Appendix 4.3 (Table A4.3.1)

significant results[14]. Data seems not problematic, because all different data sets showed similar results.

The growing literature on time series analysis emphasises that many of the macroeconomic variables might be non-stationary. Non-stationary data causes the standard test statistics to be seriously biased and misleading. It is called spurious regressions. Non-stationary time series are frequently transformed for stationary by differencing. Although Feder model is a form of growth model, it does not always imply stationarity of the variables. Therefore, it is worth testing the data for stationarity. The investigation of stationarity in a time series is closely related to the tests for "unit roots". The procedures involve various sets of tests. Firstly, each series is tested for a unit root using augmented Dickey-Fuller (ADF) test (Charemza and Deadman, 1992; Doornik and Hendry, 1995). The ADF test is based on a regression of the first difference of the series against a constant. The results of the ADF test are presented in Table (4.5). There is no evidence of unit root in the dependent variable. It means cointegration analysis is not applicable. However, the investment and human capital variable were non-stationary and they become stationary after differencing while the defence and labour variables are stationary. However, for the OLS estimation, not only the human capital and investment variables are differenced but also all variables are differenced once and some observations are lost. After differencing variables, there were no signs of unit roots (Table 4.5).

14 Regression results is provided in Appendix 4.3 (Table A4.3.4)

Table 4.5. Unit Root Tests in Levels and First Differences (1955-1994)

Variable (x)		Unit Root in x [1]		Unit Root in Δx [1]	
		DF	ADF	DF	ADF
Growth (ΔY/Y)		-8.265**	-4.022*	14.08**	-7.388**
Investment (I/Y)		-2.449	-1.817	-7.461**	-4.839**
Labour (ΔL/L)		-5.391**	-3.503	-10.25**	-6.099**
Human capital (ΔHI/Y)		-2.652	-2.07	-7.466**	-4.416**
Defence size and total effect (ΔM/Y)		-5.844**	-4.885**	-8.904**	-6.065**
Defence externality (ΔM/M)		-6.096**	-4.921**	-9.36**	-6.375
Critical values	1%	-4.209	-4.216	-3.612	-3.617
	5%	-2.938	-3.531	-2.94	-2.942

The reported values are obtained from PC-Give 8.0 version by Doornik and Hendry, 1995. For calculated values intercept and trends are included in both DF and ADF equations for levels and intercept include for first differences.
[1]where x represents level of variables and Δx represents first differences of variables.
* significant at 5%
** significant at 1%

Differencing all the variables means that they are not the same variables anymore. Independent variable become a change of growth rather than growth and also the explanatory variable of investment growth became change of investment growth, and so on. However, questions arise as to whether the model is still able to explain defence-growth relationships and whether the firs difference model is the best dynamic form..

After differencing variables, the same estimation procedures used equations (4.57), (4.58), (4.59), (4.60). Table 4.6 shows estimates of equation (4.57) with first differencing of variables. It can be seen from the Table that all variables (investment, labour, and defence) became statistically significant and positively related to economic growth. The effect of the defence sector remained similar and also the coefficient of labour remained similar.

Although R^2 is not very low for this estimation, DW test result indicates a possible auto-correlation. For more robust results, further analysis is needed.

Table 4.6 Estimates of Equation (4.57) with First Differences of Variables

Dependent variable: Economic growth (1st dif.)		
Independent variables	Coefficient	t statistics
Constant	-0.01	-0.30
Investment (1st dif.)	1.10***	3.12
Labour force (1st dif.)	0.95**	2.031
Defence Total (1st dif.)	4.57***	3.25
Diagnostic Statistics		
R^2 0.59		$\bar{R}^2$ 0.57
RSS 0.1340		DW 2.52
F stat. (3, 35) 17.144		probability : 0.0000

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

Estimation of equation (4.58) with first differencing of variables is shown in Table (4.7). The variables, investment, labour, defence size, defence externality, are statistically significant and except for defence externality, other variables are positively correlated to economic growth. Furthermore, the factor productivity differential is negative ($\delta = -1.051$).

Table 4.7 Estimates of Equation (4.58) with First Differences of Variables

Dependent variable: Economic growth (1st dif.)		
Independent variables	Coefficient	t statistics
Constant	-0.01	-0.22
Investment (1st dif.)	0.86**	2.42
Labour force (1st dif.)	1.07**	2.37
Defence size (1st dif.)	21.21**	2.56
Defence externality (1st dif.)	-0.65**	-2.04
Factor productivity Differential	-1.051	
Diagnostic Statistics		
R^2 0.64		$\bar{R}^2$ 0.60
RSS 0.1194		DW 2.43
F stat. (4, 34) 15.059	Probability : 0.0000	

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

The addition of human capital to first differencing estimation is shown in Tables (4.8) and Table (4.9). Human capital showed statistically significant effect on economic growth when it is differenced and it is positively related to economic growth.

In Table (4.8), the coefficient of investment is positive and significant. Coefficients of labour force and human capital are also positive and significant. Moreover, the defence variable is positively correlated to Turkish economic growth and it is significant at least at the 5 % level.

Table 4.8 Estimates of Equation (4.59) with First Differences of The Variables

Dependent variable: Economic growth (1st dif.) (1956-1994)		
Independent variables	Coefficient	t statistics
Constant	-0.01	-0.45
Investment (1st dif.)	1.08***	3.22
Labour force (1st dif.)	0.86*	1.92
Human capital (1st dif.)	2.06**	2.09
Defence total (1st dif.)	3.71**	2.64
Diagnostic Statistics		
R^2 0.64		$\bar{R}^2$ 0.61
RSS 0.1186		DW 2.84
F stat. (4, 34) 15.21	Probability : 0.0000	

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

Turning to Table (4.9), all the estimated coefficients have expected signs and are significant. As expected, defence size has positive effect on economic growth while the externality effect of defence spending is negative. Factor productivity differentials show negative signs and it implies that the rest of economy is more productive than the defence sector. It is as expected because the defence sector is less subject to market disciplines. Thus, the differenced estimation of four equations improved the results and test statistics.

Table 4.9. Estimates of Equation (4.60) with First Differences of the Variables

Dependent variable: Economic growth (1st dif.) (1956-1994)		
Independent variables	Coefficient	t statistics
Constant	-0.01	-0.37
Investment (1st dif.)	0.86**	2.54
Labour force (1st dif.)	0.98**	2.26
Human capital (1st dif.)	1.94**	2.06
Defence size (1st dif.)	19.40**	2.44
Defence externality (1st dif.)	-0.61**	-2.02
Factor productivity Differential	-1.056	
Diagnostic Statistics		
R^2 0.68		$\bar{R}^2$ 0.64
RSS 0.1057		DW 2.66
F stat. (5, 33) 14.047 Probability : 0.0000		

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

Realistic formulations of economic relations often require the insertion of lagged values of the variables. For instance, a rise in economic growth is likely to have an effect on human capital, which is distributed over a number of time periods. Therefore, it is worth considering the lag structure of the model. To do this, three lags are given to all the variables, including the dependent variable. The next step was to omit insignificant lags individually[15], then only the first lag of the human capital and the first lag of the dependent variable showed statistically significant results. It is expected that a lag of human capital is significant and positively related to economic growth, because the effect of human capital is not immediate: it takes time. On the other hand, the regression results with lags (Table

[15] The same procedure employed to level variables and the results are given in Appendix 4.3 (Table A4.3.3)

4.10) also indicates that lagged dependent variable or in other words, the previous year's economic growth is another explanatory variable for Turkey's economic growth and it reflects inertia. It means that the previous year's economic growth is negatively correlated to economic growth. This occurs because when a country achieves a high economic growth, it reaches a higher GDP or output. To achieve an increase to a higher output becomes more difficult than previously. It explains why developed countries have a relatively low rate of economic growth compared with developing countries, because they have a higher output level relative to developing countries. This is known as the catch-up hypothesis (Abromovitz, 1986; Baumol, 1986). It claims that poor countries tend to grow faster than rich countries. Through the international diffusion of knowledge and technology, low productivity and low-income countries have the opportunity to adopt the techniques of the leader and hence catch-up with the higher productivity countries (Abromovitz, 1986; Baumol, 1986; Taskin & Zaim, 1997). Moreover, the result also implies that the lagged dependent variable will help economic growth (if the coefficient of this variable is negative) when lagged year's economic growth was negative (eg $Y_t=\alpha-\beta Y_{t-1}$, if Y_{t-1} takes negative value, it causes an increase on Y_t which explains how negative economic growth accelerates economic growth). Although this variable has the highest t statistics in the regression, its coefficient is the lowest. This indicates that the effect is not very high.

Due to high collinearity between the two defence variables, the equations (4.58; 4.60) which show separate effects of defence size and externality effects were not used for the regression with lags. The evidence also indicates that defence has a positive effect on economic growth. Turning to test statistics, Durbin-Watson (DW) test is not valid for this estimation because of lagged dependent variable. Therefore, we reported Lagrange Multiplier serial correlation test and the test statistics are acceptable. Estimation of equation (4.59) in Table (4.10) reports our preferred model because it considers lags and it gives better test statistics like higher t statistics and high R^2 and no evidence of auto-correlation.

Table 4.10 Estimates of Equation (4.59) with First Differences of The Variables and Lagged Variables

Dependent variable: Economic growth (1st dif.) (1957-1994)		
Independent variables	Coefficient	t statistics
Constant	-0.01	-0.96
Lagged dependent $(\Delta Y/Y)_{-1}$	-0.49***	-5.00
Investment (1st dif.)	1.07***	4.18
Labour force (1st dif.)	0.96***	2.84
Human capital (1st dif.)	1.78**	2.40
Lagged human capital $(HI/Y)_{-1}$	2.58***	2.89
Defence size (1st dif.)	2.07*	1.81
Diagnostic Statistics		
R^2 0.81	$\bar{R}^2$ 0.78	
RSS 0.0590	F stat.(6, 31) 22.565 probability : 0.0000	
Lagrange Multiplier Test		
Serial Correlation χ^2 (2)	2.7728	probability : 0.2500
Normality χ^2 (2)	1.4328	probability : 0.4885
Heteroscedasticity χ^2 (12)	18.851	probability : 0.0922
Functional form χ^2 (27)	29.104	probability : 0.3559

* means significant at 10 percent level
** means significant at 5 percent level
*** means significant at 1 percent level

The study used first differences of all variables because of non-stationarity. However, growth, defence and labour variables were stationary in level (it makes cointegreation non applicable). Investment and human capital variables were non stationary in level (see DF test Table 4.5). Therefore, the study is re-estimated the equations using first difference of investment and human capital and level of the other variables[16]. The results are very similar (Table 4.11). Investment variable (first difference) is positive and significant but human capital did not give significant results. The defence size variable is positive and significant in all four different estimations and defence externality is negative and significant. The results are consistent with general findings. Diagnostic test results are also acceptable. R^2 vary between 0.49 and 0.55 and DW tests vary between 1.83 and 1.91.

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16 In ADF test results indicate non stationarity for Labour variable as well. Therefore, estimation with first difference of Labour, investment and human capital and level of growth, defence variables are represented in Appendix A4.3.5.

Table 4.11. Estimation with First Difference of Investment and Human Capital

Dependent Variable: Economic Growth				
	Equation 4.57	Equation 4.58	Equation 4.59	Equation 4.60
Constant	0.02*** (3.02)	0.02*** (2.93)	0.02*** (3.11)	0.02*** (3.00)
Investment (first diff.)	0.70*** (3.14)	0.63*** (2.89)	0.68*** (3.09)	0.62*** (2.86)
Labour force	0.94** (2.25)	1.07** (2.61)	0.96** (2.33)	1.09** (2.66)
Human capital (first diff.)	-	-	0.90 (1.27)	0.82 (1.17)
Defence size	3.42** (2.71)	18.12** (2.16)	2.81** (2.10)	16.84** (2.00)
Defence externality	-	-0.60* (-1.77)	-	-0.57* (-1.69)
R^2	0.49	0.53	0.51	0.55
DW	1.83	1.84	1.91	1.89
F statistic	11.437***	9.894***	9.134***	8.281***

t statistics in parenthesis
* significant at least 10%
** significant at least 5 %
*** significant at least 1 %

4.6. Conclusions

This Chapter has empirically investigated the relationships between Turkish defence expenditure and economic growth using a theoretically derived econometric model which is developed by Feder (1983) between 1955 and 1994. Compared to most of the empirical work which has been done in this area, a different approach has been taken. There are several important features of the data set and the estimation technique used in this paper. First, I constructed a labour force data set instead of a proxy of population. This allows us to obtain a clearer picture of defence-growth relationships. Secondly, both level and first differencing of the variables are used to avoid spurious regression. Human capital and investment data were non-stationary and they became stationary after being first differenced. Thirdly, lags were introduced into the Feder model to investigate defence-growth relationships and it gave improved results. Fourthly, incorporation of human capital into Feder model also improved results and showed human capital as positively correlated to Turkish economic growth with a lag.

Finally, the evidence showed that there is a positive and significant relationship between defence spending and economic growth for Turkey. The results are robust and in all the different regressions, the coefficients of defence spending are positive and significant. On the other hand, the externality effect of defence spending is negative. Furthermore, the defence sector is less productive than rest of the economy.

The findings of our analysis are consistent with much of the related literature. Most of the studies with the Feder model have found a positive effect or no effect of defence spending on economic growth. The results reported in this Chapter supported those findings. However, to see the robustness and reliability of the results, the next Chapter will analyse defence-growth relationships with a demand and supply side (Deger type) model which represents a different theoretical perspective.

CHAPTER 5

CHAPTER 5

AN ALTERNATIVE ANALYSIS OF DEFENCE-GROWTH RELATIONSHIPS WITH A DEMAND AND SUPPLY SIDE MODEL AND CAUSAL ANALYSIS: TIME SERIES EVIDENCE FROM TURKEY

5.1. Introduction

The primary purpose of this Chapter is to examine the link between defence expenditure and economic growth in Turkey using an alternative approach to that in Chapter 4. In Chapter 4, the relationship was analysed by a supply side (Feder type) model. In this Chapter, the relationship is re-analysed with a demand and supply side (Deger type) model using 2SLS and 3SLS simultaneous equation method. In Chapter 4, a positive defence growth relationship was found for Turkey. To test the reliability and robustness of the results, a different approach is used in this Chapter. Even more analysis is carried out to test for the robustness of the findings. These include Granger causality tests which show the exogenity of defence variable and cointegration analysis which show long-run and short-run solutions.

The Chapter is organised as follows. In the first part (5.2), the defence-growth relationship is analysed using a demand and supply side model. Section 5.2.1 briefly summarise the model and specifications. Section 5.2.2 presents empirical analysis and in section 5.2.3, some results from cointegration analysis are presented. In the second part (5.3), the defence-growth relationships is analysed using Granger causality tests. Granger causality, unit roots and choice of lag length are explained in section 5.3.1. Theoretical expectations are given in section 5.3.2. Section 5.3.3 provides test results and its implications. Finally, conclusions are presented in section 5.4.

5.2. Analysis of Defence-Growth Relationship with a Demand and Supply-side Model

The relationship between defence spending and economic growth is not simple and many variables used for estimation might be endogenous and the impact of defence spending on economic growth may have direct and indirect effects. The study in this section will test the impact of defence spending on economic growth with a simultaneous equation method as an alternative model to Chapter 4. This analysis will also explore the robustness and reliability of the findings in Chapter 4.

5.2.1. The Model and Specifications

Deger (1986b) suggested that any econometric model of the defence-growth relationship should allow for the following:

> *a) a direct effect of military expenditure on growth through various spin-offs (creation of effective demand and technological progress) which may on balance be positive;*
>
> *b) an indirect effect via saving rates, reflecting the fact that defence spending reallocates saving away from productive investment and then hampers growth; further, resource mobilisation may also be affected, thus the very propensity to save may change with a greater defence burden;*
>
> *c) the explicit modelling of open economy considerations: spending on military budgets will affect the trade balance which in turn affects saving and growth;*
>
> *d) the endogenity of military expenditure. This indicates a four equation simultaneous system, which may be necessary to examine the interaction of growth, saving, balance of trade and military spending(Deger, 1986b; 261-262).*

The above considerations for defence-growth relationships apply to Turkey and the equation for balance of trade is also an important component for Turkey because Turkey is a major arms importing country. This imposes a balance of payment problem on the economy. The import allocation effect of defence spending is quite important. Buying arms from abroad potentially reduces the capability to import investment goods which may be crucial for growth. However, some of the military imports may help economic growth. If arms imports are used for consumption, the negative effect will be worse but if the military imports cause an increase in technology, it would help economic growth (*e.g.* production of F-16 fighter aircraft in Turkey helps to increase its technology via technology transfer). Turkey has benefited from military aid from US and NATO. Therefore, the expected sign of the defence burden on balance of payments is ambiguous.

The other consideration is that Deger's various works and other previous multi-equation studies mainly employed cross-sectional methodologies. There are few single country analysis using SEMs (eg, Roux, 1996 and Scheetz, 1991). All previous studies used shares of variables in their estimation. However, Sandler and Hartley (1995) suggested that *in the time series data for single country analysis, use of shares may not be justified, instead real totals of variables can be used* (Sandler and Hartley, 1995; 213) Therefore, this study employs both share variables and real totals of variables where possible.

The bulk of the empirical studies using multi equation models are summarised by Deger and Sen (1995) as follows:

Growth equation:

$$\frac{\Delta Y}{Y}=a_0+a_1\frac{S}{Y}+a_2\frac{M}{Y}+a_3\frac{B}{Y}+a_4E_1 \qquad \textbf{(5.1)}$$

Saving equation:

$$\frac{S}{Y}=b_0+b_1\frac{M}{Y}+b_2\frac{\Delta Y}{Y}+b_3\frac{B}{Y}+b_4E_2 \qquad \textbf{(5.2)}$$

Balance of trade equation:

$$\frac{B}{Y}=c_0+c_1\frac{M}{Y}+c_2\frac{\Delta Y}{Y}+c_3E_3 \qquad \textbf{(5.3)}$$

Defence equation:

$$\frac{M}{Y}=d_0+d_1E_4 \qquad \textbf{(5.4)}$$

Where ΔY/Y is the growth rate of GDP, S/Y is the saving ratio, M/Y is the share of defence expenditure in GDP, B/Y is the trade of balance share in GDP. E_i are a set of exogenous variables chosen through data specifications. They emphasised that E_4 depends on strategies, security and wealth variables. The model will be explained in the following section.

The study uses the above equations. However, exogenous variables were chosen considering Turkey's economy and defence sector and rather than share variables, real levels (totals) are considered[17]. The equations are then constructed as follows:

17 Estimation with share variables is reported in Appendix 5.2

$$Y=a_0+a_1S+a_2M+a_3B+a_4L \quad (5.5)$$

$$S=b_0+b_1M+b_2Y+b_3B+b_4INFRT \quad (5.6)$$

$$B=c_0+c_1M+c_2Y+c_3EXRT+c_4DUM60+c_5DUM70 \quad (5.7)$$

$$M=d_0+d_1PCI+d_2DUMCYP+d_3DUMKUR+d_4GRE_{-1}+d_5NATO_{-1} \quad (5.8)$$

Where[17]:

Y= real gross national product

S= real gross saving

B= real balance of trade

M= Real defence expenditure

L= Employed labour force

PCI= Per capita income

INFRT= Inflation rate

EXRT= Real exchange rate

GRE_{-1}= Lagged Greek military expenditures as a share of GDP

$NATO_{-1}$= Lagged average share of defence burden of NATO countries (excluding Greece and Turkey)

DUMKUR= Dummy variable for conflict between Kurdish separatist and Turkey. This dummy takes a value of one for the years 1989-1994.

DUMCYP= Impulse dummy variable for year 1975 to absorb shock change in defence spending due to war between Turkey and Cyprus.

DUM60= Impulse dummy variable for year 1960 to absorb shock change in the

17 Data sources and their details are given in Chapter 2 and Appendix 5.1

exchange rate

DUM70= Impulse dummy variable for year 1970 to absorb shock change in the exchange rate

Equation 5.5 includes three endogenous explanatory variables (saving, balance of trade, defence expenditure) and an exogenous labour force (L). Given these, it is predicted that saving (S) and labour force (L) are positively correlated to economic growth which is standard from any basic growth theoretic model (Deger and Sen, 1983; Deger and Smith, 1983; Faini *et al.* 1984; Deger, 1986; Lebovic and Ishaq, 1987; Scheetz, 1991). The sign for the coefficient of balance of trade (B) should be negative because the deficits of trade balance imply net capital inflows from abroad, which stimulate economic growth. Defence spending variable is assumed to have direct positive effect on economic growth through Keynesian aggregate demand and modernisation effect.

In the second equation 5.6, saving (S) is assumed to be affected by defence expenditure, balance of trade (as a proxy of foreign savings), growth (Y) and inflation rate (INFRT). Benoit (1978) argued that in developing countries only a small part of any income not spent on defence is put into highly productive investment. Most goes into consumption and social investment, such as housing, which do not stimulate economic growth. They are not a productive investment but contribute to consumer satisfaction (Benoit, 1978). Therefore, an increase in defence spending may not mean an equivalent decrease in investment or vice versa. Following life-cycle theories of consumption, savings depends on growth. Higher income and growth tend to generate higher savings. Thus, the growth effect on saving is predicted to be positive. The external sector coefficient (B) is expected to positively affect savings through income multipliers and trade taxes (Scheetz, 1991). Finally, inflation is included in the saving equation. Inflation certainly affects savings. Deger (1986b) assumed inflation cause forced savings and therefore it is positively correlated to savings. However, this is only valid when inflation is unexpected. If a country, such as Turkey, experiences high inflation a long time and inflation is expected, it makes savings less attractive. Therefore, the study assumed inflation should be detrimental for Turkey's savings.

Equation (5.7) for the balance of trade contains defence expenditure (M), growth (Y), exchange rate (EXRT) and two impulse dummies for years of 1960 and 1970. The dummies are intended to absorb a shock change of exchange rates in those years. Defence expenditure is expected to be negatively correlated to the balance of trade. Since an increase in defence spending increases aggregate demand, if there are domestic supply constraints, a rise may reduce exportable goods and/or may result in an increase in total imports. However, this effect should be small or insignificant for Turkey. It is true that Turkey has greatly benefited from the US and the NATO alliance military transfers. The burden on balance of trade equation therefore should be obviously lower. The other variable in the balance of trade equation is an exchange rate. The rate is included to account for the effects on exports and imports of a change in the international purchasing power of domestic currency. It is expected to have a positive impact in the balance of trade equation. Finally, growth should affect the trade balance. Deger (1986b) argued that the effect for countries following export promoting strategies should be positive and for countries following import substitution industrialisation should be negative. Turkey followed import substitution industrialisation until 1980 then followed export promoting strategies. Therefore, its effect is judged to be undetermined.

Defence equation (5.8) is radically different from previous studies. For this equation, a standard demand for military expenditures is used. In general form, the estimating equation for defence expenditures is:

$$\textit{Defence Spending} = f(\textit{Income, Spill-ins, Threat, Prices}) \qquad (5.9)$$

Sandler and Hartley (1995) explained that income is a crucial determinant of military expenditures. There is a positive relationship between defence spending and country's GDP. As GDP rise, a nation has both more resource to protect and greater means to provide protection. In the equation (5.9), Spill-in indicates the real defence spending of allies. Threat is the defence spending of the rival. Prices denote the relative price of defence as composed with non-defence goods. However, price data are generally not available, so defence price variable cannot be included in the equation. Spill-in and threat are frequently lagged by one year when time series data are used because a nation must experience the threat and/or spill-in before responding to it (Sandler and Hartley, 1995: 60-61).

After consideration of above discussion, the determinants of Turkish defence expenditures are constructed as per capita income representing income (PCI), NATO for spill-in effect, the threat from Greece and two dummies for the Cyprus war and the PKK conflict. The NATO variable is the average defence spending (in real terms) of NATO members as a share of GDP (excluding Greece and Turkey) which captures the alliance effects on Turkish defence expenditure. This is frequently lagged one year when time series data are used (Sandler and Hartley, 1995). If Turkey is free-rider, the coefficient of NATO will be negative; on the other hand if Turkish defence planners adopt a follower mode of response, the coefficient will be positive. GRE is Greek military expenditure in GDP which captures the threat to Turkey. Arms race models predict that an increase in Greek defence expenditure will lead to a direct response by Turkish defence spending. Turkish and Greek bilateral relations have rarely been smooth over a long period. Their disputes have often been threatened by war. The arms race between the two countries has been supported by some empirical studies. Chletsos and Kollias (1995) found that Turkish military spending was positively affected by Greek defence allocations. Kollias (1996) found that Greek defence spending is also primarily influenced by Turkish defence spending. In recent years, both countries have engaged in the modernisation and upgrade of their military capabilities (Kollias, 1996). Ozmucur (1996) and Kollias (1995) also supports an arms race between the two countries. Therefore, the GRE variable is included in the equation and it is expected that the coefficient of GRE will enter the empirical tests with a positive sign and significant. These two variables (NATO and GRE) are proxied as a share of defence expenditures in GDP, because using real values are not quite possible due to converting common currency problems. Two dummy variables (DUMCYP and DUMKUR) are intended to capture the effect of the war between Turkey and Cyprus at the end of 1974 and the conflict between Turkey and the separatist PKK (Kurdish Worker's Party).

5.2.2. Empirical Results

Table 5.2 reports different estimates of equation (5.5-5.8). However, due to non-stationarity, all the variables are first differenced (Table 5.1) then estimation is performed. The variables are non-stationary and they became stationary after first differencing which is used to assess the robustness of the results in a dynamic structure.

Table 5.1. Unit Root Tests in Levels and First Differences

Variable (x)		Unit Root in x [1]		Unit Root in Δx [1]	
		DF	ADF	DF	ADF
Y		-1.439	-0.593	-7.473**	-3.612*
S		-0.779	-0.878	-5.741**	-4.242**
B		-5.151**	-3.597*	-7.319**	-7.61**
M		-1848	-2.674	-4.807**	-4.93**
L		-1.051	-1.259	-5.197**	-3.266*
INFRT		-1.861	-2.071	-4.455**	-3.45*
PCI		-2.549	-1.986	-7.467**	-4.229**
EXCRAT		-2.448	-2.55	-5.92**	-4.699**
GRE		-1.74	-2.01	-6.074**	-4.556**
NATO		-6.005**	-4.629**	-11.2**	-7.775**
Critical values	1%	-4.209	-4.216	-4.216	-3.617
	5%	-3.528	-3.531	-3.531	-2.942

The reported values are obtained from PC-Give 8.0 version by Doornik and Hendry, 1995. For calculated values intercept and trends are included in both DF and ADF equations for levels and intercept include for first differences.
[1]where x represents level of variables and Δx represents first differences of variables.
Y is GDP, S is gross domestic savings, M is defence expenditure, L is labour force, INFRT is inflation rate, PCI is per capita income, EXCRAT is real exchange rate, GRE is Greek defence burden and NATO is average NATO's defence burden (excluding Greece and Turkey).
* significant at 5%
** significant at 1%

The estimation results from the all the three types of estimations in Table 5.2 are not very different (OLS, 2SLS and 3SLS). The results in three estimated regressions are in line with expectations. In the growth equation, the coefficient of the endogenous variable of saving and defence spending are statistically significant and positively correlated to Turkish economic growth. But the balance of trade is, as expected, negatively correlated to economic growth. The exogenous variable of labour is also significant and positively related to economic growth. When the estimated results of the growth equation are compared with previous findings, they seem inconclusive. In all previous studies and also in this study, the effects of saving on growth are found to be significantly positive. The variable for capital inflow from abroad, is found negative or insignificant in all the previous studies. The signs of defence variables differ among studies. While Deger (1986a), Scheetz (1991), Lebovic and Ishaq (1987) found negative and statistically significant results, Deger (1986b), Deger and Smith (1983) found that defence spending has a positive impact on economic growth. The effect seems insignificant in Deger and Sen (1983). The result for the growth equation in this study are consistent with Deger (1986b) and Deger and Smith (1983). It is evident that the effect of defence spending varies across countries, not across the models, because the Feder model for Turkey also showed (Chapter 4) that there is a positive relationship between defence and economic growth.

In the saving equation (Table 5.2), although the coefficient of defence spending is significant at the OLS estimation, the coefficient is statistically insignificant for 2SLS and 3SLS. The study relies on 2SLS and 3SLS estimation due to simultaneity. It implies that defence expenditure has not reallocated saving from productive investment. Unlike various Deger studies, the effect of defence on saving is insignificant for Turkey. Coefficients of growth and balance of trade (proxy of foreign capital) are positive and statistically significant. Inflation shows negative and significant effect on savings. It implies that inflation does not provide forced saving for Turkey. Rather, it retards savings.

When the results of saving equation are compared with previous similar studies, the income variable shows a positive relationship in all studies, although the coefficient is insignificant in Scheetz (1991) and Roux (1996). On the other hand, the variable for the balance of trade is positive and statistically significant in Deger and Sen (1983), Deger (1986a) and Scheetz (1991). It is negative in Deger and Smith (1983). This study gave insignificant results for that variable which indicates that foreign capital inflow has no important effect on saving for Turkey. More importantly, the effect of defence spending on the saving equation shows a significant negative effect in Deger and Sen (1983), Deger and Smith (1983), Deger (1986a; 1986b). However, the effect is insignificant in this study and studies such as Lebovic and Ishaq (1987) and Roux (1996). Inflation gives a positive and significant result in Lebovic and Ishaq (1987). In the other similar studies, inflation is not included or gives an insignificant result in the saving equation, but in this study inflation seems to be negatively related to saving. It suggests that a very high inflation rate does not help forced savings.

In the balance of trade equation (Table 5.2), defence expenditure shows no significant relationships in all three types of estimations. This may be explained by high military aid from US and NATO alliance to Turkey or an inappropriate proxy for arm imports (alternative estimations used ACDA arms imports and the World export data but they did not give significant results; these results are reported in the Appendix A5.1.4). Coefficient of the exchange rate is, as expected, positive and significant. Two dummies gave negative and significant results. Since a few studies included four equations, a comparison of the results is not easily possible. Roux (1996) and Deger (1986b) studies included the balance of trade as a fourth equation. Roux (1996) findings for the defence variable are consistent with this study and it is insignificant. However, Deger (1986b) found that defence spending is negatively correlated to the balance of trade.

Turning to estimates of defence equation (Table 5.2). income is a major determinant of Turkish defence spending. The results suggest that Turkish defence spending is positively affected by Greek defence spending and this is in line with expectations. However, the NATO variable is statistically insignificant. The insignificant results might reflect an imperfect proxy of NATO variables because this variable enters into the equation as a share rather than level, but level values for the NATO variable cannot be accurately constructed.

A positive coefficient is also obtained in the case of the two dummy variables (DUMCYP and DUMKUR) as expected. Increasing conflict with PKK (Kurdish Worker's Party) causes an increase in Turkish defence expenditure. Comparison of defence equation with previous studies gives limited evidence because each equation includes different exogenous variable and dummies. The most commonly used variable in the defence equation is income (GDP or per capita GDP). It is positive and statistically significant both in this study and most of the other studies (Deger and Sen, 1983; Deger and Smith, 1983; Deger, 1986a; 1986b). On the other hand, Lebovic and Ishaq (1987) and Roux (1996) found income variable negatively correlated to defence expenditure. In this model, the multiplier of military expenditure on economic growth can be calculated as: $\frac{\partial Y}{\partial M}=\frac{a_1 b_1+a_2}{1-a_1 b_2}=\frac{(0.90)*(-2.54)+2.90}{1-(0.90*0.75)}=0.92$. The multiplier is positive: it suggests that the overall effect of Turkish defence expenditure is positive.

Overall the estimation, the test statistics are acceptable. The R^2 varies between 0.60 and 0.80 and Durbin-Watson statistics provide no evidence of autocorrelation for the first difference of estimation (Table 5.2).

Table 5.2. Estimation Results (1956-1994)

	Exogenous variables	OLS	2SLS	3SLS
Growth equation	Constant	314770 (2.51)**	307900 (2.07)**	296930 (2.00)*
	ΔS	0.74 (6.51)***	0.76 (2.34)**	0.90 (2.78)***
	ΔB	-0.51 (-4.30)***	-0.36 (-1.96)**	-0.36 (-1.97)**
	ΔM	2.90 (3.59)***	3.03 (2.81)***	2.97 (2.76)***
	ΔL	1.10 (2.76)***	1.05 (2.54)***	0.90 (2.27)**
	Diagnostic tests	R^2: 0.80 DW: 1.95	σ: 566074	σ: 581431
Saving equation	Constant	-172420 (-1.57)	3787 (0.02)	-68690 (-0.42)
	ΔM	-2.54 (-2.86)***	-0.97 (-0.72)	-1.39 (-1.04)
	ΔB	0.59 (4.66)***	0.45 (1.73)*	0.41 (1.57)
	ΔY	0.75 (7.71)***	0.46 (2.26)**	0.55 (2.75)***
	ΔINF	-21273 (-3.81)***	-17842 (-2.23)**	-14612 (-1.88)*
	Diagnostic tests	R^2: 0.68 DW: 1.57	σ: 544428	σ: 5186781
Balance of trade equation	Constant	516440 (3.99)***	560000 (3.04)***	575110 (3.12)***
	ΔM	-1.27 (-1.33)	-1.02 (-0.72)	-0.73 (-0.51)
	ΔY	-0.30 (-2.68)**	-0.36 (-1.59)	--0.40 (-1.75)
	ΔEXRT	3598 (4.29)***	3541 (4.19)***	3391 (4.04)***
	DUM60	-419920 (-4.14)***	-424500 (-4.17)***	-4186100 (-4.14)***
	DUM70	-202970 (-2.80)***	-2000300 (-2.77)***	-1960900 (-2.75)***
	Diagnostic tests	R^2: 0.60 DW: 2.20	σ: 582512	σ: 586544
Defence equation	Constant	1746 (0.10)	1746 (0.11)	78562 (0.05)
	ΔPCI	0.12 (5.26)***	0.12 (5.34)***	0.13 (5.49)***
	ΔGRE_{-1}	50871 (2.26)**	50871 (2.29)**	56045 (2.55)**
	$\Delta NATO_{-1}$	-7501 (-0.07)	-7501 (-0.08)	-14315 (-0.15)
	DUMKUR	108260 (2.97)***	108260 (3.01)***	108450 (3.04)***
	DUMCYP	366450 (4.34)***	366450 (4.40)***	369650 (4.47)***
	Diagnostic tests	R^2: 0.70 DW: 1.79	σ: 76990	σ: 77071

t statistics in the parenthesis. For 2SLS estimation; loglik=-1992.45 T=39 and LR test of over-identifying restrictions: $Chi^2(22)$ =65.328 [0.0000]; For 3SLS estimation; loglik=-1993.54 T=39 and LR test of over-identifying restrictions: $Chi^2(22)$ =67.504 [0.0000]
ΔY= real gross national product (first difference), ΔS= real gross saving (first difference), ΔB=real balance of trade (first difference), ΔM= Real defence expenditure (first difference), ΔL= Employed labour force (first difference), ΔPCI= Per capita income (first difference), ΔINFRT= Inflation rate (first difference), ΔEXRT= Real exchange rate (first difference), ΔGRE_{-1}= Greek military expenditures as a share of GDP (first difference), $\Delta NATO_{-1}$= Average share of defence burden of NATO countries (excluding Greece and Turkey) (first difference), DUMKUR= Dummy variable for conflict between Kurdish separatist and Turkey. This dummy takes a value of one for the years 1989-1994, DUMCYP= Impulse dummy variable for year 1975 to absorb shock change in defence spending due to war between Turkey and Cyprus, DUM60= Impulse dummy variable for year 1960 to absorb shock change in the exchange rate, DUM70= Impulse dummy variable for year 1970 to absorb shock change in the exchange rate,
Notes: All computations in this study have been carried out by PC-GIVE 8.0 and PC-FIML 8.0 (See Doornik and Hendry, 1994; 1995)

5.2.3. Results from Cointegration Analysis

The results of this Chapter so far have supported the findings of a positive impact of defence on Turkish economic growth. To assess whether the findings are robust and to see long-run and short-run solution with a cointegration methodology, further investigations were carried out, using equations 5.5. and 5.6[18]. We know from the Table 5.1 that the variables are non-stationary in level and stationary when they are first differenced.

The cointegration analysis between economic growth and defence expenditure is tested following the procedure outlined in Engle and Granger (1987). They suggest a two step estimation procedure in which the static long run equation is initially estimated and tested for cointegration. When the cointegration relationship exists the residuals (which will be by definition I (0) are the used in the error correction model. Table 5.3. shows the results for cointegration regression. The most frequently used test for cointegration residuals for a unit are the residual based DF (Dickey-Fuller) and ADF (Augmented Dickey-Fuller) 1981 test. For the usual cointegration tests, the null hypothesis is that the series are not cointegrated against the alternative that they are. The tests results showed that cointegration exists (Table 5.3). In the long run, positive relationships between Turkish economic growth and defence spending are supported by these results.

18 Because of stationarity of balance of trade variable in level, cointegration analysis is not applicable for this equation, and due to unsatisfactory results, defence equation presented in the Appendix Table A5.4.

Table 5.3. The Engle-Granger First Stage (Long-Run) Estimation for Growth Equation (1955-1994)

	Constant	S	B	M	L	Trend
Y	-1323900***	0.84***	-0.46**	3.01***	1.49***	231640***
t statistics	-5.52	8.67	-2.23	3.41	6.79	6.52
Statistics						
R^2	0.99		F statistics	2058 (0.0000)		
DF: -3.266***			ADF: -3.647***			

Where Y is GDP, S is gross domestic savings, M is defence expenditure, L is labour force, B is balance of trade
* significant at 10%
** significant at 5%
*** significant at 1%

Table 5.4 presents the short-run dynamics of Turkish economic growth. In this estimation, saving, labour and defence spending are positively correlated with economic growth and coefficient of balance of trade is negatively significant. The results are as expected and consistent with 2SLS and 3SLS findings. The negative sign for RES_{t-1} is also as expected. The test statistics of this estimation is also acceptable with a high R^2.

Table 5.4. The Engle-granger Second Stage (Short-run and ECM) Estimation for Growth Equation

Dependent Variable ΔY			
Explanatory Variables	Coefficient	t statistics	probability
Constant	201960**	1.70	0.08
ΔS	0.78***	7.57	0.00
ΔB	-0.56***	-5.20	0.00
ΔM	2.39***	3.22	0.00
ΔL	1.75***	4.19	0.00
RES_{t-1}	-0.45***	-3.03	0.00
Summary Statistics		Diagnostic	
R^2	0.84	AR 1- 2F(2, 31)	0.43
DW	1.79	ARCH 1 F(1, 31)	0.43
SE	494229	NORM $chi^2(2)$	5.57
F (5, 33)	35.743	Xi^2 F(10, 22)	0.36

Where Y is GDP, S is gross domestic savings, L is labour. M is defence spending, B is balance of trade and RES is Residuals from cointegrating regression.
* significant at 10%
** significant at 5%
*** significant at 1%

The long-run effect of defence spending on gross domestic saving are represented in Table 5.5. In the long run, the coefficient of defence spending is insignificant. This is consistent with 2SLS and 3SLS findings. In the long run, the determinants of savings are income, balance of trade and the economy's inflation rate. This Table also presents DF (Dickey-Fuller) and ADF (Augmented Dickey-Fuller) residual based unit root test results which indicate that cointegration exists.

Table 5.5. The Engle-Granger First Stage (Long-Run) Estimation for Saving Equation (1955-1994)

	Constant	Y	B	M	INFRT	Trend
S	-2653800***	0.65***	0.85***	-0.07	-17963***	-255090***
t statistics	-9.75	7.97	4.05	-0.06	-2.75	-5.66
Statistics						
R^2	0.96		F (5, 33)		195.11 (0.0000)	
DF: -2.712***			ADF: -2.917***			

Where Y is GDP, S is gross domestic savings, M is defence expenditure, L is labour force, B is balance of trade, INFRT is inflation rate.
* significant at 10%
** significant at 5%
*** significant at 1%

The Engle Granger short run results for savings equation (Table 5.6) showed that defence spending has a negative and significant effect on saving in the short run. The inflation rate also has a negative effect, while income and balance of trade affect savings positively. RES_{t-1} has the expected negative and significant sign.

Table 5.6. The Engle-Granger Second Stage (Short-run and ECM) Estimation for Saving Equation

Dependent Variable ΔS			
Explanatory Variables	Coefficient	t statistics	probability
Constant	-186060*	-1.71	0.07
ΔY	0.72***	7.34	0.00
ΔB	0.62***	4.86	0.00
ΔM	-1.99**	-2.05	0.04
ΔINFRT	-19664***	-3.47	0.00
RES_{t-1}	-0.17**	-2.30	0.04
Summary Statistics		Diagnostic	
R^2	0.69	AR 1- 2F(2, 31)	2.20
DW	1.50	ARCH 1 F(1, 31)	0.38
SE	479838	NORM $chi^2(2)$	0.03
F (5, 33)	15.117	Xi^2 F(10, 22)	1.71
		RESET F(1, 32)	4.29

Where Y is GDP. S is gross domestic savings, L is labour, M is defence spending, B is balance of trade, INFRT is inflation rate and RES is Residuals from cointegrating regression.
* significant at 10%
** significant at 5%
*** significant at 1%

The whole cointegration analysis results showed that the findings are almost the same as findings of 2SLS and 3SLS estimations. The positive effect of defence spending on Turkish economic growth is supported by both cointegration analysis and Deger-type SEM analysis.

5.3. Causal Analysis of Turkish Defence-Growth Relationships

We have investigated Turkish defence-growth relationships using three different approaches. All the findings supported a positive effect of Turkish defence spending on its economic growth. However, the exogenity of the defence variable has not been tested. The third analysis of Turkish defence-growth relationships in this Chapter will explores exogenity of defence variable using Granger causality tests.

5.3.1. Granger Causality, Unit Roots and Choice of Lag Length

A question that frequently arises in time series analysis is whether or not one economic variable can help to forecast another economic variable. For instance, does defence spending cause economic growth. This question was proposed by Granger (1969). Testing causality in the Granger sense involves using F tests to test whether lagged information on available Y provides any statistically significant information about variable X in the presence of lagged X. If not then "Y does not Granger cause X".

The procedure assumes the long-run relationship between the series. The test for Granger causality consists of the equations:

$$X_t = a_0 + \sum_{i=1}^{m} b_i X_{t-i} + \sum_{j=1}^{n} c_j Y_{t-j} + u_t \qquad \textbf{(5.10)}$$

where u_t is a serially independent random vector with mean zero and finite covariance matrix.

The testing for Granger causality requires that data series must be stationary. Models containing non-stationary variables will often lead to a problem of spurious regression. (Engle and Granger, 1987). To test for the stationary of the variables, unit root tests are commonly used which is developed by Dickey and Fuller (1979). If data series contains a non-stationary variables, it should be differenced to result in a stationary series. In this study, the following augmented Dickey-Fuller (ADF) regression is employed to test the unit root hypothesis:

$$\Delta X_t = \alpha_0 + \alpha_1 TIME + \alpha_2 X_{t-1} + \alpha_3 \sum_{i=1}^{k} \Delta X_{t-1} + \varepsilon \qquad (5.11)$$

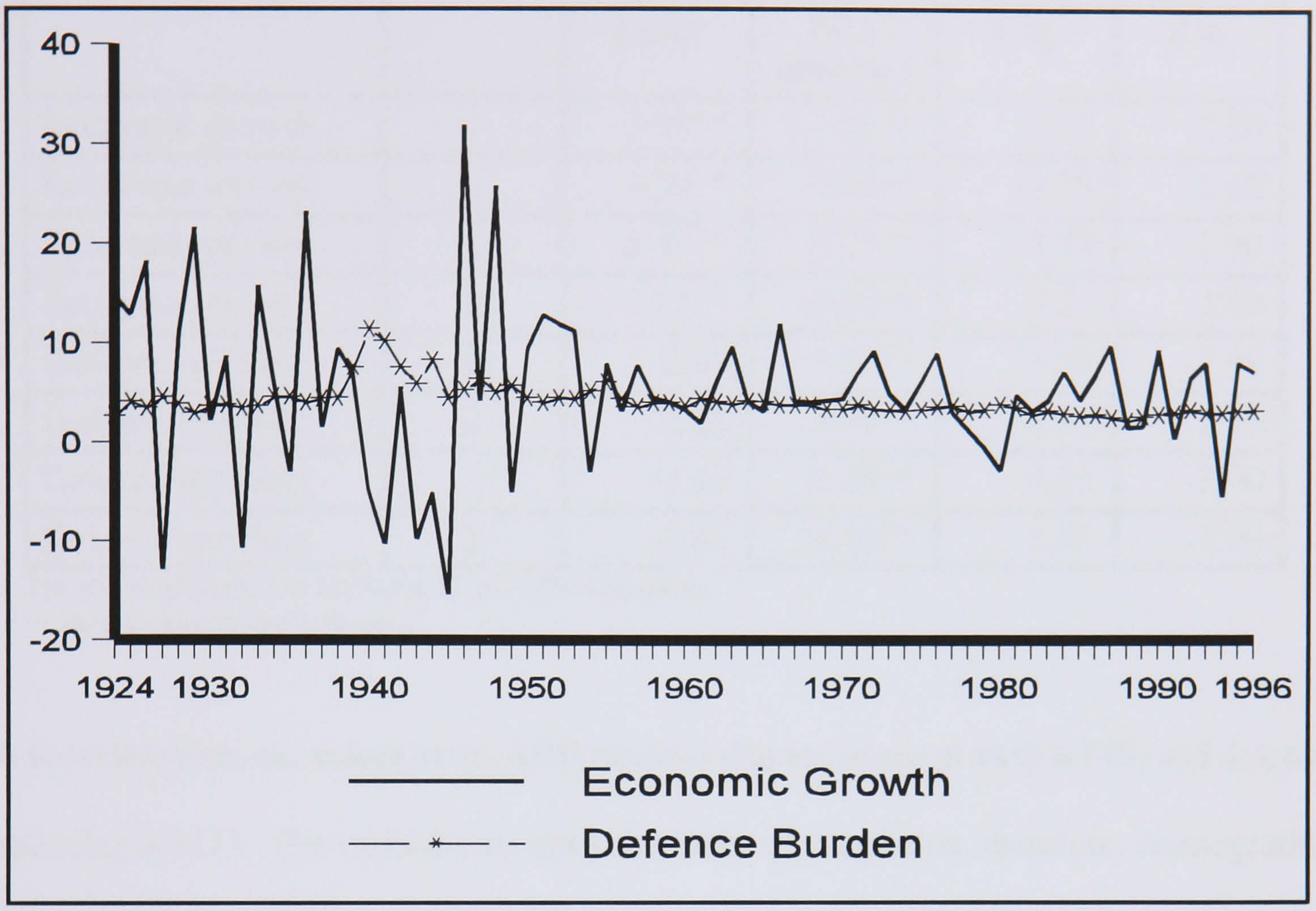
where X_t stands for economic growth or defence spending variables.

Granger causality tests are very sensitive to choice of lag length. Therefore, choice of lag length needs careful attention. This study uses Akaike's final prediction error (FPE) to determine appropriate lag length.

5.3.2. Theoretical Expectations

The study hypothesised that defence expenditure is an exogenous variable relative to economic growth while economic growth is an endogenous variable relative to defence spending. For this analysis, economic growth and defence burden (defence shares in the GNP) over the period 1924-1994 are used. Although level data are better for explaining the defence growth relationships, only share data are available for earlier years (1924-1950). Figure 5.1 shows trends in defence burdens and economic growth for Turkey.

Figure 5.1 Turkey's Economic Growth and Defence Burden (1924-1996)



Source: Ministry of Finance, Turkey

5.3.3. Tests, Results and Discussions

Table (5.7) reports the ADF test results for the level as well as for the first differences variables. As can be seen from the Table, calculated ADF statistics is less than its critical value for economic growth. It means the series is said to be stationary or integrated of order zero (i.e. I (0)). On the other hand, the defence spending variable seems non-stationary and it became stationary after differencing once.

Table 5.7 ADF Tests for Unit Roots

Variables	Lag	Tests statistics		Critical values	
		Level	First difference	1 %	5 %
Economic growth	3	-3.97**	-7.55**	-3.53	-2.90
Economic growth	2	-4.59**	-7.93**	-3.53	-2.90
Economic growth	1	-5.49**	-9.75**	-3.53	-2.90
Economic growth	0	-10.02**	-17.02**	-3.53	-2.90
Defence spending	3	-2.07	-5.31**	-3.53	-2.90
Defence spending	2	-2.05	-5.41**	-3.53	-2.90
Defence spending	1	-2.60	-7.44**	-3.53	-2.90
Defence spending	0	-2.64	-8.43**	-3.53	-2.90

The intercept term are included in the ADF equations
** means significant 1 % level

It is evident from the values of the ADF statistics that economic growth is I (0) and defence spending is I (1). The variables are not same order of integration, therefore, cointegrating regression is not applicable. The Granger causality test can still be applied on the variables (Asseery, 1996; Chen, 1993).

The procedure assumes the long-run relationship between the series. The tests for Granger causality consist of the equations:

$$EG_t = a_0 + \sum_{i=1}^{m} b_i EG_{t-i} + \sum_{j=1}^{n} c_j DS_{t-j} + u_t \qquad \textbf{(5.12)}$$

$$DS_t = \alpha_0 + \sum_{i=1}^{p} \beta_i EG_{t-i} + \sum_{j=1}^{r} \gamma_j DS_{t-j} + \varepsilon_t \qquad \textbf{(5.13)}$$

where u_t and ε_t are a serially independent random vector with mean zero and finite covariance matrix. EG refers to economic growth and DS is for defence spending.

Equation (5.12) used to test causality runs from defence spending to economic growth, whereas equation (5.13) tests that causality run from economic growth to defence spending. The causality test to be performed can be written simply:

a) DS causes EG if H_0: C_j=0, j=1, ... , n can be rejected

a) EG causes DS if H_0: β_i=0, i=1, ... , p can be rejected

Feedback is said to occur if both (a) and (b) hold. If (a) and (b) cannot be rejected then it can be stated that there are no causal relationships between defence spending and economic growth. *A priori*, start with a lag length of 5 on both variables for each equation and work down. The results of calculating FPE for the different permutations are given in Table (5.8). It can be seen from the Table that the appropriate value of m, n, p and r, respectively. For these calculations, level variable of economic growth and first difference of defence spending variable were used because of non-stationarity of the defence spending variable in levels.

Table 5.8. Akaike Information Criterion

Dependent variable economic growth (EG)			Dependent variable defence spending (DS)		
ΔEG_{t-i}	ΔDS_{t-i}	FPE	ΔEG_{t-i}	ΔDS_{t-i}	FPE
5	5	**43.81**	5	5	1.39
5	4	63.50	5	4	1.35
5	3	63.05	5	3	1.31
5	2	67.57	5	2	1.27
4	5	44.40	4	5	1.35
4	4	64.47	4	4	1.29
4	3	63.16	4	3	1.25
4	2	69.49	4	2	1.21
3	5	54.56	3	5	1.33
3	4	72.55	3	4	1.29
3	3	70.21	3	3	1.24
3	2	73.84	3	2	1.20
2	5	56.00	2	5	1.29
2	4	75.70	2	4	1.25
2	3	73.52	2	3	1.20
2	2	88.17	2	2	**1.17**

These results indicate that appropriate lag length for the economic growth equation are 5-5 and for the defence equation are 2-2. Regression results of equation 5.12 and 5.13 are shown in Table 5.9 and Granger causality test results are presented in Table 5.10. It implies that defence spending affects economic growth while economic growth is exogenous.

Table 5.9. Regression Results of Equations (5.12) and (5.13)

Explanatory Variables	Dependent Variable	
	ΔEG_t	ΔDS_t
Constant	-0.602 (-0.79)	-0.004 (-0.03)
ΔEG_{t-1}	-0.99 (-9.03)	0.014 (1.03)
ΔEG_{t-2}	-0.71 (-5.02)	0.013 (0.99)
ΔEG_{t-3}	-0.61 (-4.42)	-
ΔEG_{t-4}	-0.50 (-3.76)	-
ΔEG_{t-5}	-0.15 (-1.57)	-
ΔDS_{t-1}	-4.23 (-5.57)	-0.064 (-1.07)
ΔDS_{t-2}	0.19 (0.22)	-0.16 (-1.24)
ΔDS_{t-3}	-3.62 (-4.22)	-
ΔDS_{t-4}	-1.69 (-1.97)	-
ΔDS_{t-5}	-4.26 (-5.17)	-
R^2	0.78	0.07
DW	1.89	1.98

Notes: Numbers in brackets are t-ratios: DW is Durbin-Watson statistics: SE standard error of regressions: SC is the Lagrange multiplier test of residual serial correlation: FF is the Ramsey RESET test for functional form: Norm. Is the normality test of the residuals

Table 5.10. Granger Causality Tests (1924-1994)

Null hypothesis	F statistics
$\sum_{i=1}^{5} b_j=0$ Defence causes economic growth	F (5, 54)= 11.672 probability: 0.0000
$\sum_{i=1}^{2} \gamma_i=0$ Economic growth causes defence	F (2, 63)= 0.61028 probability: 0.5464

It is evident from these results that Granger causality between economic growth and defence spending does exist, and more important, the direction of causality running from defence spending to economic growth cannot be rejected at the 1% level of significance. These results coupled with the existence of a long-run relationship between economic growth and defence spending confirm that economic growth over the period of estimation was dependent on defence spending.

5.4. Conclusions

The Chapter has analysed defence-growth relationship with a demand and supply side (Deger type) model using simultaneous equation methodologies (2SLS and 3SLS). The data comprised 39 years of annual observations from 1956 to 1994. The empirical results suggest Deger's findings of positive (aggregate demand and spin-off) effects of defence expenditure have applied for Turkey. Turkey's economic growth is stimulated by defence spending, but defence spending has no significant effect on saving. Deger type indirect effect of defence spending seems insignificant in this study. Furthermore, there is no significant relation between defence spending and balance of trade. It suggests that Turkish defence spending has greatly benefited from military aid from the US and NATO alliance. Therefore, Turkey's balance of trade has not been negatively affected. Determinants of Turkish defence expenditure are mainly its income level, the conflict with PKK and Greece's defence spending. The results are consistent with findings of Chapter (4). Finally, using real values of variables rather than their shares improved the empirical results. The findings support the positive effect of defence spending. To test for the robustness and reliability of the results more analysis was undertaken. Firstly, Engle-Granger Error Correction representation was employed in the growth and savings equations. The results showed cointegration existed and a positive effect of defence spending on economic growth was supported by these findings either in the long-run or in the short-run. Exogenity of defence variable is also answered in this Chapter. The analysis demonstrates that Turkish defence spending Granger causes economic growth, while economic growth does not Granger causes defence spending. It implies that there is bi-directional causality between two variables and it makes defence variable exogenous while economic growth variable is endogenous. These findings justify the defence-growth analysis for Turkey.

The study so far shows that positive effect of defence spending on Turkish economic growth cannot be rejected: either supply-side (Feder type) or demand and supply-side (Deger type) models gave similar results. The following Chapter will analyse Greek defence-growth relationships for comparison with Turkey. Can the results be generalised across countries? Greece provides a comparative case study for answering this question.

CHAPTER 6

CHAPTER 6

ANALYSIS OF GREECE'S DEFENCE-GROWTH RELATIONSHIPS

6.1. Introduction

In the previous Chapters (Chapters 4 and 5), Turkey's defence-growth relationship was examined. The results suggested that the Turkish defence sector stimulate economic growth in Turkey. The aim of this Chapter is to analyse Greece's defence-growth relationships so as to compare the results with those obtained for Turkey. Greece and Turkey show similarities. Both countries allocate large budgets to their defence sector as compared to other NATO countries and they started to produce their own equipment during the 1980s. One might therefore expect that Greece's defence-growth relationship should be similar to that found for Turkey. This Chapter is an attempt to see if we can generalise the results for Turkey, thereby assessing their robustness between similar nations.

The analysis for Greece follows the same procedure and tests used for Turkey. The relationships between Greek defence spending and economic growth is estimated, first, with a supply-side (Feder type) model using ordinary least squares (OLS) estimation for the time period 1958-1994, and, second, with a demand and supply-side (Deger type) model using OLS, 2SLS, 3SLS for the same period. This Chapter also provides some results from cointegration analysis to test and compare the results those obtained for Turkey.

The remainder of the Chapter proceeds as follows. Section 6.2 briefly reviews the Greek economy. Section 6.3 critically analyse Greece's defence economy. In section 6.4 previous

Greek defence-growth studies are reviewed. Section 6.5 is devoted to empirical analysis with two parts. The first part (6.5.1) analyses the relationship with a supply-side (Feder type) model. In this part, section 6.5.1.1 describes the model and its specifications: The estimation procedures and results are discussed in section 6.5.1.2. In the second part (6.5.2), Deger type demand and supply-side analysis is performed. This part includes the model and specifications (6.5.2.1), estimation results (6.5.2.2) and some results from cointegration analysis (6.5.2.3). Finally, section 6.6 summarises the main findings and draws some conclusions. Throughout, the aim is to use Greece to ascertain whether the results for Turkey can be verified for another similar country.

6.2. The Greek Economy

Greece is a small country with a population of over 10 million and is located at the southern edge of the Balkan peninsular. Greece is a member of the European Union and NATO and its economic development was retarded by historical factors (World War II and the civil war between 1939-1949) until 1950. However, after 1950, important transformations took place in the economy. Between 1954-1974, the Greek economy achieved a high GDP growth but after the first oil shock and the recession of mid-1970s, the Greek economic performance slowed down. During the 1980s, the Greek economy stagnated. It isolated itself from the mainstream of the industrial development process and its exports specialised in low value-added products (OECD, 1993). The low growth rate of the Greek economy continued until 1994. The Greek economy gathered strength in 1996 (OECD, 1997). The traditional Greek industrial sectors were food, beverages, tobacco, textiles, clothing, leather, furniture and cement. An expanding shipbuilding sector was mostly involved in repairs (Avramides, 1995).

Greece's general macroeconomics trends are shown in Table 6.1 which contains general macroeconomic data initially with ten years intervals then, between 1980 and 1990 with five year intervals and annual data after 1990. Greece's population growth rate has been very low during the period of 1954-1995. The Greek population rose from 7.9 million people in 1954 to 10.46 million in 1995. The inflation rate has been low until mid-1970s but after the late 1970s, the annual rate increased and varied between 10% and 30%. Due to a large wave of emigration, especially during the 1950s and 1960s, the unemployment rate has been very low. However, there was an increasing trend after 1980. The growth of GNP (gross national product) between 1958 and 1994 averaged 4.8 % annually. In per capita income, there was an increasing trend until 1980s then it became stable. The investment/GNP ratio showed a downward trend during the period. A slight increase was shown in the government consumption/GNP ratio but the ratio declined after 1985. In conclusion, Greece had rapid economic growth from 1954 to mid-1970s, after which the Greek economy was characterised by high inflation and macroeconomic stagnation (OECD, 1996).

Table 6.1. Main Economic Indicators of Greece (1954-1995)

Indicators	1954	1960	1970	1980	1985	1990	1991	1992	1993	1994	1995
Population (million)	7.89	8.33	8.79	9.64	9.93	10.09	10.20	10.31	10.35	10.43	10.46
Annual Inflation rate (%)	15.2	1.5	3.9	28.6	20.3	17.6	17.9	12.1	12.0	8.6	8.9
Unemployment rate (%)	-	6.1	3.1	2.8	7.8	7.0	7.7	8.7	9.7	9.6	10.0
Annual real growth rate of GNP* (%)	6.2	4.3	6.9	1.9	3.2	-0.8	3.5	0.4	-0.9	1.5	1.9
Per-capita GNP (1990 thousand Greek Drachmas)	310	368	805	1,191	1,190	1,275	1,307	1,298	1,289	1,298	-
Investment/GNP (%)	14.8	26.0	23.2	23.4	19.2	23.5	21.3	20.5	19.5	18.8	23.3
Government consumption/ GNP (%)	11.3	11.2	12.4	15.8	20.5	15.7	14.8	14.1	14.2	14.0	-
Export/GNP (%)	7.3	5.8	6.3	12.5	13.7	9.9	10.1	10.4	9.4	9.8	-

* Calculated using 1990 constant Greek Drachmas
Sources: OECD Economic Surveys Greece and OECD Labour Force Statistics, IMF/IFS, US ACDA (1996)

6.3. Greece's Defence Economy

The Greek defence burden is the highest among NATO and European Union members. Table 6.2 and Figure 6.1 show indicators of Greek defence expenditures between 1958 and 1996 yearly. Defence expenditure is given in 1990 constant prices. The growth rate of defence expenditure has averaged 4.9 % per annum. The rate peaked at 1975 (70%) due to the Cyprus-Turkish war. During this period, the rate of economic growth also averaged 4.9% per annum.

Table 6.2 Selected Indicators of Greek Defence Expenditure

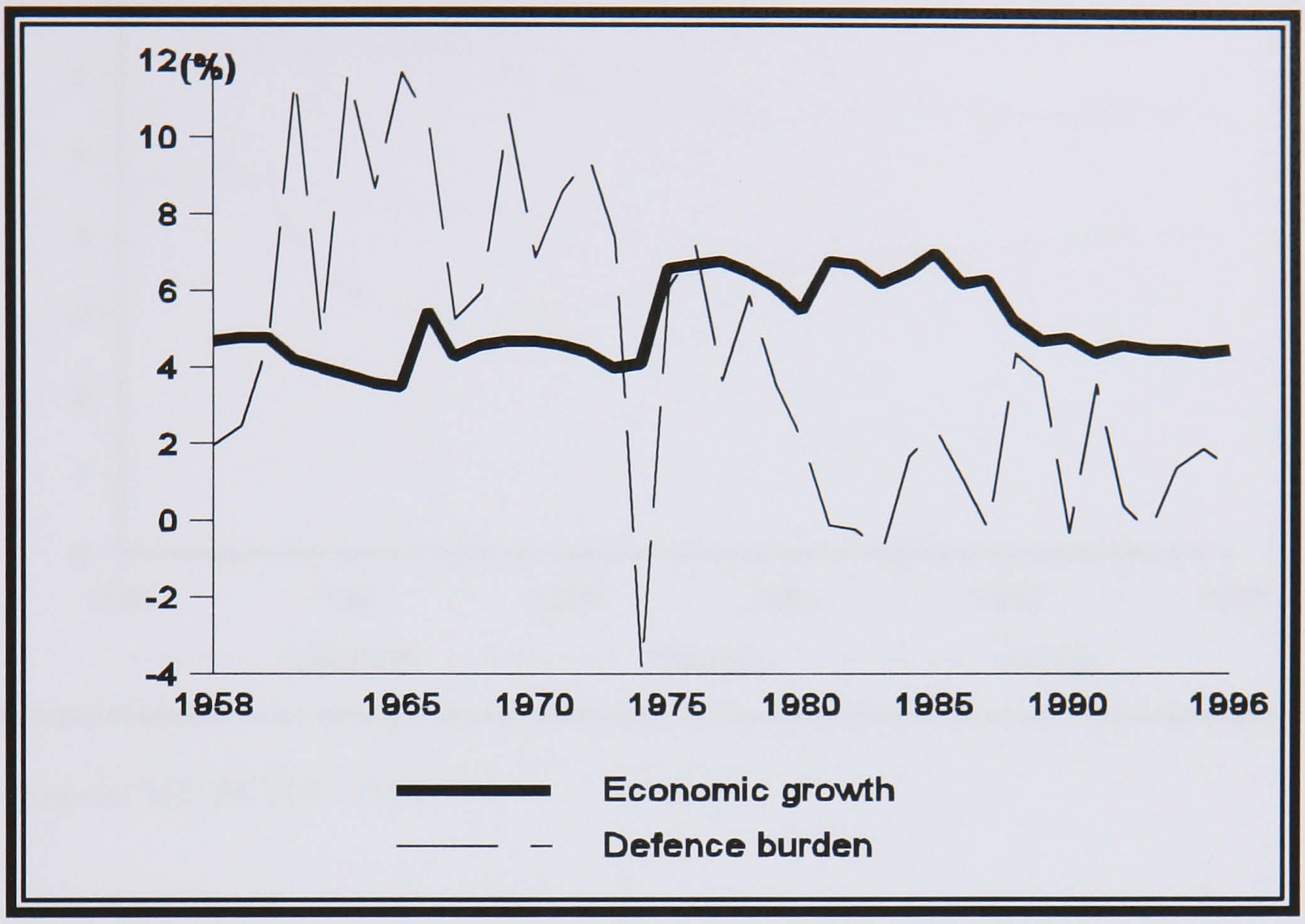
Years	ME (billion drachmas)	ΔME (%)	ΔGNP (%)	ME/ GNP (%)	Years	ME (billion drachmas)	ΔME (%)	ΔGNP (%)	ME/ GNP (%)
1958	135	-2.4	2.0	4.7	*1978*	708	1.4	5.9	6.5
1959	141	4.5	2.5	4.8	*1979*	685	-3.2	3.6	6.1
1960	148	4.8	4.7	4.8	*1980*	630	-8.1	2.1	5.5
1961	144	-3.1	11.6	4.2	*1981*	776	23.3	-0.1	6.8
1962	143	-0.4	4.8	4.0	*1982*	766	-1.3	-0.2	6.7
1963	151	5.8	11.7	3.8	*1983*	706	-7.9	-0.8	6.2
1964	154	1.9	8.7	3.6	*1984*	753	6.7	1.7	6.5
1965	171	10.5	11.7	3.5	*1985*	830	10.2	2.4	7.0
1966	189	10.6	10.4	5.5	*1986*	742	-10.6	1.1	6.2
1967	241	27.6	5.3	4.3	*1987*	754	1.6	-0.2	6.3
1968	275	14.3	6.0	4.6	*1988*	653	-13.5	4.4	5.2
1969	311	13.2	10.6	4.7	*1989*	608	-6.9	3.8	4.7
1970	330	6.2	6.9	4.7	*1990*	612	0.8	-0.3	4.8
1971	352	6.5	8.6	4.6	*1991*	588	-3.9	3.6	4.4
1972	374	6.4	9.5	4.4	*1992*	617	5.0	0.4	4.6
1973	361	-3.5	7.4	4.0	*1993*	605	-2.1	-0.3	4.5
1974	360	-0.3	-3.9	4.1	*1994*	615	1.7	1.4	4.5
1975	612	70.1	6.1	6.6	*1995*	629	2.3	1.9	4.4
1976	662	8.1	7.2	6.7	*1996*	662	5.2	1.4	4.5
1977	698	5.4	3.7	6.8					

Sources: SIPRI yearbooks, IMF/IFS yearbooks, NATO Review (1998)

Notes:

- ME: Military expenditure with 1990 constant Greek billion Drachmas
- ΔME: Real growth rates of military expenditure
- ΔGNP: Real growth rates of gross national product
- ME/GNP: Share of military expenditure in the GNP

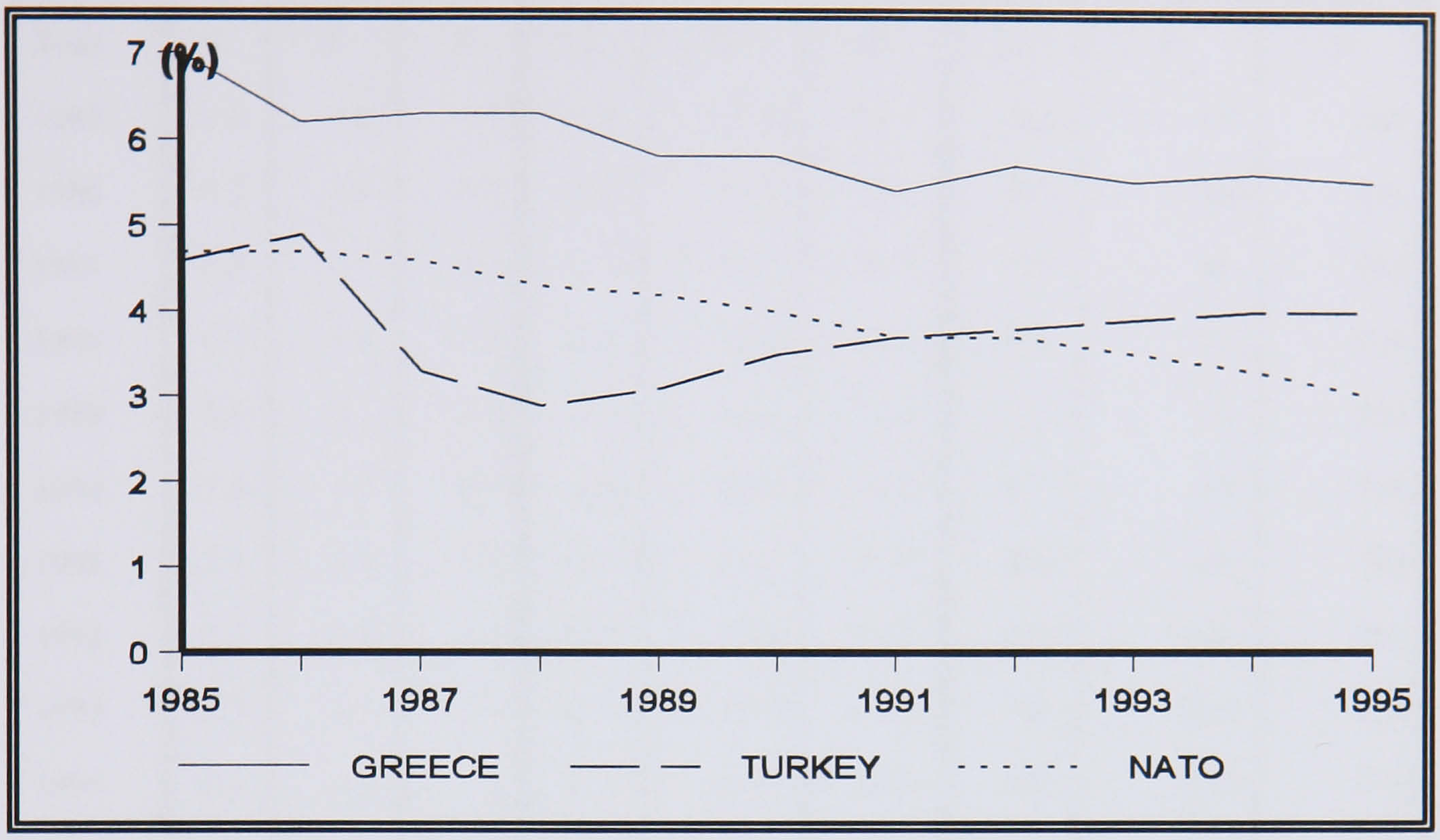
Figure 6.1. Trends of Greek Defence Burden and Economic Growth



Sources: SIPRI, IMF/IFS, NATO Review

For a comparative study, it is meaningful to compare Greece defence burdens with Turkey and the NATO average. Table 6.3 and Figure 6.2 show such comparative data between 1985 and 1995. During the period, the Greek defence burden was higher than both Turkey and NATO average (the average defence burden between 1985 and 1995 between 1985-1995 was 5.9% for Greece, 3.8% for Turkey and 3.9% for NATO: US ACDA, 1996). The other perspective of defence expenditure is its share in the central government budget. Greece's ME/CGB ratio is higher than NATO average but it is lower than Turkey's figures. Per capita military expenditure of Greece is also lower than NATO but much higher than Turkey, because Greece's population is very low when compared to Turkey. This makes *per capita* defence spending higher for Greece.

Figure 6.2. Defence Burden for Greece, Turkey and NATO



Sources: US ACDA, 1996

Table 6.3 Defence Burden for Greece, Turkey and NATO

	ME/GNP (%)			ME/CGB (%)			PCME		
Year	**G**	**T**	**N**	**G**	**T**	**N**	**G**	**T**	**N**
1985	7.0	4.6	4.7	13.8	17.9	14.4	538	97	907
1986	6.2	4.9	4.7	12.5	22.5	14.7	480	110	935
1987	6.3	3.3	4.6	11.9	19.4	14.7	487	80	932
1988	6.3	2.9	4.3	11.9	17.7	14.2	505	72	908
1989	5.8	3.1	4.2	9.5	18.4	14.0	477	74	900
1990	5.8	3.5	4.0	8.8	20.3	13.2	475	89	855
1991	5.4	3.7	3.7	11.9	17.9	11.5	450	94	780
1992	5.7	3.8	3.7	12.5	18.8	11.2	472	100	787
1993	5.5	3.9	3.5	12.1	15.8	10.6	466	108	748
1994	5.6	4.0	3.3	11.5	17.4	10.0	472	105	710
1995	5.5	4.0	3.0	10.8	17.6	9.4	482	108	668

Source: US ACDA 1996

Notes:

- ME/GNP represents shares of military expenditures in gross national product
- ME/CGB is the share of military expenditure in central government budget
- PCME is per capita military expenditure with 1995 constant US $
- G is Greece
- T is Turkey
- N is NATO

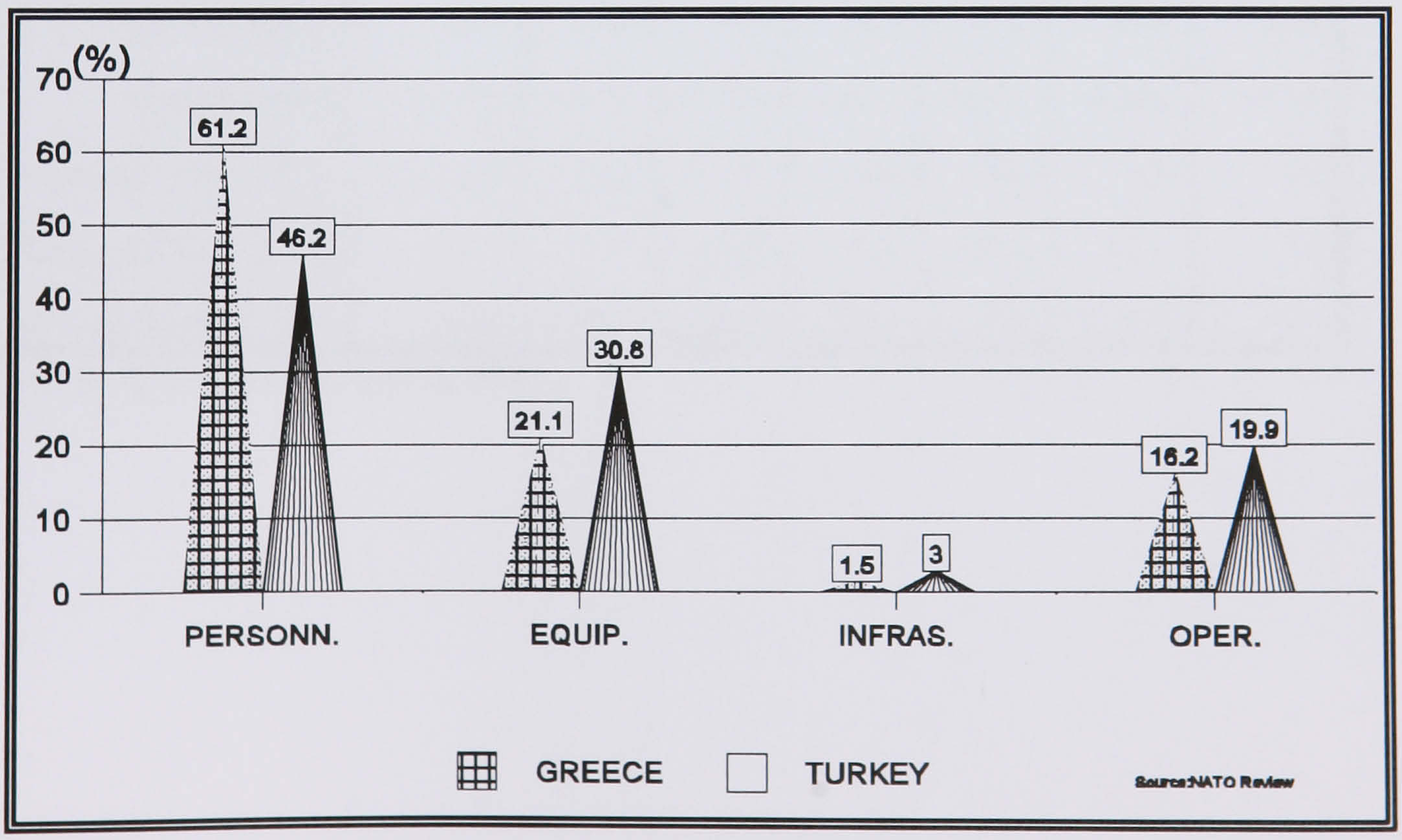
Defence spending can be divided into personnel, equipment, infrastructure and other operational expenditures. In this respect, Table 6.4 and Figure 6.3 compare Greek and Turkish figures. The main point of this Table is that Greek defence expenditure devoted to personnel is higher than Turkey's, whereas equipment and infrastructure expenditures are lower than Turkey. While between 1990 and 1994, an average of 63% of Greek defence expenditure goes to personnel expenditure, the figure for Turkey was 50.1% (hence, different capital-labour ratios).

Table 6.4 Distribution of Greek and Turkish Defence Expenditure by Category

Years	Personnel Expenditure(%)		Equipment Expenditure (%)		Infrastructure Expenditure (%)		Other Operational Expenditure (%)	
	Greece	Turkey	Greece	Turkey	Greece	Turkey	Greece	Turkey
1991	64.4	48.5	20.3	22.7	1.7	2.8	13.6	26.0
1992	61.4	48.7	23.4	24.8	2.4	3.5	12.8	23.0
1993	62.2	54.5	24.7	22.9	2.6	2.9	10.5	19.7
1994	63.0	51.0	24.4	29.3	0.6	2.6	12.0	17.1
1995	63.3	43.0	19.8	37.7	1.9	2.5	14.9	16.9
1996	61.2	46.2	21.1	30.8	1.5	3.0	16.2	19.9
Average 1990-1994	63.0	50.1	22.8	23.7	1.7	3.0	12.2	22.5

Notes: i) Share of military personnel expenditure in the total defence expenditure
ii) Share of military equipment expenditure in the total defence expenditure
iii) Share of military infrastructure expenditure in the total defence expenditure
iv) Share of other operational expenditure in the total defence expenditure
Source : NATO Review January 1996; Spring 1998

Figure 6.3. Distribution of Greek and Turkish Defence Expenditure by Category (1996)



Sources: NATO Review

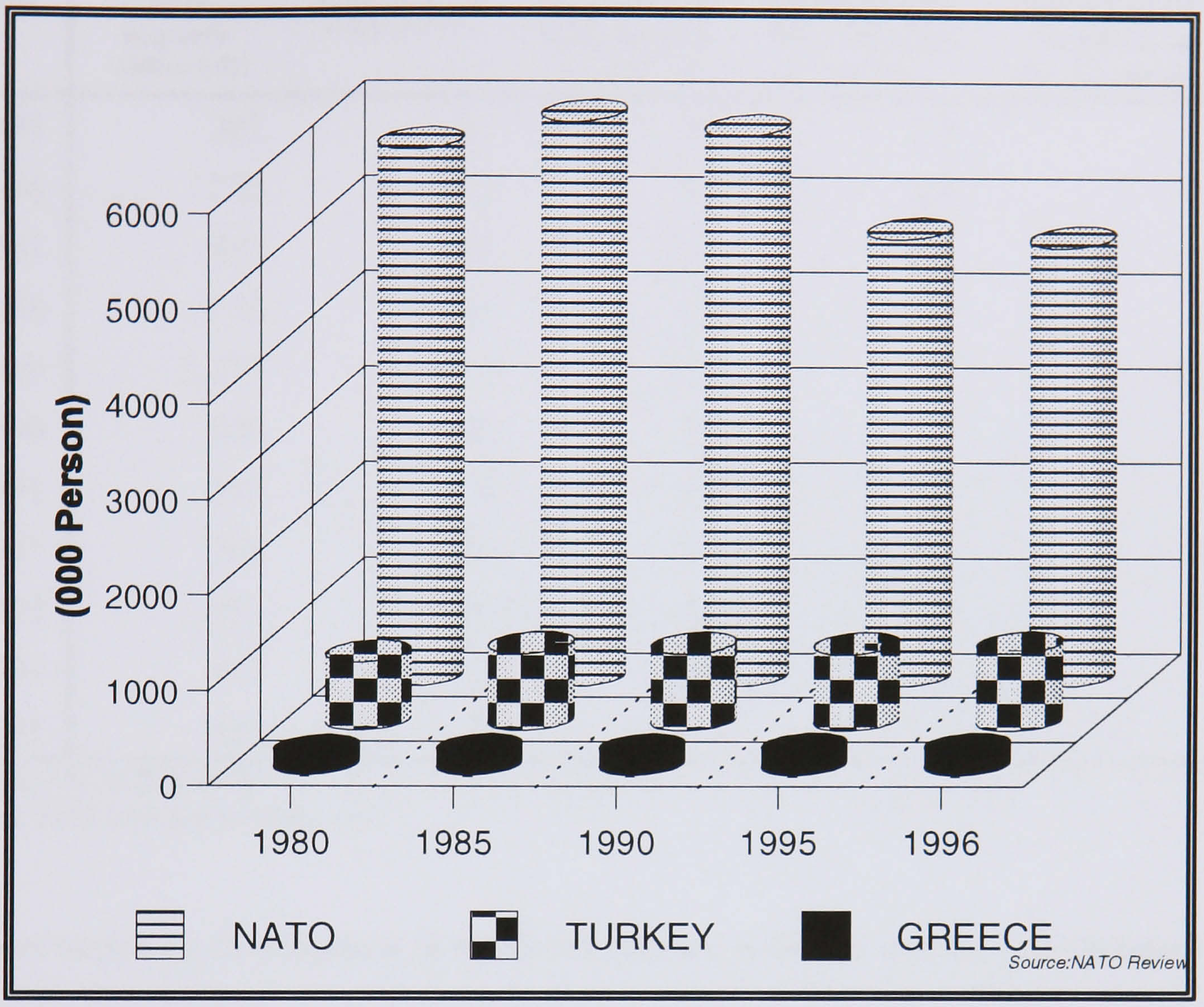
Greece has very large armed forces compared with its population. Greece armed forces were about 212 thousand in 1995, which was equivalent to about 5.9 % of the total labour force. About 73% of the armed forces personnel are male conscripts doing their national service which currently lasts for about 19 months and it is compulsory for all able-bodied males. Compulsory military service in Greece seems likely to remain for the near future because the country feels threatened due to the Turkish threat in Aegean sea and Cyprus. However, Greece has a very low population growth rate. Very large armed forces are likely to create a problem in territorial defence (Kollias, 1995). Table 6.5 and Figure 6.4 shows comparative military personnel data for Greece, Turkey and NATO. Greek armed forces ranked 26 in the world in 1995 (US ACDA, 1996).

Table 6.5 Military Personnel in Greece, Turkey and NATO

	1980	1985	1990	1993	1994	1995	1996
Military Personnel							
Greece (000)	186	201	201	213	206	213	213
Turkey (000)	717	814	769	686	811	807	818
NATO (000)	5,636	5,930	5,778	4,905	4,893	4,700	4,617
Greece/NATO (%)	3.3	3.4	3.5	4.4	4.2	4.5	4.6
Turkey/NATO (%)	12.7	13.7	13.3	14.0	16.6	17.1	17.7
Greece/Turkey (%)	25.9	24.6	26.1	31.0	25.4	26.2	26.0

Source: NATO Review, Spring 1998

Figure 6.4 Military Personnel in Greece, Turkey and NATO



Sources: NATO Review

Although Greece has started to produce its own military requirements, Greece still imports most of its military equipment and arms exports are extremely low. These are also very similar for Turkey. Arms imports, arms exports and its share in total imports and exports for Greece between 1985 and 1995 can be seen in Table 6.6 and Figure 6.5. Greece was ranked 10th highest arms importer in 1995 (US ACDA, 1997).

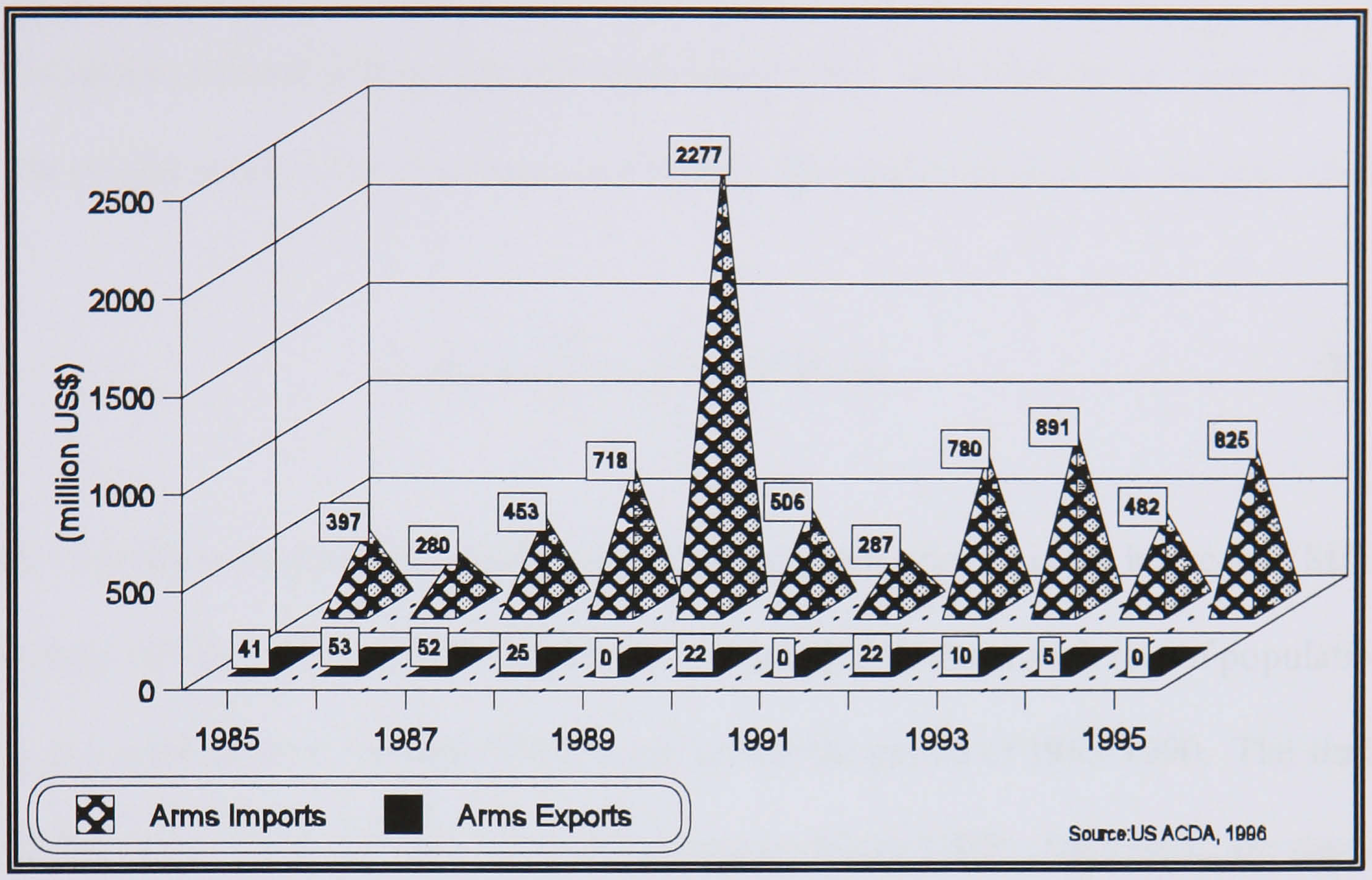
Table 6.6 Greece's Arm Imports and Exports

Year	Arm Imports (Million US$)	Arm Exports (Million US$)	Arm Imports/ Total Imports (%)	Arm Exports/ Total Exports (%)	Balance of Arms Trade (Arms Ex.-Arms Imp.)
1985	397	41	2.9	0.7	-334
1986	280	53	1.9	0.7	-247
1987	453	52	2.7	0.6	-379
1988	718	25	4.7	0.4	-674
1989	2,277	0	11.8	0	-2,206
1990	506	22	2.2	0.2	-479
1991	287	0	1.2	0	-300
1992	780	22	3.1	0.2	-735
1993	891	10	3.9	0.1	-832
1994	482	5	2.2	0.1	-
1995	825	0	-	-	-

Source: US ACDA 1996
Notes: 1995 constant millions US$

A very important development in the Greek defence economy was the establishment of a domestic defence industry in the mid-1970s. The main reason for establishing this defence industry was strategic rather than economic. Therefore, leading defence companies were founded and operated by the state (Avramides, 1995). The owner of these companies are state and military forces (Bartzokas, 1992). The projects aimed to develop self sufficiency of defence requirements. The fields of arm production are aeronautics, military arms and vehicles and shipyards. Most of the production activities involve licenced production. The defence industry also created new jobs for the Greek economy (Avramides, 1995).

Figure 6.5. Greece's Arm Imports and Exports



Sources: NATO Review

To summarise, this section has briefly surveyed Greece's defence expenditure, armed forces and defence industry. It showed that Greece has a high defence burden, a high proportion of its labour force goes to armed forces and it has a developing defence industry. The defence sector seems an important element in Greece economy. The development of the defence industry in Greece is very similar to Turkey's: thus, the relationships between Greece's defence expenditure and economic growth should be analysed. Greece and Turkey are both members of NATO and they spend very high proportion of GNP to defence. After analysis of Turkey's defence-growth relationships in Chapter 4 and Chapter 5, Greece provides a comparative case study for assessing whether a similar defence-growth trade-off exists (*i.e.* similar to Turkey). Before the empirical analysis, the next section will review previous defence-growth studies for Greece.

6.4. Previous Greek Defence-Growth Studies

In recent years, Greek defence-growth relationship has attracted some authors. Kollias (1995) analysed Greek defence-growth relationship using the techniques of cointegration and the related notion of error correction methods. His single equation for the long run is:

$$Y_t=\alpha_0+\alpha_1\frac{M}{Y_t}+\alpha_2\frac{I}{Y_t}+\alpha_3 POP_t+\mu_t \quad \textbf{(6.1)}$$

Where Y is the gross domestic product (GDP) at constant price, α is the intercept, (M/Y) is the share of GDP, (I/Y) is investment share of GDP, POP is the growth rate of population and μ_t is a residual term. Kollias (1995) study covers the period of 1963-1990. The study found that defence spending has a positive impact on Greek GDP. The results are shown in Table 6.7: because of non-stationarity, the variables were first differenced. First differences are denoted by Δ and RES_{t-1} is the lagged value of residuals from the cointegrating regression.

Table 6.7. Empirical Results of Kollias (1995) Study

Dependant Variable ΔY		
	Coefficient	t statistics
Constant	0.022	2.69
ΔM/Y	0.108	2.40
ΔI/Y	0.122	1.96
ΔPOP	-0.003	0.46
ΔY_{t-1}	0.384	2.44
RES_{t-1}	-0.103	2.89

Δ represents first difference of variables

Chletsos and Kollias (1995) investigated the relationship using OLS analysis covering the period 1974-1990. In this study, they hypothesised that military spending can have direct positive effects through aggregate demand stimulation and other spin-off effects and negative effect of military expenditure through crowding-out of investment. Their model is based on the typical Keynesian national income equation (GDP=C+I+G) and is of the following form:

$$CONS=f(M/Y,\ PD/Y,\ IT/Y,\ Y) \qquad \textbf{(6.2)}$$

$$I=f(PD/G,\ Y_{-1},\ M/Y,\ DUM2) \qquad \textbf{(6.3)}$$

$$M/Y=f(MLC,\ Y,\ DUM1,\ DUM2) \qquad \textbf{(6.4)}$$

$$Y=f(CONS,\ I,\ M/Y) \qquad \textbf{(6.5)}$$

Where CONS is total consumption expenditure as percentage of GDP, I is total investment expenditure as percentage of GDP, M/Y is the military spending as percentage of GDP, Y is gross domestic product at constant prices, PD/Y is the ratio of public deficits to GDP, PD/G is the ratio of public deficit to central government budget, IT is the ratio of indirect taxes to GDP, MLC is the ratio of per soldier spending of Greece over Turkey's acting as external threat variable, DUM1 is Cyprus invasion dummy variable and DUM2 is government change dummy variable. Their findings are as predicted. Defence spending positively affects consumption and through it gross domestic product; on the other hand, the effect is negative on investment. Their results are shown in Table 6.8

Table 6.8. Empirical Results of Chletsos & Kollias (1995) Study

CONS		I		M/Y	
	Coefficient		Coefficient		Coefficient
M/Y	0.01 (2.19)	PD/G	-0.35 (-2.43)	MLC	0.69 (5.09)
PD/Y	0.46 (4.48)	Y_{-1}	0.00 (-2.31)	Y	0.00 (2.70)
IT	-9.25 (2.67)	M/Y	-0.01 (-1.61)	DUM1	2.40 (6.41)
Y	0.00 (-2.31)	DUM2	0.02 (1.75)	DUM2	0.25 (1.17)
R^2	0.89	R^2	0.90	R^2	0.79
DW	2.03	DW	1.62	DW	1.79

t statistics in parenthesis

Antonakis (1996) analysed defence-growth relationship using simultaneous equation models and employed 3SLS estimation techniques. This complete model is:

$$\Delta Y/Y=a_0+a_1S/Y+a_2M/Y+a_3PCI \quad \textbf{(6.6)}$$

$$\Delta S/S=b_0+b_1M/Y+b_2\Delta Y/Y+b_3(\Delta Y/Y*PCI)+b_4INFRT \quad \textbf{(6.7)}$$

$$M/Y=c_0+c_1PCI+c_2DUM+c_3M/Y_{(-1)}+c_4GA \quad \textbf{(6.8)}$$

Where ΔY/Y is output growth rate, S/Y is saving income ratio, M/Y is military burden, PCI is per capita GDP, INFRT is inflation, (ΔY/Y*PCI) is output growth rate multiplied by per capita GDP, GA is share of output devoted to expenditures on general administration and DUM is dummy variable for a continuous threat from Turkey after 1974. The empirical results are presented in Table 6.9. His findings are contrary to Kollias (1995) and Chletsos and Kollias (1995). Negative effect on growth and positive effect on saving are found. The study had a low R^2 for the growth equation and the R^2 is even lower for the saving equation. Therefore, the results were not robust.

Table 6.9. Empirical Results of Antonakis (1996) Study

Growth Equation ($\Delta Y/Y$)		Saving Equation (S/Y)		Defence Equation (M/Y)	
	Coefficient		Coefficient		Coefficient
Constant	8.48 (2.39)	Constant	-10.98 (-1.77)	Constant	6.31 (7.10)
S/Y	0.46 (6.75)	M/Y	2.82 (2.19)	PCI	-0.03 (-3.70)
M/Y	-1.55 (-2.55)	$\Delta Y/Y$	1.67 (1.56)	DUM	1.63 (6.12)
PCI	-0.06 (-1.70)	($\Delta Y/Y$*PCI)	0.01 (0.30)	M/Y_{-1}	0.41 (4.74)
		INFRT	0.15 (0.82)	GA	-0.48 (-5.0)
R^2	0.37	R^2	0.14	R^2	0.84

t statistics in parenthesis

The last paper analysing Greek defence-growth relationships came from Antonakis (1997). He used Feder model and estimated Greek defence growth relationships between 1958-1991. The estimated equations for this analysis are:

$$\frac{\Delta Y}{Y}=\alpha\frac{I}{Y}+\beta\frac{\Delta L}{L}+\gamma\frac{\Delta M}{M}\frac{M}{Y} \tag{6.9}$$

$$\frac{\Delta Y}{Y}=\alpha\frac{I}{Y}+\beta\frac{\Delta L}{L}+\gamma\frac{\Delta M}{M} \tag{6.10}$$

Where ($\Delta Y/Y$) is growth rate of GDP, (I/Y) is investment ratio, ($\Delta L/L$) is population growth rate and ($\Delta dM/M$) and [($\Delta M/M$)*(M/Y)] are defence variables representing effect of defence spending on economic growth. After this study, he concluded that Greece's defence spending is detrimental to its economic growth. (Table 6.10). However, the results are not robust. Although the coefficient of investment is statistically significant and positive, the defence variable is only significant at the 10% level and the equation "explains" under 50% of the variation in growth rates.

Table 6.10. Empirical Results of Antonakis (1997) Study

Dependant Variable ΔY/Y		
	Equation 6.9	Equation 6.10
	Coefficient	Coefficient
Constant	-8.24 (-3.24)	-8.45 (-3.31
I/Y	0.55 (5.56)	0.56 (5.61)
ΔL/L	-0.01(-0.01)	-0.03 (-0.03)
(ΔM/M)*(M/Y)	-1.54 (1.71)	-
ΔM/M	-	-0.10 (-1.80)
R^2	0.46	0.46

t statistics in parenthesis

Greek defence-growth studies were briefly reviewed above. The results are summarised in Table 6.11, which are inconclusive. There are several shortcomings from these studies. In the Kollias (1995) paper the model is not based on a theoretical framework. However, the paper employed recent econometric techniques. In the Chletsos and Kollias (1995) paper, theory entails simply *ad hoc* justification of the chosen set of regression. The sample period is relatively short. The short time period might have led to the introduction of bias in the estimates. In Antonakis (1996), first paper a Deger type model was employed and in the second paper (1997) he used a Feder type model. However, his data set, sample period, choice of variables and estimation techniques are rather different across the studies. This study employs level of variables for Deger type model and the defence equation is extracted from standard demand for military expenditures model. In the second study, a Feder type estimation, Cyprus dummy and trend variable are included in the model and also the stationarity of variables is considered.

Table 6.11 The Greek Defence-Growth Empirical Studies

Author	Model	Sample Period	Remarks	Conclusion
Kollias (1995)	Production function *(Ad Hoc)*	1963-1990	single equation, cointegration and ERM	Positive and significant effect of defence on growth
Chletsos and Kollias (1995)	Keynesian national income equation	1974-1990	Four equations, consumption, investment, military and GDP equations, OLS estimations	Positive direct effect of defence on growth, negative impact on investment
Antonakis (1996)	Demand and supply side (Deger) model	1958-1990	Three equations, defence, saving, and growth equations. 3SLS	Negative direct effect of defence on growth, positive indirect effect. Net effect is negative
Antonakis (1997)	Feder model	1958-1991	Single equation, two sectors model, military, nonmilitary, OLS	Defence had a negative impact on growth

6.5. Empirical Analysis

In Chapters 4 and 5, the defence-growth relationship was analysed using two different models for Turkey and it was found that Turkish defence spending is positively related to its economic growth. Of course, these results cannot be generalised across countries. To facilitate comparison, this Chapter uses the models from Turkey to estimate a Greek defence-growth relationship using a highly similar specification and sample periods to those employed in Chapters 4 and 5. This comparison is meaningful because Turkey and Greece are both members of NATO alliance, they both have a large armed forces relative to their population and their defence burdens are highest in the NATO. Due to data limitations, identical data series and sample period could not be used. The sample period for Greece is between 1958-1994 and population is proxied instead of the labour force.

6.5.1. Supply-side (Feder type) Analysis

6.5.1.1. The Model and Specifications

The model used in this section is extracted from Chapter 4. The model is developed by Feder (1983) for investigating export growth relationships but Ram (1986) redeveloped this model for analysing defence-growth relationship. The model used here is same as for Turkey

The econometric form of models used are:

(i) Two sector Feder model:

$$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\left(\frac{\delta}{1+\delta}+C_m\right)\frac{\Delta M}{Y} \tag{6.11}$$

(ii) With separate externality effect and factor productivity differentials of defence expenditure:

$$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\left(\frac{\delta}{1+\delta}-\theta\right)\frac{\Delta M}{Y}+\theta\frac{\Delta M}{M} \tag{6.12}$$

Human capital is not included in the equations because such data are not readily available for Greece. Definition of variables and predictions are as specified in Chapter 4.

6.5.1.2. Empirical Results

Equation 6.11 and 6.12 are estimated using OLS. Table 6.12 reports empirical results from the estimation of equation 6.11 and 6.12 using ordinary least squares (OLS) estimation methods. The results showed that the coefficient of investment is statistically significant and positive in both estimations. They are as expected, because economic growth of a developing country is mainly stimulated by its increasing capital stock. However, the coefficient on the labour force variable is not statistically significant. The reason for this could be that population may not be a good proxy for labour force. Total effect of defence spending represented in equation 6.11 and it is insignificant and also estimates of equation 6.12 gave insignificant results for defence size and defence externality variables. It implies that the defence sector has no important effect on economic growth in Greece. Factor productivity differentials between the defence sector and the rest of the economy are negative. It means the civilian sector is more productive than the military sector. The defence variables are insignificant for Greece, whereas, for Turkey, the defence variable is positive and significant. Turkey is at a relatively low stage of development when compared with Greece. Positive effects of defence spending mainly apply to LDCs, such as the creation of effective demand, enhancing human capital and the creation of the infrastructure. These might be reasons why positive relationships are found.

Table 6.12. Estimates of Equation 6.11 and 6.12

Dependent variable: Economic growth				
	Equation 11		Equation 12	
Independent variables	Coefficient	t statistics	Coefficient	t statistics
Constant	-0.13***	-3.35	-0.13***	-3.43
Investment	0.80***	4.75	0.81***	4.81
Labour Force	-1.56	-1.14	-1.63	-1.2
Defence size	1.29	1.55	-3.69	-0.79
Defence externality	-	-	0.23	1.09
Factor productivity Differential	-	-	-0.77	-
Diagnostic Statistics				
R^2	0.43		0.45	
DW	1.36		1.39	
F stat. (3, 33)	8.5082***	F stat. (4.32)	6.7218***	

* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level
The variables used in the estimation were measured as follows: Economic growth (ΔY/Y): Dependent variable of the model is measured as the annual rate of growth of output. In order to do this, the difference between current value of the real GNP and previous year real GNP is divided by the previous years real GNP. Labour force (ΔL/L): growth rate of labour force. Greece's population is proxied due to unavailability of labour force data. The growth rate is calculated as explained above. Investment (I/Y): Investment GNP ratio. Real gross fixed capital of Greece is divided by previous year's real GNP. Defence size (ΔM/Y): The difference of real military expenditure between current and previous years are divided by the previous year real GNP. Defence externality (ΔM/M): Real growth rate of defence expenditure. It is calculated as in the above variables.

In the estimation, the R^2s are relatively low. To investigate this problem, dummy variables are considered. Following Antonakis (1997), a trend variable is also be added into equation. Moreover, in July 1974, there was a Turkish military intervention in Cyprus. It greatly affected the Greek defence economy (Kollias, 1995) and from 1975, Greek defence expenditure increased substantially. Therefore, a Cyprus dummy should be included as well. Considering above discussions, equations 6.11 and 6.12 are re-estimated using trend and Cyprus dummy. The dummy took value of one between 1975 and 1981 and zero elsewhere. The results are also shown in Table 6.13. The first estimation (equation 6.11) included the trend variable. Addition of the trend gave significant and negative results; it improved the estimation results and the diagnostic statistics with higher R^2, but the defence variable remained insignificant. Secondly, both the Cyprus dummy and the trend variables were added into equation 6.11 then re-estimated and the results remained similar. While investment and the trend variable show significant and positive relationships with Greece economic growth, the Cyprus dummy and the defence variable are not statistically significant. It is evident that neither defence spending nor the Cyprus dummy is related to Greek economic growth. The Cyprus war caused an increase in Greek defence expenditure but Greek defence spending has no important effect on growth. Therefore, the dummy variable did not give significant results. The same procedure was employed with equation 6.12: this shows the separate defence size effect and externality effect of defence spending. Both defence variables are not statistically significant in all three estimations, but inclusion of a trend and the Cyprus dummy variables improved the diagnostic statistics (Table 6.13).

Table 6.13. Estimates of Equation 6.11 and 6.12 with Trend and Cyprus Dummy

Dependent variable: Economic growth				
	Equation 11	Equation 11	Equation 12	Equation 12
Constant	-0.04 (-1.02)	-0.06 (-1.29)	-0.05 (-1.11)	-0.06 (-1.31)
Investment	0.59 *** (3.43)	0.61*** (3.37)	0.60*** (3.49)	0.61*** (3.38)
Labour Force	-1.49 (-1.19)	-1.09 (-0.67)	-1.55 (-1.24)	-1.32 (-0.80)
Defence size	0.84 (1.08)	0.97 (1.14)	-3.06 (-0.72)	-2.80 (-0.62)
Defence externality	-	-	0.18 (0.93)	0.17 (0.85)
Cyprus dummy	-	-0.01 (-0.39)	-	-0.01 (-0.21)
Trend	-0.01*** (-2.75)	-0.01** (-2.44)	0.01** (2.64)	-0.01** (-2.40)
Factor productivity differential	-	-	-0.74	-0.72
R^2	0.54	0.54	0.55	0.55
DW	1.71	1.68	1.71	1.69
F statistic	9.553***	7.472***	7.787***	6.297***

t statistics in parentheses
* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level

For further investigation and to test reliability and robustness of the results, stationarity of the variables is tested. The same procedure used in Chapter 4 was employed. In Chapter 4, due to non-stationarity of variables, first differences of variables are employed for final versions of estimation and this method highly improved the empirical results for Turkey. Greek data was tested firstly for unit roots. The variables indeed showed unit roots and they became stationary after being first differenced (Table 6.14).

Table 6.14. Unit Root Tests in Levels and First Differences

Variable (x)		Unit Root in x [1]		Unit Root in Δx [1]	
		DF	ADF	DF	ADF
Growth		-5.06**	-5.0596**	-9.165**	-9.1653**
Investment		-3.437	-3.4374	-5.472**	-5.4720**
Labour		-3.477	-3.4769	-7.335**	-7.3351**
Defence size		-5.633**	-5.6330**	-9.315**	-9.3149**
Defence externality		-5.612**	-5.6122**	-9.399**	-9.3988**
Critical values	1%	-4.232	-3.623	-3.629	-3.629
	5%	-3.539	-2.945	-2.947	-2.947

The reported values are obtained from PC-Give 8.0 version by Doornik and Hendry, 1995. For calculated values intercept and trends are included in both DF and ADF equations for levels and intercept include for first differences.
[1]where x represents level of variables and Δx represents first differences of variables.
* significant at 5%
** significant at 1%

First differences of variables are re-estimated. The estimation results are shown in Table 6.15. The trend variable is omitted because after the first difference of variables, the trend does not exist, but a Cyprus dummy is included (the constant represents the trend). It can be seen from the Table that the results remained almost the same. Significant and positive results are obtained for investment but the defence variables and Cyprus dummy gave insignificant results in all four different estimations. Labour force is also insignificant. Labour force data rather than population for Greece is only available between 1965 and 1994. Using labour force data, the equations were estimated for these years, but no significant results were obtained. These results are represented in Appendix 6.2. Despite all the different estimations, no significant results were obtained for defence spending. **It suggests that Greece defence spending has no important effect on its economic growth.** In this estimation, diagnostic test results are not very satisfactory, the R^2's are very low and the DW tests are very high indicating possible auto-correlation.

Table 6.15 Estimates of Equations with First Differences of Variables

Dependent variable: Economic growth (1959-1994) First Difference				
	Equation 11	Equation 11	Equation 12	Equation 12
Constant	-0.02 (-0.01)	-0.01 (-0.04)	-0.01 (-0.01)	0.01 (-0.59)
Investment (first diff.)	0.82*** (3.60)	0.81*** (3.53)	0.81*** (3.53)	0.81 (3.47)***
Labour Force (first diff.)	1.70 (1.19)	1.68 (1.16)	1.55 (1.01)	1.52 (0.97)
Defence size (first diff.)	0.84 (1.26)	0.84 (1.23)	-0.21 (-0.06)	-0.28 (-0.07)
Defence externality (first diff.)	-	-	0.05 (0.29)	0.05 (0.30)
Cyprus dummy	-	0.01 (0.09)	-	0.01 (0.12)
Factor productivity differential	-	-	-0.13	-0.18
R^2	0.32	0.32	0.32	0.32
DW	2.88	2.87	2.87	2.87
F statistic	5.086***	3.698**	3.728**	2.891**

t statistics in parentheses
* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level

Because of insufficient tests statistics, an alternative estimation was performed (Table 6.16) using only first difference of investment and labour variables. Yet only these two variables were non-stationary in level (see Table 6.14). After estimation, the results remained almost the same. Coefficient of the investment variable is positive and significant and defence variables are insignificant. Moreover, the R^2's are improved and DW test statistics indicates no sign of auto-correlation.

Table 6.16 Estimates of Equations with First Differences of Investment and Labour Force Variables

Dependent variable: Economic growth		
	Equation 11	Equation 12
Constant	0.09 (8.23)***	0.09 (8.03)***
Investment(first diff.)	0.48 (2.57)***	0.49 (2.55)***
Labour (first diff.)	1.80 (1.53)	2.03 (1.51)
Defence size	0.25 (0.33)	2.01 (0.42)
Defence externality	-	-0.08 (-0.37)
Trend	-0.01 (-4.91)***	-0.01 (-4.85)***
R^2	0.55	0.56
DW	1.54	1.51
F statistic	9.84***	7.68***

t statistics in parentheses
* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level

Finally, Greece defence-growth association is estimated using four different versions of previously used Feder model. The results are presented in Table 6.17: the investment parameter is significantly positive in almost all cases and labour force gave an insignificant result in all type of estimations. Defence parameters (the size and externality) are not statistically significant in any cases. No significant effect of defence spending on Greece's economic growth is supported by four different types of estimations. It is clearly seen from these estimation that while investment is major determinants of Greek economic growth, the labour force and defence sector have no important effects on growth.

Table 6.17 Estimation Results of Four Different Versions of Feder Model for Greece

Dependent variable: Economic growth				
	Biswas and Ram (1986)	Ward *et al.* (1991)	Ward and Davis (1992)	Alexander (1991)
Constant	-0.12*** (-3.00)	283.27** (2.13)	-0.12*** (-3.35)	-0.13*** (-3.18)
Investment	0.76 (4.39)***	-0.008 (-0.10)	0.72*** (4.32)	0.79*** (4.45)
Labour	-1.61 (-1.15)	0.06 (0.05)	-0.91 (-0.66)	-1.60 (-1.10)
Defence size effects	0.85 (1.45)	-5.37 (-0.83)	-5.11 (-0.75)	0.55 (0.74)
Defence externality	-	0.90 (0.92)	0.97 (0.99)	-
Government size effects	-	0.02 (0.01)	-4.04 (-1.46)	0.40 (0.58)
Government externality	-	-0.02 (-0.05)	0.69* (1.70)	-
Effect of export		-	-	0.04 (0.10)

t statistics in parentheses
* t statistics significant at the 0.10 level
** t statistics significant at the 0.05 level
*** t statistics significant at the 0.01 level

The econometric form of previously used some important Feder models are:

Biswas and Ram (1986): $$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\left(\frac{\delta}{1+\delta}+C_m\right)\frac{\Delta M}{M}\frac{M}{Y}+\varepsilon$$

Ward et al. (1991): $$\Delta Y=\alpha_0+\alpha_1 I+\beta\frac{Y}{L}\Delta L+\left(\frac{\delta_m}{1+\delta_m}-\theta_m\right)\Delta M+\theta_m\frac{\Delta M}{G}Y+\left(\frac{\delta_n}{1+\delta_n}-\theta_n\right)\Delta N+\theta_n\frac{\Delta N}{G}Y+\varepsilon$$

Ward-Davis (1992): $$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\left(\frac{\delta_m}{1+\delta_m}-\theta_m\right)\frac{\Delta M}{Y}+\theta_m\frac{\Delta M}{G}+\left(\frac{\delta_n}{1+\delta_n}-\theta_n\right)\frac{\Delta N}{Y}+\theta_n\frac{\Delta N}{G}+\varepsilon$$

Alexander (1991): $$\frac{\Delta Y}{Y}=\alpha_0+\alpha_1\frac{I}{Y}+\beta\frac{\Delta L}{L}+\left(\frac{\delta_n}{1+\delta_n}+B_n\right)\frac{\Delta N}{N}\frac{N}{Y}+\left(\frac{\delta_m}{1+\delta_m}+B_m\right)\frac{\Delta M}{M}\frac{M}{Y}+\left(\frac{\delta_x}{1+\delta_x}+B_x\right)\frac{\Delta X}{X}\frac{X}{Y}+\varepsilon$$

The variables used in the previous estimations were measured as follows:
Economic growth ($\Delta Y/Y$): Dependent variable of the model is measured as the annual rate of growth of output. In order to do this, the difference between current value of real GNP and previous year real GNP is divided by the previous years real GNP. Labour Force ($\Delta L/L$): growth rate of labour force. Population growth rate of Greece were proxied. Investment (I/Y): Investment GNP ratio. Real gross fixed capital of Greece is divided by previous year's real GNP. Defence size ($\Delta M/Y$): The difference of real military

expenditure between current and previous years are divided by the previous year real GNP. Defence externality ($\Delta M/M$): Real growth rate of defence expenditure. It is calculated same as above variables. ΔY: Difference between current year GNP and previous year GNP. ΔL: Difference between current year population and previous year population. ΔM: Difference between current year defence spending and previous year defence spending. ΔN: Difference between current year non-defence government spending and previous year non-defence government spending. $\Delta M/G$: ΔM divided by previous year total government spending . $\Delta N/G$: ΔN divided by previous year total government spending. ΔY: Difference between current year GNP and previous year GNP. $\Delta X/Y$: Share of export in GNP. $[(\Delta X/X)*(X/Y)]$: Growth rates of export multiply by share of export in GNP.

When these results are compared with Turkey's (Chapter 4), the investment variable is positive and significant both in Turkey and Greece. While the labour force has a positive impact on Turkish economic growth, the variable is insignificant for Greece. For Turkey, labour force data are used but due to the unavailability of labour force data, Greece's population is proxied, so this may be the reason why the labour force is insignificant for Greece. Turning to defence variables, the total effect of defence spending is positive for Turkey and externalities from the defence sector to the rest of the economy are negative. The effects are insignificant for Greece. This implies that while Turkish military expenditure stimulates its economic growth, Greece defence spending has no important effect on Greece's economy. **The results also suggest that the effect of defence spending differs across countries.** Turkey and Greece are very similar in many ways (high defence burden, similar security concern, similar defence industrial base and large armed forces). Components of defence spending in these two countries are different. While Greece spends more for military personnel, Turkey spends more for equipment. Turkish military is heavily involved in health, education and infrastructure (see Chapter 7).

Furthermore, the Feder model generally gives a small positive effect of defence spending or no significant effect of defence spending on economic growth. To obtain robust results of the Greek defence-growth relationships, the analysis should be performed using alternative methods and models. Turkish defence-growth relationships were firstly analysed with Feder model then secondly, the Deger model was used for analysing Turkish defence-growth relationships in Chapters 4 and 5. Both analyses showed that Turkish defence spending is positively correlated to its economic growth. The same method will be employed for Greece. The next section will analyse Greek defence-growth relationships with an alternative model.

6.5.2. Demand and Supply-side (Deger type) Analysis

6.5.2.1. The Model and Specifications

The results reported thus far all are based on various version of the Feder type model. To study whether these results are model-invariant, this sub-section runs the data through a Deger type model, essentially the same one used for the analysis of Turkey. Both model types showed that Turkish defence spending is positively related to its economic growth. The results for Greece are presented below.

The equations for this analysis are constructed as follows[19]:

$$Y=a_0+a_1S+a_2M+a_3B+a_4P \quad \textbf{(6.13)}$$

$$S=b_0+b_1M+b_2Y+b_3B+b_4INFRT \quad \textbf{(6.14)}$$

$$B=c_0+c_1Y+c_2M+c_3EXCRT \quad \textbf{(6.15)}$$

$$M=d_0+d_1PCI+d_2DUMCYP+d_3TUR_{-1}+d_4NATO_{-1} \quad \textbf{(6.16)}$$

19 The model and its variables are extensively explained in Chapter 5.

Definition of variables and predictions are as specified in Chapter 5. Equation 6.13 is the same as Chapter 5 but for Greece, population is proxied for labour force. For saving, the same equation is constructed. In the balance of trade equation, dummy variables are excluded because they were related to Turkish economy and finally, the defence equation is the same as in the previous Chapter.

6.5.2.2. Empirical Results

Table 6.19 reports the estimates for the equation system (6.13 to6.16) using OLS, 2SLS and 3SLS estimation techniques. The approach is similar to that used in Chapter 5. Firstly, the variables are tested for unit roots and due to non-stationarity, all the variables first differenced and they became stationary after being first differenced (Table 6.18).

Table 6.18. Unit Root Tests in Levels and First Differences

Variable (x)		Unit Root in x [1]		Unit Root in Δx [1]	
		DF	ADF	DF	ADF
Y		-1.539	-0.299	-5.189**	-5.188**
S		-1.96	-1.583	-6.328**	-6.328**
B		-1.522	-3.986*	-6.732**	-6.731**
M		-1.324	-0.913	-5.724**	–5.724**
P		0.342	-1.303	-3.482**	-3.481*
INFRT		-2.56	-2.942	-6.922**	-6.922**
PCI		-2.392	-0.015	-4.106**	-4.106**
TUR		-3.147*	-3.100	-4.888**	-4.888**
NATO		-0.500	-2.999	-6.16**	-6.159**
Critical values	1%	-3.623	-4.232	-3.629	-3.629
	5%	-2.945	-3.539	-2.947	-2.947

The reported values are obtained from PC-Give 8.0 version by Doornik and Hendry, 1995. For calculated values intercept and trends are included in both DF and ADF equations for levels and intercept include for first differences.
[1]where x represents level of variables and Δx represents first differences of variables.
Y is GDP, S is gross domestic savings, B is balance of trade, M is defence expenditure, P is population, INFRT is annual inflation rate, PCI is per capita income, TUR is Turkish defence burden and NATO is average NATO defence burden excluding Turkey and Greece.
* significant at 5%
** significant at 1%

The estimation results in Table 6.19 show that in equation (6.13), the saving and defence variables are positively correlated to economic growth. These results are consistent with the previous Chapter. In Chapter 5, the estimated results showed that Turkish economic growth is stimulated by its savings and its defence spending. These results apply for Greece. On the other hand, balance of trade as a proxy of capital inflows from abroad and population as a proxy of labour force showed insignificant results. It may be that they are not very good proxies. Three different estimations (OLS, 2SLS, 3SLS) showed very similar results. The second equation in this analysis is the saving equation (6.14) that Greece's gross savings are positively correlated to its income. However, savings are negatively correlated with its defence expenditure. Balance of trade and inflation variables did not give significant results. When these results are compared with Turkey's, Turkish defence spending showed no significant effect on its saving. However, the effect is negative and statistically significant for Greece. It implies that increasing defence expenditure in Greece will cause lower savings level, hence lower investment (crowding-out). The results are not so different in the three types of estimation. The third equation balance of trade (6.15) did not give any significant results. The R^2 is very low (0.12) and no variables seem significant. The main reason for this may be inaccurate data. For balance of trade, both exports of goods and services in national accounts minus imports of goods and services in national accounts and merchandise exports minus merchandise imports are proxied. Both proxies gave very similar results. In Chapter 5, Turkish balance of trade is mainly affected by its exchange rate and its income but for Greece, these variables are not significant. The results were not expected. Because of fixed exchange rate regimes of many LDCs, balance of trade data are not very accurate for time series.

The final equation in this estimation is the defence equation (6.16). The same equation used in Chapter 5 is estimated and only the Cyprus dummy gave significant results in 2SLS and 3SLS estimation. It showed Cyprus war caused an increasing trend in Greece defence spending. The dummy took a value of one between 1975-1981 and zero elsewhere. Although the results of growth and the saving equation are acceptable, the results of balance of trade and defence equations are weak and their diagnostic tests are not satisfactory. They exhibit a very low R^2.

Table 6.19. Estimation Results

	Exogenous variables	OLS	2SLS	3SLS
Growth equation	Constant	241.33 (4.63)***	242.19 (3.47)***	218.66 (6.02)***
	ΔS	0.95 (7.78)***	1.24 (7.99)***	1.23 (10.61)***
	ΔB	-0.06 (0.70)	-0.01 (-0.02)	-0.09 (-0.31)
	ΔM	1.20 (2.58)**	1.99 (2.84)***	2.47 (3.86)***
	ΔP	5.58 (0.07)	212.01 (-0.21)	30.06 (0.09)
	Diagnostic tests	R^2: 0.66	σ: 171.92	σ: 181.57
		DW: 1.33		
Saving equation	Constant	-137.5 (-4.46)***	-162.30 (-4.42)***	-178.23 (-5.55)***
	ΔM	-0.96 (2.28)**	-2.78 (-2.68)**	-2.12 (3.79)***
	ΔB	0.02 (0.20)	-0.04 (-0.19)	0.02 (0.11)
	ΔY	0.63 (7.60)***	0.75 (7.45)***	0.81 (10.71)***
	ΔINF	-1.77 (0.61)	-5.88 (-1.11)	0.01 (0.01)
	Diagnostic tests	R^2: 0.68	σ: 142.92	σ: 149.54
		DW: 1.99		
Balance of trade equation	Constant	-5.97 (-0.16)	-1.18 (-0.02)	-0.69 (-0.01)
	ΔY	-0.06 (-0.73)	-0.09 (-0.73)	-0.09 (-0.78)
	ΔM	-0.70 (-1.72)*	-0.26 (-0.35)	-0.15 (-0.21)
	ΔEXRT	-0.16 (-0.21)	-0.21 (-0.20)	-0.20 (-0.19)
	Diagnostic tests	R^2: 0.12	σ: 183.13	σ: 183.33
		DW: 2.49		
Defence equation	Constant	1.13 (0.07)	1.13 (0.07)	-3.00 (-0.20)
	ΔPCI	0.18 (0.54)	0.18 (0.55)	0.24 (0.75)
	ΔTUR_{-1}	2.40 (0.11)	2.40 (0.11)	-0.80 (-0.04)
	$\Delta NATO_{-1}$	53.20 (0.71)	53.20 (0.74)	19.07 (0.26)
	DUMCYP	52.78 (2.09)	52.78 (2.12)**	56.29 (2.34)**
	Diagnostic tests	R^2: 0.17	σ: 57.53	σ: 57.85
		DW: 2.01		

t statistics in the parenthesis

For 2SLS estimation; loglik= -748.13 T= 36 and LR test of over-identifying restrictions: $Chi^2(21)$ = 300.97 [0.0000]; For 3SLS estimation: loglik= -736.07 T= 36 and LR test of over-identifying restrictions: $Chi^2(21)$ = 276.85 [0.0000]

The variables were measured as follows: ΔY= real gross national product (first difference); ΔS= real gross saving (first difference); ΔB= real balance of trade (first difference); ΔM= Real defence expenditure (first difference); ΔP= Population growth (first difference); ΔPCI= Per capita income (first difference); ΔEXRT= Real exchange rate (first difference); ΔTUR_{-1}= Lagged Turkish military expenditures as a share of GDP (first difference); $\Delta NATO_{-1}$= Lagged average shares of defence burden of NATO countries (excluding Greece and Turkey) (first difference); DUMCYP= Dummy variable took value of one for the years 1975 to 1981 and zero elsewhere; Notes: All computations in this study have been carried out by PC-GIVE 8.0 and PC-FIML 8.0 (See Doornik and Hendry, 1994; 1995)

In the defence equation, the lagged variables ΔTUR_{-1} and $\Delta NATO_{-1}$ gave insignificant results, the variables were positive and significant for Turkey. It may be well that Greek defence spending does not react with a lag to Turkish defence spending but instead reacts instantaneously. Therefore the equation system was re-run replacing the lagged variable ΔTUR_{-1} and $\Delta NATO_{-1}$ with ΔTUR and $\Delta NATO$. The results are shown in Table 6.20. The first three equations gave very similar results with improving diagnostic tests. In the growth equation, coefficient of saving and defence are positive and significant. In the saving equation, coefficient of defence is negative and significant but output is positively correlated. Poor results for the balance of trade equation remained. The empirical results of defence equation are highly improved. ΔTUR variable is positively correlated to Greece defence spending. It suggests that Greece instantly responds to the Turkish defence spending. Greece defence spending is determined by its income, Turkey's defence spending, and Cyprus war (Table 6.20).

Table 6.20. Estimation Results

	Exogenous variables	OLS	2SLS	3SLS
Growth equation	Constant	241.33 (4.63)***	236.16 (3.43)***	220.87 (5.15)***
	ΔS	0.95 (7.78)***	1.26 (7.91)***	1.25 (8.50)***
	ΔB	-0.06 (0.70)	-0.04 (-0.08)	0.01 (0.01)
	ΔM	1.20 (2.58)**	2.08 (2.49)**	2.41 (3.41)***
	ΔP	5.58 (0.07)	-249.96 (-0.26)	-46.94 (-0.10)
	Diagnostic tests	R^2: 0.66 DW: 1.33	σ: 175.24	σ: 180.78
Saving equation	Constant	-137.5 (-4.46)***	-160.73 (-4.07)***	-174.09 (-4.66)***
	ΔM	-0.96 (2.28)**	-2.81 (-2.60)**	-1.99 (-2.54)**
	ΔB	0.02 (0.20)	-0.24 (-0.61)	-0.18 (-0.50)
	ΔY	0.63 (7.60)***	0.76 (6.86)***	0.78 (7.67)***
	ΔINF	-1.77 (0.61)	-9.12 (1.46)	1.27 (0.42)
	Diagnostic tests	R^2: 0.68 DW: 1.99	σ: 156.72	σ: 150.19
Balance of trade equation	Constant	-5.97 (-0.16)	-6.82 (-0.18)	-9.64 (-0.26)
	ΔY	-0.06 (-0.73)	-0.65 (-1.13)	-0.63 (-1.12)
	ΔM	-0.70 (-1.72)*	-0.06 (-0.73)	-0.06 (-0.71)
	ΔEXRT	-0.16 (-0.21)	-0.19 (-0.24)	-0.28 (-0.39)
	Diagnostic tests	R^2: 0.12 DW: 2.49	σ: 135.53	σ: 135.59
Defence equation	Constant	-2.98 (-0.26)	-1.01 (-0.09)	-2.58 (-0.24)
	ΔPCI	0.48 (1.79)*	0.40 (1.47)	0.53 (2.00)**
	ΔTUR	54.77 (3.29)***	54.28 (3.30)***	45.00 (2.93)***
	ΔNATO	123.92 (1.87)*	101.4 (1.64)	134.92 (2.43)**
	DUMCYP	39.76 (1.98)**	40.0 (2.00)**	42.24 (2.39)**
	Diagnostic tests	R^2: 0.47 DW: 2.26	σ: 45.95	σ: 46.39

t statistics in the parenthesis
For 2SLS estimation; loglik= -817.88 = 37 and LR test of over-identifying restrictions: $Chi^2(13)$ = 421.61
[0.0000]; For 3SLS estimation; loglik= -790.57 T= 37 and LR test of over-identifying restrictions: $Chi^2(13)$
= 366.99 [0.0000]

The variables were measured as follows: ΔY= real gross national product (first difference); ΔS= real gross saving (first difference); ΔB= real balance of trade (first difference); ΔM= Real defence expenditure (first difference); ΔP= Population growth (first difference); ΔPCI= Per capita income (first difference); ΔEXRT= Real exchange rate (first difference); ΔINFRT= Inflation rate (first difference); ΔTUR= Turkish military expenditures as a share of GDP (first difference); ΔNATO= Average share of defence burden of NATO countries (excluding Greece and Turkey) (first difference); DUMCYP= Dummy variable took value of 1 for the years 1975 to 1981 and zero elsewhere; Notes: All computations in this study have been carried out by PC-GIVE 8.0 and PC-FIML 8.0 (See Doornik and Hendry, 1994; 1995)

Balance of trade equation gave inaccurate results. Therefore, in final estimation, this equation is omitted and the results are presented in Table 6.21. The results suggest that Greek economic growth is positively affected by its gross savings and defence expenditure and Greek gross savings are negatively affected by its defence expenditure. Major determinants of Greece defence spending are its income level and Turkish defence expenditure. Greece response to Turkish defence spending is instant with no lag.

In this model, the multiplier of military expenditure on growth can be calculated as:

$$\frac{\partial Y}{\partial M}=\frac{a_1 b_1+a_2}{1-a_1 b_2}=\frac{(0.95)*(-0.96)+1.20}{1-(0.95*0.63)}=0.71 \qquad \textbf{(6.17)}$$

The multiplier is positive, suggesting that the net effect of Greek defence expenditure is positive in this model and estimation (the multiplier for Turkey is 0.92).

Table 6.21. Estimation Results

	Exogenous variables	OLS	2SLS	3SLS
Growth equation	Constant	241.33 (4.63)***	244.89 (3.75)***	204.65 (5.34)***
	ΔS	0.95 (7.78)***	1.29 (7.80)***	1.26 (7.82)***
	ΔB	-0.06 (0.70)	0.05 (0.28)	-0.04 (-0.26)
	ΔM	1.20 (2.58)**	2.35 (3.14)***	2.27 (3.11)***
	ΔP	5.58 (0.07)	-416.47 (-0.45)	211.48 (0.58)
	Diagnostic tests	R^2: 0.66 DW: 1.33	σ: 185.26	σ: 183.01
Saving Equation	Constant	-137.5 (-4.46)***	-159.49 (-4.00)***	-173.48 (-4.58)***
	ΔM	-0.96 (2.28)**	-2.83 (-3.02)***	-2.00 (2.85)***
	ΔB	0.02 (0.20)	-0.06 (-0.44)	0.04 (0.38)
	ΔY	0.63 (7.60)***	0.78 (6.91)***	0.80 (7.39)***
	ΔINF	-1.77 (0.61)	-9.36 (-1.60)	-1.05 (-0.38)
	Diagnostic tests	R^2: 0.68 DW: 1.99	σ: 158.70	σ: 146.88
Defence equation	Constant	-2.98 (-0.26)	-1.99 (-0.19)	-3.45 (-0.34)
	ΔPCI	0.48 (1.79)*	0.45 (1.75)*	0.54 (2.18)**
	ΔTUR	54.77 (3.29)***	34.93 (2.02)**	30.96 (2.33)**
	ΔNATO	123.92 (1.87)*	92.70 (1.61)	115.03 (2.68)**
	DUMCYP	39.76 (1.98)**	38.98 (2.09)**	41.54 (2.82)***
	Diagnostic tests	R^2: 0.47 DW: 2.26	σ: 41.88	σ: 43.25

t statistics in the parenthesis
For 2SLS estimation; loglik= -620.57 T= 37 and LR test of over-identifying restrictions: $Chi^2(8)$ = 371.95 [0.0000]; For 3SLS estimation; loglik= -538.03 T= 37 and LR test of over-identifying restrictions: $Chi^2(8)$ = 206.87 [0.0000]
The variables were measured as follows: ΔY= real gross national product (first difference); ΔS= real gross saving (first difference); ΔB= real balance of trade (first difference); ΔM= Real defence expenditure (first difference); ΔP= Population growth (first difference); ΔPCI= Per capita income (first difference); ΔINFRT= Inflation rate (first difference); ΔTUR= Turkish military expenditures as a share of GDP (first difference); ΔNATO= Average share of defence burden of NATO countries (excluding Greece and Turkey) (first difference); DUMCYP= Dummy variable took value of 1 for the years 1975 to 1981 and zero elsewhere; Notes: All computations in this study have been carried out by PC-GIVE 8.0 and PC-FIML 8.0 (See Doornik and Hendry, 1994; 1995)

6.5.2.3. Some Results from Cointegration Analysis

In Chapter 5, some results from an error correction mechanism were presented to show the long-run and short-run solutions. To test the reliability of the results and to make a similar comparative study, the same analysis was carried out for Greece. The equation used for Deger type analysis are re-estimatiod using Engle-Granger (1987) mechanism. It is shown in Table 6.14 that the variables are non-stationary in level and stationary when they are first differenced.

Table 6.22 The Engle-Granger First Stage (Long-run) Estimation for Growth Equation

	Constant	S	B	M	P	Trend
Y	2861.2	1.133***	-0.189	1.662***	-157.69	260.40***
t statistics	0.827	10.435	-0.998	5.106	-0.371	8.945
Statistics						
R^2	0.99		F statistics		3427 (0000)	
ADF	-3.515***		DF		3.811***	

Y is GDP, S is gross domestic savings, B is balance of trade, M is defence expenditure, P is population,
* significant at 10%
** significant at 5%
*** significant at 1%

Engle-Granger suggest the two step procedure for cointegration analysis. Firstly, a long-run relationship is estimated (Table 6.22). In this Table, DF and ADF test results indicate that cointegration exists. In the long run, savings and defence spending affect economic growth positively and balance of trade and population did not show any significant results.

The second stage of Engle-Granger mechanism is to estimate first differences of variables using first lag of the residuals. The results are shown in Table 6.23, and are similar. Savings and defence spending are positively correlated to economic growth. In the short run, balance of trade gave negative and statistically significant result. RES_{t-1} gave a negative and significant result, as expected. The findings are consistent with 2SLS and 3SLS findings.

Table 6.23. The Engle-Granger Second Stage (Short-run and ECM) Estimation for Growth Equation

Dependent Variable ΔY			
Explanatory Variables	Coefficient	t statistics	probability
Constant	187.26***	4.21	0.00
ΔS	0.89***	9.67	0.00
ΔB	-0.27**	-2.15	0.03
ΔM	1.07***	3.04	0.00
ΔP	1028.2	1.63	0.11
RES_{t-1}	-0.66***	-4.43	0.00
Summary Statistics			
R^2	0.81	SE	119.40
DW	1.41	F (5, 30)	25.936 ***

Where Δ represents first differences of variables. Y is GDP, S is gross domestic savings, B is balance of trade, M is defence expenditure, P is population, and RES_{t-1} is Residuals from cointegrating regression. L represents natural logarithms and Δ represents first differences of variables.
* significant at 10%
** significant at 5%
*** significant at 1%

The same procedure was used for the saving equation. In the long-run Greek defence spending has a negative effect on its gross domestic savings. The effect is the same in the short run. It implies that Greek defence spending is harmful for its savings. The residuals are also negative and significant as expected. The saving equation results are also consistent with 2SLS and 3SLS findings (Table 6.24 and 6.25).

Table 6.24. The Engle-Granger First Stage (Long-run) Estimation for Saving Equation

	Constant	Y	B	M	INFRT	Trend
S	-1070.7***	0.72***	0.15	-0.92***	1.69	-180.9***
t statistics	-7.16	11.58	1.06	-3.43	0.42	-10.27
Statistics						
R^2	0.95		F statistics	121.6*** (000)		
DF	-4.292***		ADF	-3.844***		

Where Y is GDP, S is gross domestic savings, B is balance of trade, M is defence expenditure, INFRT is annual inflation rate.
* significant at 10%
** significant at 5%
*** significant at 1%

Table 6.25. The Engle-Granger Second Stage (Short-run and ECM) Estimation for Saving Equation

Dependent Variable ΔS			
Explanatory Variables	Coefficient	t statistics	probability
Constant	-199.48***	-6.88	0.00
ΔY	0.81***	10.59	0.00
ΔB	0.14	1.33	0.19
ΔM	-0.80**	-2.14	0.04
ΔINFRT	4.07	1.23	0.22
RES_{t-1}	-0.69***	-4.16	0.00
Summary Statistics			
R^2	0.80	SE	107.84
DW	1.60	F (5, 30)	24.822***

Where Δ represents first differences of variables. Y is GDP, S is gross domestic savings. B is balance of trade, M is defence expenditure, INFRT is annual inflation rate and RES_{t-1} is residuals from cointegrating regression. L represents natural logarithms and Δ represents first differences of variables.
* significant at 10%
** significant at 5%
*** significant at 1%

Finally, cointegration analysis is used on the defence equation. The results showed that cointegration exists (Table 6.26). In the long run, the determinants of Greek defence spending are per capita income, average NATO defence spending and the Cyprus conflict. Turkish defence spending seems an insignificant determinant of Greek defence spending in the long run (see Table 6.26).

Table 6.26. The Engle-Granger First Stage (Long-run) Estimation for Defence Equation

	Constant	PCI	TUR	NATO	CYP	Trend
M	-2150.3	0.77	7.65	410.69	94.55	15.56
t statistics	-4.89***	4.05***	0.29	4.87***	1.95*	2.59**
Statistics						
R^2	0.93		F statistics		84.315 (0000)	
DF	-3.031***		ADF		-2.931***	
ADF	-2.931***					

Where Y is GDP, M is defence expenditure, PCI is per capita income, TUR is Turkish defence burden and NATO is average NATO defence burden excluding Turkey and Greece, CYP is Cyprus dummy.
* significant at 10%
** significant at 5%
*** significant at 1%

The short-run dynamics of Greece defence spending are represented in Table 6.27. In the short-run, Greek defence spending is determined by its income, Turkey's defence spending, average NATO defence spending and the Cyprus conflict. The results are very similar to the long-run but the difference is that Turkish defence spending positively affects Greek defence spending in the short run, but not in the long run.

In general the evidence from cointegrating regressions are consistent with findings of 2SLS and 3SLS estimation. They support the general findings of this study.

Table 6.27. The Engle-Granger Second Stage (Short-run and ECM) Estimation for Defence Equation

Dependent Variable ΔM			
Explanatory Variables	Coefficient	t statistics	probability
Constant	-0.17	-0.16	0.98
ΔPCI	0.45*	1.65	0.10
ΔTUR	46.16***	2.84	0.00
ΔNATO	149.97**	2.35	0.02
ΔCYP	37.39*	1.95	0.06
RES_{t-1}	-0.26**	2.14	0.03
Summary Statistics			
R^2	0.54	SE	44.10
DW	2.09	F (5, 30)	7.1303***

Where Δ represents first differences of variables. M is defence expenditure, PCI is per capita income, TUR is Turkish defence burden and NATO is average NATO defence burden excluding Turkey and Greece, CYP is Cyprus dummy and RES_{t-1} is residuals from cointegrating regression.
* significant at 10%
** significant at 5%
*** significant at 1%

The results for Turkey and Greece are shown in Table 6.28. While both models suggest a positive effect of defence spending on Turkish economic growth, the results for Greece are inconclusive. Interestingly, the Feder model did not give any significant results for Greece. A Feder model only considers the supply-side of an economy. Supply side considerations might be less important for the Greek defence sector which is based on arms imports. On the other hand, on the demand side, the Greek defence sector showed a positive effect on economic growth.

Table 6.28. Comparative Results

		Greece	Turkey
Feder Model	Effect of defence size on growth	Insignificant	Positive
	Externality effect of defence on growth	Insignificant	Negative
Deger Model	Effect of defence spending on growth	Positive	Positive
	Effect of defence spending on saving	Negative	Insignificant
	Effect of defence spending on balance of trade	-	Insignificant
	Determinants of defence spending	•Per capita income •Turkish defence expenditure •Cyprus war	•Per capita income •Greek defence expenditure •The conflict with PKK •Cyprus war

6.6. Conclusions

This Chapter briefly surveyed the Greece economy and intensively investigated its defence-growth relationship. The results were compared to Chapter 4 and Chapter 5 for Turkey. To ease comparison, in both cases Feder type models (supply-side) and Deger type (demand and supply-side) were used for the time period 1958-1994.

Various conclusions may be drawn. Both Greece and Turkey carry high defence burdens and both use large conscripted armed forces. Both began to establish an indigenous arms industry at a similar time. Even so, both are major arms importers and only minor arms exporters. But with respect to the economic impact of military spending on their respective economies, the countries differ significantly.

The estimation with a supply side model showed that Greek defence expenditure has no significant impact on its economic growth. Defence size and externality effects are non-significant. However, like Turkey, the factor productivity differential is negative implying the defence sector is less productive in the Greece economy.

But when a Deger type demand and supply-side model is estimated, the results are different. They suggest that Greek defence spending has a statistically significant positive direct effect on economic growth but an indirect and statistically significant negative effect on gross savings. The net effect is positive. The estimated model also suggest that the major determinants of Greek defence spending are its per capita income, contemporaneous rather than lagged, Turkey defence spending, the Cyprus War in 1974, as well as NATO's military expenditure.

In sum, the empirical evidence suggests that the defence-growth relation for Greece is inconclusive. While the Feder type model suggests no significant trade-off between defence spending and growth, the Deger type model suggests a positive net effect of defence spending on economic growth for Greece. The results are different when different models are used. Estimation with a demand and supply-side (Deger type) model suggest that Greece defence spending has a significant positive direct effect on economic growth and a significant negative indirect effect on gross savings. The calculated multiplier showed that the net effect is positive. The models also suggest that the major determinants of Greece defence spending are its income, Turkish defence spending and NATO's average expenditures. Cyprus disputes also positively affected Greece defence spending.

The evidence from cointegration analysis are consistent with the findings of Deger type analysis.

Finally, the effect of defence spending differs across the countries even when the countries are very similar, as in the case of Turkey and Greece are similar (defence burden, economic structure, threat, defence industrial base). Very similar time perods and same models were deliberately used to estimate Greece's and Turkey's defence-growth trade-offs in this Chapter and in Chapters 4 and 5. Although Turkey's defence sector appears to stimulate economic growth, the results are inconclusive for Greece.

In this study, Greece was used as a reference point and comparator for the results from Turkey. The aim was to see if the Turkey results generalise to similar countries. This Chapter has shown that they do not.

CHAPTER 7

CHAPTER 7

A DISAGGREGATED ANALYSIS OF DEFENCE EXPENDITURE AND ECONOMIC GROWTH: A COINTEGRATION ANALYSIS

7.1. Introduction

So far, the study has discussed how total defence spending affects economic growth. However, the effects of sub-components of defence expenditure were not considered separately. Defence spending was accepted as homogeneous spending. In this Chapter, the relationship between economic growth and defence spending is analysed using disaggregated defence expenditure data- an approach which has not been used in the literature. **The main aim of this Chapter is to check the robustness of the estimates and to make a further original contribution by testing for the effects of sub-components of defence spending on economic growth.**

This Chapter also shows how defence equipment spending affects economic growth across two countries. Previous Chapters showed that the defence spending of each country (Greece and Turkey) has a different effect on their economic growth. The defence data of NATO countries show how defence expenditure is allocated between equipment, personnel, infrastructure and other operational inputs (capital and labour). Personnel and other operational expenditures dominate defence budgets (an average of 72.6% for Turkey and 75.2% for Greece for 1990-1994: Table 7.1). Equipment spending is also an important component of defence spending. This spending includes R&D spending in the NATO classification. The composition of defence spending in Turkey and Greece is different. This might cause different impacts on economic growth because of different capital-labour ratios, combination of military manpower, the impact of each countries' defence industrial base (including R&D, technology) and arms imports capacity. The different components of defence expenditure are likely to have different impacts on a nation's growth rate.

The plan of this Chapter is as follows. In section 7.2. disaggregated data and its availability are described. In section 7.3. the model and methodology is discussed. Sections 7.4 and 7.5 are devoted to empirical analysis. Section 7.6 discusses the findings and the last section 7.7 presents conclusions.

7.2. Disaggregated Data

Defence expenditure can affect the economy through a number of channels because defence expenditure includes different types of spending. They are personnel spending, equipment spending (include R&D), infrastructural spending and other operational spending. NATO publishes disaggregated defence data for its member countries showing four types of defence spending (equipment, personnel, infrastructure, other). However, the data set have limitations. Firstly, the four groups of data are only available after 1985. Between 1975 and 1985, NATO published percentage of defence equipment in total defence spending. Non-equipment defence spending as a whole can be calculated from these data. Although NATO publishes an average of four year data (such as 1970-1974, 1975-179), these data are not available on annual basis. Annual equipment spending data for Greece are available from

1977. Table 7.1 shows a brief disaggregated data for Turkey and Greece[20]. The disaggregated data do not show the proportion of equipment spending which goes to arms imports. This might be important for determining the effect of disaggregated defence spending on economic growth, but the data are not available.

Table 7.1. Disaggregated Defence Expenditure Data for Turkey and Greece

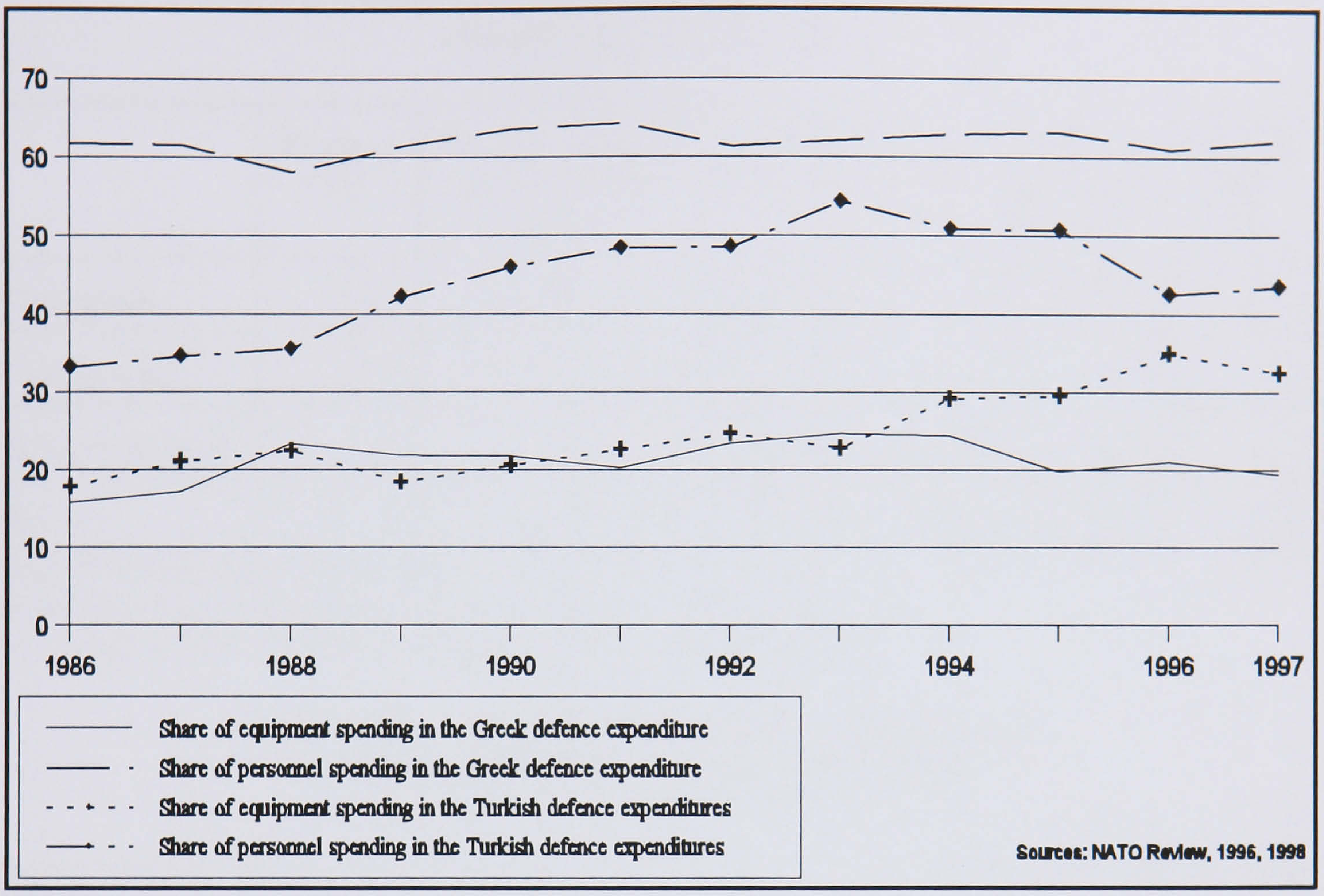
Period	Equipment %		Personnel %		Infrastructure %		Other %	
	Turkey	*Greece*	*Turkey*	*Greece*	*Turkey*	*Greece*	*Turkey*	*Greece*
Average 1975-79	19.2	19.3	47.6	57.6	7.3	5.3	23.7	17.0
Average 1980-84	9.1	17.4	45.3	54.6	13.2	2.8	30.1	24.9
Average 1985-89	18.2	18.2	37.1	60.5	5.4	2.2	38.4	18.4
Average 1990-94	23.7	22.8	50.1	63.0	3.0	1.7	22.5	12.2
1986	17.9	15.8	33.3	61.8	6.1	1.9	42.6	20.5
1987	21.2	17.2	34.7	61.7	5.9	1.9	38.3	19.2
1988	22.5	23.3	35.6	58.2	4.5	2.3	37.5	16.1
1989	18.5	21.9	42.3	61.5	4.0	2.6	35.2	14.0
1990	20.7	21.8	46.1	63.7	3.4	3.3	29.8	11.2
1991	22.7	20.3	48.5	64.4	2.8	1.7	26.0	13.6
1992	24.8	23.4	48.7	61.4	3.5	2.4	23.0	12.8
1993	22.9	24.7	54.5	62.2	2.9	2.6	19.7	10.5
1994	29.3	24.4	51.0	63.0	2.6	0.6	17.1	12.0
1995	29.7	19.8	50.9	63.3	2.5	1.9	16.9	14.9
1996	35.1	21.1	42.7	61.2	2.6	1.5	19.6	16.2
1997[e]	32.6	19.4	43.7	62.2	3.0	2.1	20.7	16.2

NATO Review; Spring, 1998; January, 1996
[e]:estimate
Note: R&D expenditure are included in equipment expenditures

[20] Appendix 7.1. provide full data set used in this Chapter

Table 7.1 and Figure 7.1 illustrates the distribution of defence expenditure in Turkey and Greece. It can be seen from the Table that in both countries, the majority of the defence spending goes to personnel. In 1997, 43.7% of Turkey's defence spending was for personnel and this figure is even higher for Greece (62.2%). On the other hand, equipment spending figures for Turkey were 32.6% and 19.4% for Greece. The trend over the time is similar. The share figures might reflect the relatively low cost of military personnel in Turkey (differences in definitions are a further possibility but this is unlikely for NATO data). Turkey's equipment spending and also equipment shares are higher than Greece's while Greek defence personnel spending is always higher than Turkey. Figure 7.1 shows that Turkish defence equipment spending represents an increasing trend between 1986-1997. Spending on personnel in Turkey shows an increasing trend until 1996. A decreasing trend can be seen from infrastructural spending over the years. It is as expected, because the need for infrastructure is likely to decrease when countries are developed. Other operational spending also shows a decreasing trend. It shows that personnel and equipment spending became more important in total defence spending, because higher technology causes higher spending on equipment and needs skilled personnel, so causing an increase in personnel spending.

Figure 7.1. Trends of Turkish and Greek Defence Equipment and Personnel Spending



Source: NATO Review, 1996; 1998

To see the a broad picture of disaggregated data, the whole of NATO and some other NATO countries' distributed defence expenditure are presented in Table 7.2 and Figure 7.2. They show that personnel shares dominates all countries defence budget and while Turkish figures on personnel is lowest of the group, the figure is the highest for Portugal (77.3%). Equipment spending shares are the higher in Greece and Turkey when compared with all other NATO nations. Other operational expenditure of Turkey is much higher than Greece, Spain, Italy, Portugal and NATO Europe average but the same as all NATO average because of USA's higher operational expenditures. Turkey is out of line with others in respect to personnel spending. Wage payments are low in Turkey when compared to other NATO nations. This might be main reason for low personnel spending. On the other hand, equipment spending figures are relatively high for Turkey and Greece.

Table 7.2. Comparative Disaggregated Defence Expenditure (An average of 1990-1994)

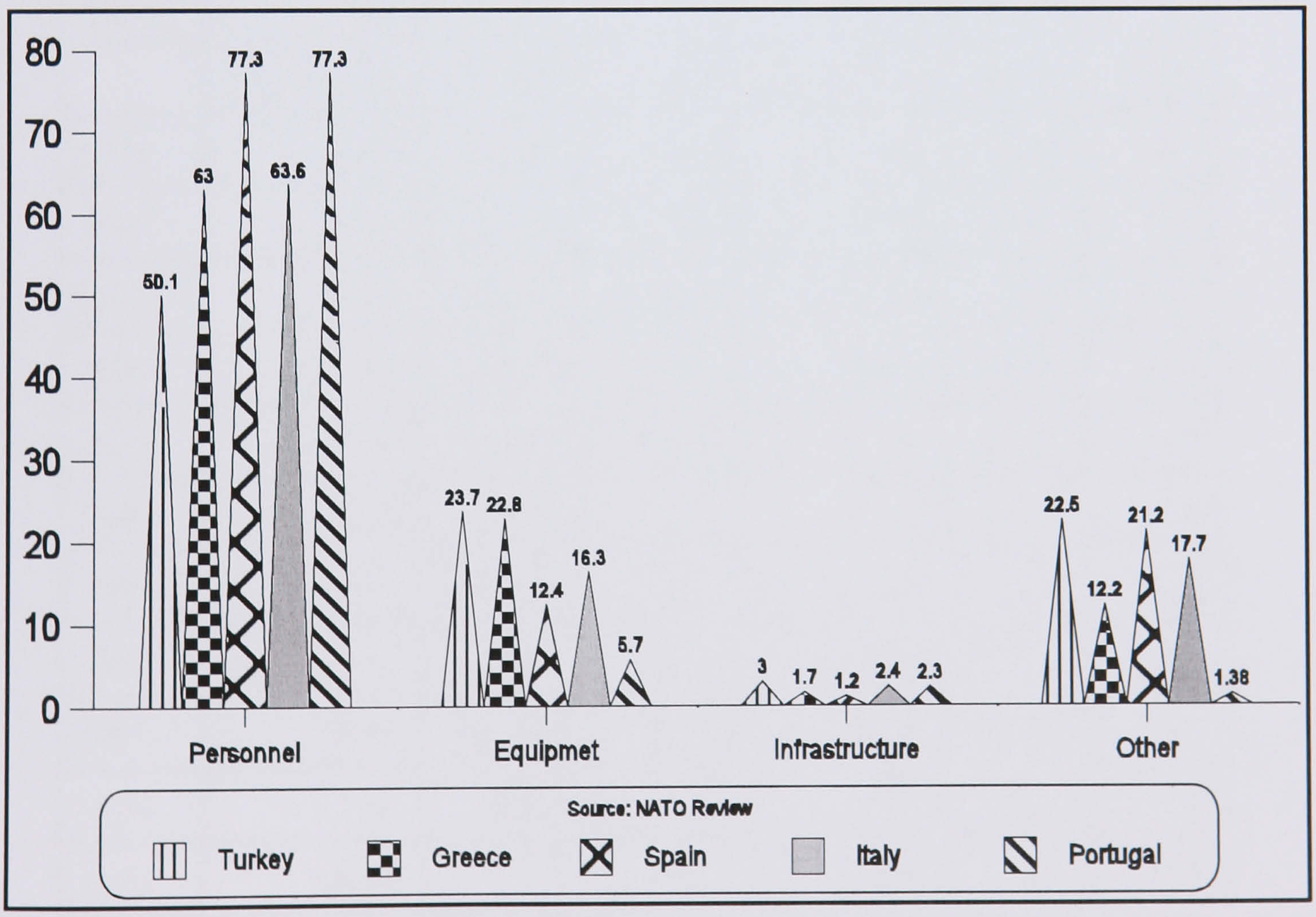
	Turkey (%)	Greece (%)	Spain (%)	Italy (%)	Portugal (%)	NATO[1] Europe (%)	NATO[2] All (%)
Personnel	50.1	63.0	64.9	63.6	77.3	60.5	57.8
Equipment	23.7	22.8	12.4	16.3	5.7	13.6	15.0
Infrastructure	3.0	1.7	1.2	2.4	2.3	4.7	4.3
Other	22.5	12.2	21.2	17.7	13.8	20.7	22.5

Source: NATO Review, 1996, 1998

[1]An average of NATO Europe countries excluding Turkey and Greece

[2] An average of whole NATO countries excluding Turkey and Greece

Figure 7.2. Comparative Share of Disaggregated Defence Spending (Average 1990-1994)



Source: NATO Review

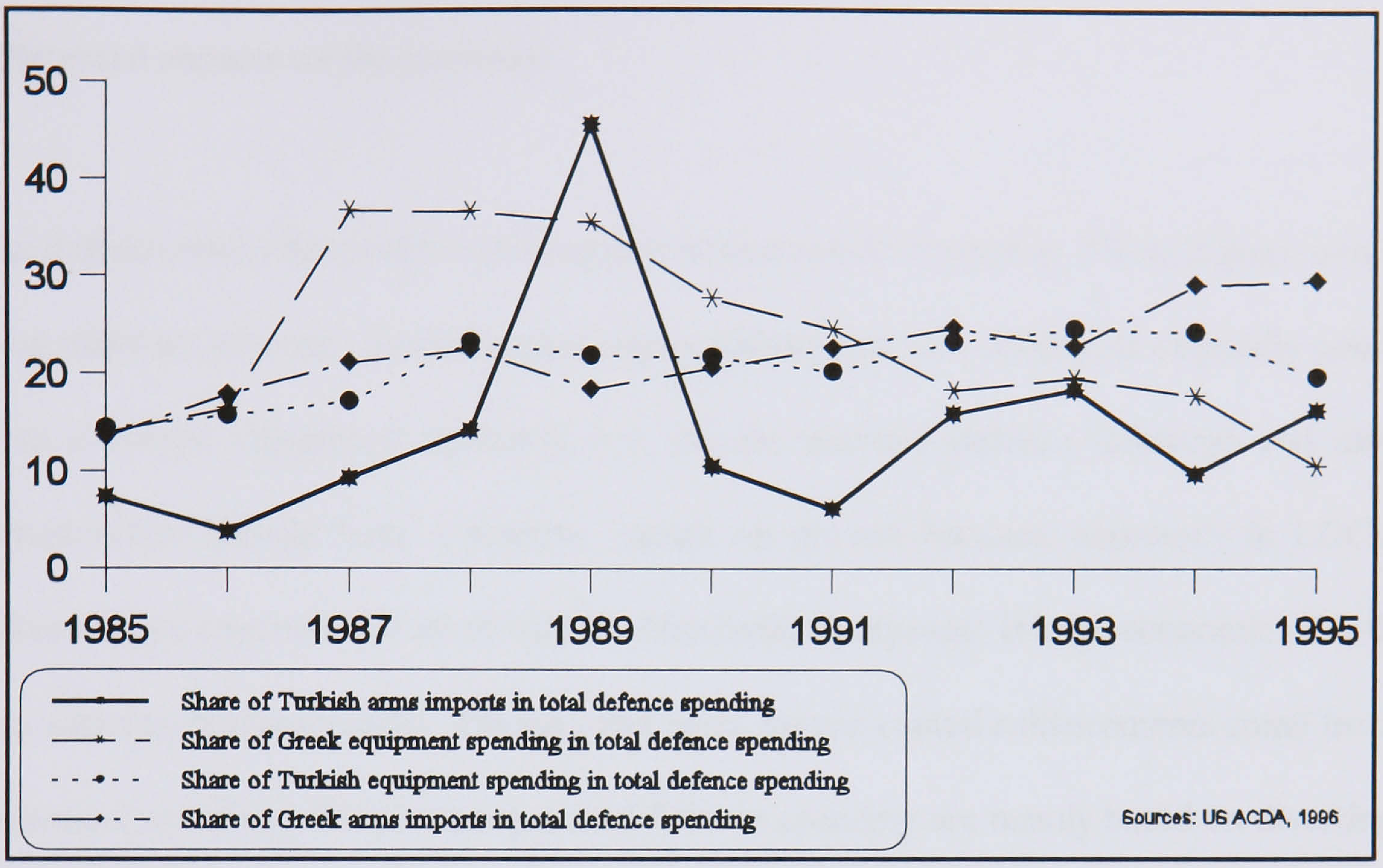
The other important feature of defence spending is the proportion of defence equipment spending which goes to arms imports. This would show the real figures for domestic arms production; but there are no available data showing the proportion of equipment spending which goes to arms imports. However, comparison of spending on equipment and on arms import might give some ideas. Table 7.3 and Figure 7.3 show the trend of Turkish and Greek arms imports share in total defence spending and in the share of defence equipment spending. There appears to be no direct relation between arms imports and equipment spending. However, except for 1989, there is a parallel trend between them for Greece but the trend is not valid for Turkey. The calculated correlation coefficient of arms imports and equipment spending were 0.21 for Turkey and 0.63 for Greece.

Table 7.3. Share of Arms Imports in Total Defence Spending

YEAR	TURKEY (%)			GREECE (%)		
	US ACDA	SIPRI	EQU	US ACDA	SIPRI	EQU
1985	14.03	24.48	13.6	7.43	5.21	14.5
1986	16.49	22.40	17.9	3.76	4.95	15.8
1987	36.78	43.56	21.2	9.32	2.96	17.2
1988	35.65	46.47	22.5	14.21	25.46	23.3
1989	35.56	41.77	18.5	47.58	55.17	21.9
1990	27.80	19.59	20.7	10.53	31.61	21.8
1991	24.65	17.46	22.7	6.21	15.51	20.3
1992	18.41	28.54	24.8	15.98	71.74	23.4
1993	19.67	35.89	22.9	18.39	23.71	24.7
1994	17.84	34.59	29.3	9.77	25.75	24.4
1995	10.60	-	29.7	16.32	-	19.8

Sources: US ACDA, 1996; SIPRI yearbooks
US ACDA: Share of arms imports in total defence spending using US ACDA data
SIPRI: Share of arms imports in total defence spending using SIPRI data
EQU: Share of equipment in total defence budget

Figure 7.3. Trends of Arms Imports and Equipment Spending in Turkey and Greece (%)



Sources: US ACDA, 1996

This Chapter makes a valuable and original contribution to the defence-growth issue in several respects. First, the relationships are analysed using disaggregated data; secondly, this study employs the recent econometric technique of error correction mechanisms. Thirdly, in respect of defence spending, two very similar countries are compared: once again, to see whether the results can be generalised across countries (see Chapter 6).

7.3. The Model and Methodology

This study focuses on the relationship between the disaggregated defence spending (equipment and non-equipment) and economic growth in Turkey and in Greece. Empirical analysis of the economic effect of defence spending faces inevitable difficulties (Kollias, 1995; 16-18). These difficulties are even greater when disaggregated defence data are used. There are a number of channels through which defence spending may influence the performance of the economy. However, this Chapter explores the hypothesis that equipment, personnel, infrastructure and other operational expenditure spending have differential impacts on the economy.

The defence sector has positive and negative impacts on the economy. These impacts come from different sources. Technological improvements and spin-off effects originally come from domestic equipment spending (*i.e.* on the national defence industry) and also infrastructure should have a positive impact on growth because, especially in LDCs, infrastructure expenditures are mostly used for civilian purposes. It helps economic growth (*eg*. airports, bridges, roads). On the other hand, human capital enhancements come from personnel spending. Negative impacts of defence spending are mainly based on diverting resources from other sectors to defence with the defence sector being less productive[21]. For the estimation, real values are produced using total defence spending and share of defence equipment and personnel spending. Then real level values are used rather than share variables. For single country analysis, real values give better results (see Chapter2). Given those, this study modelled economic growth as:

$$Y=\alpha_0+\alpha_1 I+\alpha_2 L+\alpha_3 M+u_t \tag{7.1}$$

where Y is real gross domestic product, α_0 is the intercept, I is fixed capital formation, L is civilian employed labour force, M is real defence spending and u_t is residual term. For a disaggregated analysis, (M) defence spending is divided into equipment expenditure, personnel spending, infrastructure and other operational expenditures (NATO classification). Equipment spending includes R&D as there are no available separate R&D data. The model

21 See Chapter 4

then is as follows;

$$Y=\alpha_0+\alpha_1 I+\alpha_2 L+\alpha_3 EQU+\alpha_4 PER+\alpha_5 INFR+\alpha_6 OTH+\alpha_7 u_t \qquad \textbf{(7.2)}$$

Where, EQU is real defence equipment spending, PER is real defence personnel spending, INFR is defence infrastructure spending and OTH is other operational defence spending. The annual data for this classification are available for a limited time period (1985-1996), but between 1975-1996, annual equipment spending data are available. Then, the equation can be rearranged as equipment spending and non-equipment defence spending (equation 7.3).

$$Y=\alpha_0+\alpha_1 I+\alpha_2 L+\alpha_3 EQU+\alpha_4 NEQU+u_t \qquad \textbf{(7.3)}$$

where NEQU is non-equipment defence spending.

Then, the study hypothesised from the model (equation 7.3) that investment and labour force variables are positively related to economic growth[22]. Equipment spending in the defence budget should affect economic growth positively. This spending includes R&D spending. R&D spending may have a useful application for the civilian sector and also direct technological effect and spin-off may help economic growth. However, if countries' equipment spending mainly goes to overseas purchases, these effect should be small. Greece and Turkey are major arms importer countries. High arms imports may lead to an adverse balance of payments. Therefore, the positive effect of equipment spending could be very low, but Turkey's defence industrial base is more developed than Greece. Turkey produces F-16 fighter aircraft and many other equipment (see Chapter 3). Therefore, the positive effect for Turkey should be higher. On the other hand, all this spending may inhibit

[22] Hypothesises for investment and labour force are given in Chapter 4

economic growth, if the spending diverts resources from more productive public and private civil investment. Non-equipment defence spending is not a homogeneous variable because it includes personnel spending and other operational spending. Personnel spending affects economies through human capital enhancements and training activities. These expenditures can promote economic growth especially in LDCs (by providing training and education to a segment of the population: Benoit, 1978). Personnel spending affects economic growth negatively if the military forces divert the labour force from the civilian sector to defence. This can be the case for Greece because of lack of labour force but it is not the case for Turkey. Turkey has experienced a high unemployment rates for a long time. While non-equipment spending should be positive for Turkey, this effect seems ambiguous for Greece.

The study applies integration and cointegration analysis after Engle and Granger (1987). It has been shown (Granger, 1986; Engle, Granger, 1987) that if two variable Y_t and Y_{t-1} are integrated of the same order I (1) then any linear combination of these series $\mu_t=X_t-\alpha Y_t$ may be I (0). It become apparent that u_t is the "equilibrium error" that measures the deviations from the equilibrium and may itself be stationary. The error correction variable in a short-run dynamic relationship measures the proportion of the disequilibrium from one period that is corrected in the next period.

Testing for the stability of the relationship involves testing for stationarity of the residuals of the cointegrating regression. Before this is done, stationarity of the variables must be tested. This is accomplished by testing the hypothesis of a unit root in each variable of the equation in levels and in first differences. The study employs the same methodology for Turkish and Greek defence-growth relationships.

7.4. Empirical Analysis of Disaggregated Turkish Defence Expenditure

In this part, the effect of Turkish defence equipment spending on economic growth is tested empirically. The annual data series of four different types of defence expenditures (equipment, personnel, infrastructure, other operational) are only available between 1985-1995. This data series was used for OLS estimation and they did not give satisfactory results. Cointegration methodology were not been used because of very short time series of data. The results are presented in the Appendix A7.2.2. This study use a small sample of 21 observations which means that the results are at best suggestive rather than conclusive[23].

The first step of the estimation is to determine the order of integration of the series. Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests were used to test whether variables were stationary or needed to be differenced. The number of times series need to be differenced is given by the order of the integration- *i.e.* if the variable is integrated of the order of 1, it will be differenced once. All test results were compared with the critical values. With respect to critical values, Table 7.4. indicates that, all the variables are I (1) at 1% and 5% significance levels in DF and ADF tests with the exception of labour. This variable is I(2), and because of the small sample properties, the labour force can be treated I (1) at the 10% significance level.

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[23] Data sources are given in Chapter 2 and data are provided in Appendix 7

Table 7.4. Turkey: Unit Root Tests in Levels and First Differences (1975-1996)

Variable (x)		Unit Root in x [1] DF	Unit Root in x [1] ADF	Unit Root in Δx [1] DF	Unit Root in Δx [1] ADF
LY		-2.037	-2.012	-5.390**	-3.626**
LI		-2.380	-3.609	-3.782*	-3.193*
LL		-0.461	-2.859	-2.527	–2.376
LEQU		-1.967	-3.339	-3.407*	-3.212*
LNEQU		-2.190	-2.611	-4.172**	-4.805**
Critical values	1%	-4.469	-4.500	-3.807	-3.830
	5%	-3.645	-3.659	-3.020	-3.029

The reported values are obtained from PC-Give 8.0 version by Doornik and Hendry, 1995. For calculated values intercept and trends are included in both DF and ADF equations for levels and intercept include for first differences.

[1]where x represents level of variables and Δx represents first differences of variables.

Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.

* significant at 5%

** significant at 1%

Like the earlier tests of each variable for unit roots, the formal test for a cointegration relationship requires the application of the DF and ADF tests for the residuals. These tests are shown in Table 7.5 and 7.6, respectively. The residual based DF test and ADF test results appear to support stable, genuine long run relationships- *i.e.* cointegration exists among the variables involved. The rejection of the non-cointegration hypothesis show that imposed relationship is a valid cointegrating vector.

Table 7.5. Turkey: DF Test from Error-Correction Model

Cointegrating regressions	Calculated DF	Critical values	
		1%	5%
LY=f(LI, LL, LEQU, LNEQU, TREND)	-4.008**	-2.682	-1.958

The reported critical values are taken from PC-Give 8.0 versions. The intercept term is not included in the ECM DF equation
Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.
* significant at 5%
** significant at 1%

Table 7.6. Turkey: ADF Test from Error-Correction Model

Cointegrating regressions	Calculated DF	Critical values	
		1%	5%
LY=f(LI, LL, LEQU, LNEQU, TREND)	-3.761**	-2.689	-1.959

The reported critical values are taken from PC-Give 8.0 version. The intercept term is not included in the ECM ADF equation
Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.
* significant at 5%
** significant at 1%

After analysing the stationarity of the variables, the Engle-Granger two step procedure was applied to the Turkish data. The first step is the estimation of a long-run cointegrating relationships using the levels of the variables of equation (7.3). Evidence of cointegration includes critically a significant DF test on the residuals, high R^2 and significant t statistics of the coefficients. The long-run estimation enabled us to decide whether or not the variables in the levels equation are cointegrated (Table 7.7)[24]. In this estimation, Turkish economic growth is positively affected by its investment, labour force and defence equipment spending in the long run. The results are consistent with expectations. The positive effect of defence

24 Estimation with only equipment spending or non-equipment defence spending is presented in Appendix A7.2.1. The results are similar.

equipment spending might come from new developing defence industrial base and from technological improvements in the defence sector (eg. producing F-16 combat aircraft: see Table 7.7).

Table 7.7 Turkey: Results for Cointegrating Regression 1975-1996

	Constant	LI	LL	LEQU	LNEQU	Trend
LY	-0.25	0.10*	0.90*	0.03*	0.01	0.02**
t statistics	-0.03	1.84	1.88	1.92	0.01	2.07

Statistics			
R^2	0.99	F statistics(5, 16)	500.29 (0.000)
AR 1-2F (2, 14)	1.601 (0.2343)	DF	-4.008***
DW	2.44	ADF	-3.761***

Where Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.
* significant at 10%
** significant at 5%
*** significant at 1%

The second stage of the Engle and Granger (short-run) estimation is shown in Table 7.8. The validity of the RES_{t-1} specification requires the existence of a long-run relationship or cointegration between the variables. The error correction terms are significant at 1% and have the expected negative signs. Investment variable is as expected positive and significant. The labour variable is insignificant in the short run. Defence equipment and non-equipment defence spending gave insignificant results for Turkey. When the results of long run and short run are compared, the coefficients of non-equipment defence spending are insignificant in both estimations. This implies that Turkish personnel and other operational expenditure do not have any important effect on Turkish economic growth over the period 1975-1996. This result was not expected but non-equipment defence spending is not an homogeneous variable. This might cause a bias in the results. On the other hand, the coefficient of equipment spending is positive and significant in the long run and insignificant in the short run. Equipment spending provides technological improvements and spin-off in the long run. Turkey's new developing defence industry seems to have a positive impact on its economic growth in the long run. The overall goodness of fit of the error correction specification to defence-growth data is satisfactory in terms of R^2 and the statistical tests reported in Table 7.8.

Table 7.8. Turkey: Dynamic Short-run Effects of Turkish Disaggregated Defence Spending

Dependent Variable ΔY (1976-1996)			
Explanatory Variables	Coefficient	t statistics	probability
Constant	0.02**	2.69	0.01
ΔLI	0.09***	2.03	0.05
ΔLL	0.47	0.98	0.33
ΔLEQU	0.01	0.04	0.96
ΔLNEQU	0.05	0.88	0.39
RES_{t-1}	-1.04***	-4.33	0.00
Summary Statistics		Diagnostic	
R^2	0.75	AR 1- 2F(2, 13)	0.220
DW	2.09	ARCH 1 F(1, 14)	0.507
SE	0.021	NORM $chi^2(2)$	3.473
F (5,15)	8.9456	Xi^2 F(10, 4)	1.069
		RESET F(1, 14)	0.288

Where Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending, NEQU is non-equipment defence spending, and RES is Residuals from cointegrating regression. L represents natural logarithms and Δ represents first differences of variables.
* significant at 10%
** significant at 5%
*** significant at 1%

7.5. Empirical Analysis of Disaggregated Greek Defence Expenditure

The same procedure for the Turkish data was followed for estimating the effect of defence equipment spending and non-equipment defence spending on Greek economic growth. Once again, Greece is a comparator to determine whether the results can be generalised between similar countries.

The visual inspection of the variables (i.e. LY, LI, LEQU, LNEQU) showed that they are all stationary in levels and stationary in first differences. The study then applied the Dickey-Fuller (DF) test and Augmented Dickey Fuller (ADF) test for unit roots as a formal test. It can be seen from Table 7.9 that the hypothesis of unit root in LY, LI, LL, LEQU and LNEQU cannot be rejected at 1% and 5% significance level both in DF and ADF tests. The only exception is LEQU. The variable seems stationary in DF tests but non-stationary in ADF tests. When all variables are first differenced, they become stationary in both DF and ADF tests. It means the variables I(1) but the LL variable is I(2). However, the result also supports the general conclusion of the variables being non-stationary.

Table 7.9. Greece: Unit Root Tests in Levels and First Differences (1977-1996)

Variable (x)		Unit Root in x[1]		Unit Root in Δx[1]	
		DF	ADF	DF	ADF
LY		-2.3369	-2.4386	-4.0215**	-3.6771*
LI		-1.8948	-2.3555	-3.6352*	-3.0778*
LL		-2.2813	-3.0642	-2.4161	-1.7504
LEQU		-3.7336*	-3.5833	-5.1803**	-4.2393**
LNEQU		-1.9238	-1.7664	-4.3147**	-2.9722
Critical values	1%	-4.535	-4.574	-3.857	3.888
	5%	-3.675	-3.692	-3.04	3.052

The reported values are obtained from PC-Give 8.0 version by Doornik and Hendry, 1995. For calculated values intercept and trends are included in both DF and ADF equations for levels and intercept include for first differences.

[1]where x represents level of variables and Δx represents first differences of variables.

Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.

* significant at 5%

** significant at 1%

The study employed the residual-based DF and ADF tests. The results showed that although cointegration does exist in DF test, the null hypothesis of non-cointegration cannot be rejected in the ADF tests for Greece (Table 7.10; Table 7.11).

Table 7.10. Greece: DF Test from Error-Correction Model (1977-1996)

Cointegrating regressions	Calculated DF	Critical values	
		1%	5%
LY=f(LI, LL, LEQU, LNEQU, TREND)	-2.98**	-2.697	-1.96

The reported critical values are taken from PC-Give 8.0 versions. The intercept term is not included in the ECM DF equation
Where Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.
* significant at 5%
** significant at 1%

Table 7.11. Greece: ADF Test from Error-Correction Model (1977-1996)

Cointegrating regressions	Calculated DF	Critical values	
		1%	5%
LY=f(LI, LL, LEQU, LNEQU, TREND)	-1.299	-1.961	-2.706

The reported critical values are taken from PC-Give 8.0 versions. The intercept term is not included in the ECM ADF equation
Where Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.
* significant at 5%
** significant at 1%

The next step is to estimate long-run relationships. The results for cointegrating regression are shown in Table 7.12. In this estimation, investment (LI) is statistically significant and positive. The capital stock is its main factor of production. The empirical result of long-run relationship showed that labour force is not significant. The short time series might be the reason for this result. The results for defence equipment spending (LEQU) and non-defence equipment spending (NLEQU) are statistically insignificant. This implies that Greek equipment spending has no important impact on its economic growth. It might be that Greece has a relatively smaller defence industrial base and its imports of defence equipment are higher than Turkey. It is also noted that the time trend (trend) variable involved the equation 7.3, with a positive and significant coefficient. It reflects changes in technology and it promotes economic growth.

Table 7.12. Greece: Results for Cointegrating Regression 1977-1996

	Constant	LI	LL	LEQU	LNEQU	Trend
LY	1.843	0.234***	0.758	-0.016	0.074	0.010***
t statistics	0.496	4.873	1.438	-0.473	1.554	3.062
Statistics						
R^2	0.98		F (5, 14)		165.44 (0.000)	
AR 1-2F (2, 12)	1.5035 (0.2614)		DW		-2.98***	
DW	1.38		DF		-1.299	

Where Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.
* significant at 10%
** significant at 5%
*** significant at 1%

The last stage of cointegration methodology is to estimate the dynamic short run effect of Greek defence expenditure using error correction terms (Table 7.13). In this estimation, the error correction coefficient (RES_{t-1}) has the expected negative sign and is statistically significant. The coefficient of the ΔLI and ΔLL are consistent with expectations and enter into our dynamic short-run regression with a positive sign. The result for Greek defence equipment spending is negative and significant in the short run. Greece is a major arms importer country in the world. Defence equipment mainly comes from overseas purchases. This might cause a balance of payment problems so inhibiting economic growth. Non-equipment defence spending has a positive and significant effect in the short run. This result is not as predicted. The reason for this result might be higher personnel spending stimulates aggregate demand in the Greek economy.

Table 7.13. Greece: Dynamic Short-run Effects of Greek Disaggregated Defence Spending (1977-1996)

Dependent Variable ΔY			
Explanatory Variables	Coefficient	t statistics	probability
Constant	0.007	1.268	0.22
ΔLI	0.218***	5.377	0.00
ΔLL	1.362*	1.890	0.08
ΔLEQU	-0.042*	-1.733	0.10
ΔLNEQU	0.099**	2.492	0.02
RES_{t-1}	-0.63**	-2.249	0.04
Summary Statistics		Diagnostic	
R^2	0.72	AR 1- 2F(2, 11)	0.10585
DW	1.87	ARCH 1 F(1, 11)	0.41946
SE	0.012	NORM $chi^2(2)$	4.2551
F (5,13)	6.9145	Xi^2 F(10, 2)	0.0848
		RESET F(1, 11)	1.9902

Where Y is GDP. I is gross fixed investment, L is labour, EQU is defence equipment spending, NEQU is non-equipment defence spending, and RES is Residuals from cointegrating regression. L represents natural logarithms and Δ represents first differences of variables.
* significant at 10%
** significant at 5%
*** significant at 1%

The results obtained from the two countries differ. While Turkey's disaggregated defence data show no important effect on growth in the short run, the results for Greece are different. Greek defence equipment spending negatively effects its economic growth and non-equipment defence spending has a positive impact on economic growth in the short run. In the long run, Turkey's defence equipment spending showed a positive and significant impact on Turkish economic growth while non-equipment defence spending has no important effects. The long run results for Greece disaggregated defence spending did not give any significant results (Table 7.14).

The positive effect of defence equipment spending for Turkey implies that its developing defence industry helps its economic growth and the negative coefficient of defence equipment spending for Greece (short run) implies that high proportion of arms imports are harmful for the Greek economy.

Table 7.14. Comparison of the Results

	Long-run		Short-run	
	LEQU	**LNEQU**	**ΔLEQU**	**ΔNLEQU**
Turkey	Positive significant	Positive insignificant	Positive insignificant	Positive insignificant
Greece	Positive insignificant	Positive insignificant	Negative significant	Positive significant

7.6. Conclusions

This Chapter investigated the disaggregated defence expenditures effects on economic growth in an error correction context for two countries. While Greece spends higher proportion of its defence budget on personnel, Turkey spends a relatively low proportion on defence personnel. The empirical results showed that the effects of disaggregated defence expenditure for each country are different and the results also differ between the long run and short run. For Turkey, equipment spending has a positive impact on economic growth in the long run but there is no important impact in the short run. For Greece, equipment spending has no important impact in the long run and the effect is negative in the short run, suggesting that arms imports creates balance of payments problems for Greece and hence retards the Greek economy.

Non-equipment defence spending did not show any important effect in either the short run or long run for Turkey. It suggests Turkey's personnel and other operational expenditures are not harmful to economic growth. However, non-equipment defence spending affects the Greek economy positively in the short run. Greek defence personnel spending might stimulate aggregate demand. Because of non-availability of long enough time series data, the study used shorter time series. Therefore, the results should be treated with caution.

CHAPTER 8

CHAPTER 8

CONCLUSIONS AND PROPOSALS FOR FUTURE RESEARCH

8.1. Summary and Conclusions

This Chapter summarises the results of the earlier Chapters and reaches some broader conclusions. The main purpose of this study has been to explore the relationship between defence spending and economic growth for Turkey. The central hypothesis of the thesis was Turkish defence spending should have a positive impact on its economic growth. The main motivation of the thesis was the lack of single country analysis in this area.

Following Benoit's (1973) path breaking study, many researchers have analysed the issue, but most of the studies have used cross sectional analysis. Single country analysis of any defence-growth relationship has been neglected. The other motivation of this thesis was trend of Turkish defence expenditure and its economic growth. Turkey has achieved considerably high economic growth with a high defence burden. Turkey is a member of NATO and constantly allocates substantially high budgets to its defence sector compared with other NATO nations and the role of the military in Turkey is very important (politically and economically). For comparative purposes, the relationship between Greek defence expenditures and economic growth was analysed for the period 1958-1994. Greece and Turkey have many similarities. Both countries have a high defence burden and both are members of NATO. They started to produce their own military equipment after the 1980s. So Greece was included to test the robustness of the results obtained for Turkey (*i.e.* to see whether the results for Turkey can be generalised across similar countries).

Chapter 2 reviewed alternative approaches to defence-growth relationships. It also reviewed some important empirical defence-growth studies and data problems were discussed. The previous studies showed that there is no consensus among the findings. Mainly, three types of methods were used, namely, Feder type (supply-side) models, Deger type (demand and supply-side) models and Granger causality tests. The majority of the Deger type models found a negative effect of defence spending on economic growth, while the Feder type models have either a small positive impact of defence spending or have no significant impact on economic growth. The classification into developed countries and LDCs did not show any clear results. Moreover, causality studies have not reached any consensus. The Feder model offers much scope for empirical study. It considers externalities among sectors; it may explain the size effect of defence spending and also factor productivity differentials between the defence and civilian sectors; but it focuses on the supply-side only. Therefore, it tends to a give positive effect of defence spending. On the other hand, Deger type model consider both the supply and demand sides. Nevertheless, this model also has some shortcomings. Firstly, the theoretical derivation of the equation is unclear and *ad hoc* and it is very sensitive to specification errors. Granger causality is not an answer to defence-growth relationships. It is a test for exogenity of the defence variable. This thesis focused initially on Feder type supply-side model; then to test for robustness and for the reliability of the results, a Deger type model, Granger causality and error correction models were introduced into the analysis. Data sources and problems were also presented and discussed in Chapter 2.

Trends in Turkish defence expenditure and economic growth, the Turkish armed forces, its defence industry and its modernisation were analysed in Chapter 3 (Turkey's military-industrial complex). The growth rate of the Turkish economy has shown dramatic fluctuations over time although the average rate is rather high and Turkish defence expenditure has also shown an increasing trend. Despite the fact that many countries have started to cut the size of their armies, the Turkish army has not shown any decreasing trends and it remains one of the largest armed forced in the world (ranked 6th in 1995: US ACDA,1996). Moreover, Turkey is a major arms importing country: its arms imports ranked 8th in 1996 (US ACDA, 1997). Turkey has also established a domestic defence industry and now produces its own fighter aircraft (F-16); and the shipbuilding industry and military electronics industry have been developed; but, so far it has not led to lower arms imports nor to higher arms exports.

Chapter 4 of the study presents a model to test for the Turkish defence-growth relationships. This Chapter argued that Turkish defence spending has an important effect on its economic growth. A Feder type supply-side model was used to test for the size effect of defence spending and for any externalities from the defence sector to the rest of the economy. There are several important features of this Chapter. First, labour force data were constructed instead of using a proxy based on population. Second, a human capital variable was introduced into the Feder model. This Chapter showed that Turkish economic growth is supported by its defence sector. These findings are consistent with most of the literature and also support the central hypothesis of this thesis.

Chapter 4 analysed Turkish defence-growth relationships using a supply-side model and it found that Turkish defence expenditures are positively correlated with its economic growth. However, Feder type models generally give either a *positive* effect of defence spending or *no important effect* of defence spending on economic growth. To test for the reliability and robustness of the results, a different approach is used in Chapter 5. This is based on Deger type supply and demand-side model and the analysis provided further evidence on the Turkish defence-growth relationship. In this model, the direct and indirect effects of defence spending on economic growth are identified. The findings of this Chapter support those of Chapter 4: **Turkey's economic growth is stimulated by its defence spending.** This approach also provided a model of the determinants of Turkish defence spending (*e.g.* arms race effects). They are its income, the conflict with PKK and the defence spending of Greece. Although Deger type models generally tend to find a negative effect of defence on growth, this Chapter estimates a positive relationship. In contrast, many of the Deger studies generally find a direct positive effect and negative indirect effect (through investment), giving an overall negative impact. In this study, the direct and indirect effects are positive, implying that defence spending does not cause a crowding-out effect for Turkey. In this Chapter, the Engle-Granger error correction representation was used for the growth equation. The positive effect of defence spending on Turkish economic growth is also supported by cointegration analysis.

Furthermore, Chapter 5 analysed the causal relationships between the Turkish defence burden and economic growth. In this Chapter, relatively longer data series were used. It covers almost all the period of the Turkish republic (1924-1996). Because of problem of spurious regression, all variables were tested for stationarity. The analysis demonstrated that Turkish defence spending Granger causes economic growth, while economic growth does not Granger causes defence spending.

Greece provided a comparative case study and Chapter 6 addresses Greece's defence-growth relationships. Greece is used as a case study to see whether the results for Turkey can be generalised to similar nations, since these two countries' defence characteristics are very similar. Like Turkey, Greece has a high defence burden and large armed forces when compared with its population and its armed forces are mainly based on conscripts. Greece is a major arms importing country and its arms exports are very low. However, the findings of this Chapter show that defence spending differently affects the two countries. While the Feder type model showed no significant effect for Greece, the Deger type model showed a net positive impact on Greek economic growth. As a result, the findings are inconclusive. **The main conclusions of this Chapter are that the effects of defence spending differ across the countries even when the countries are very similar.**

Defence expenditure is usually divided into personnel, equipment, maintenance and infrastructure expenditures. Their effects on economic growth could be different and could vary between countries: this is the focus of Chapter 7. When compared, it turns out that Turkey spends less on personnel but more on equipment, infrastructure and maintenance than Greece. While Turkey spends 50.1% of its defence budgets on personnel, this figure is 63% for Greece (an average of 1990-1994; NATO Review, 1996). The different impact of defence expenditure on economic growth in Turkey and Greece might be due to the different composition of their respective military spending.

Finally, Chapter 7 investigated the effects of disaggregated defence expenditure on economic growth in an error correction context for Turkey. Turkey spends a higher proportion of its defence budget on equipment and a relatively low proportion on defence personnel compared with the other NATO nations. The empirical results showed that the effect of defence equipment spending is positive for Turkey. It implies that the Turkish defence industry assists its economic growth.

Chapter 7 also investigated the effect of disaggregated Greek defence spending as a comparative study. The results differed. Greek defence equipment spending has a negative impact on its economic growth, while the effect is positive for Turkey: the Turkish defence industry is more developed than Greece which might explain the negative effect for Greece. Greece's high arm imports might cause a balance of payment problem and so retard the country's economic growth.

The main findings of this thesis which differ from those of the existing analyses and from the literature on the defence-growth relationship can be summarised as follows:

i) The bulk of the empirical defence-growth studies has been reviewed and it was shown that the issue remains controversial.

ii) Turkey has allocated a considerably higher percentage of its GNP to defence and Turkey has one of the largest armed forces in the world. Moreover, although a major arms importing country, Turkey has started to build its own defence industry after 1980 and the sector has been growing.

iii) Empirical evidence showed that there are a positive and significant relationships between defence spending and economic growth for Turkey when the Feder type supply-side model was used.

iv) The positive effect of defence spending on Turkish economic growth is also supported by the Deger model.

v) Turkish defence expenditure is determined by its income, the conflict with PKK and the defence spending of Greece.

vi) Greece is used as a comparator to test the reliability of the results for Turkey. Greece has a high defence burden, large armed forces and has started to produce its own military equipment but the effects of defence spending differ from Turkey. Greek defence spending has no important effect on its economic growth when Feder model used and has a net positive effect when Deger model used. The evidence indicates that the defence-growth relationship for Greece is inconclusive.

vii) Disaggregated analysis of Turkey and Greece's defence spending show that equipment spending and non-equipment spending have a different impact on their economic growth and also the effect is different in the short-run and in the long-run.

viii) In conclusion, Turkish defence spending seems to help its economic growth, while the effect is not clear for Greece. Thus, the failure to obtain similar results for Greece suggests that cross country studies can be problematic.

8.2. Proposals for Further Research

This thesis has both strengths and weaknesses. In terms of its strength, the thesis is noteworthy because it is the most comprehensive analysis of Turkish defence-growth relationships. This thesis also uses recent data and econometric methods and does not rely on OLS estimation. The data series used in this thesis cover a relatively long period for a developing country.

In terms of weaknesses, due to data limitations, the findings are not always clear. Defence expenditure data are not very accurate for a number of reasons, namely, definitions differ, significant amounts of security expenditure never enter the account and the data differ considerably between the data sources. Turkey's long period of high inflation creates valuation problems. For disaggregated analysis, very limited data are available. Using population as a proxy for labour for Turkey and Greece and the small sample for disaggregated analysis in Chapter 7 makes these empirical results limited and tentative. Despite these problems, the thesis is an important contribution to understanding the defence-growth relationship in Turkey.

A number of suggestions can be made for future work on defence-growth relationships. Cross section analysis provides limited evidence, because countries differ. Choosing a cross country sample can be problematic and also currency conversion makes comparative data less reliable. It is clear that still more single country studies are needed to obtain a clear picture of the issue. The single country analysis overcomes the heterogenity problem and takes into account the historical and institutional information unique for each country (Dunne, Nikalaidou, 1998). Some Mediterranean countries, such as, Portugal and Spain in

NATO are good examples for further analysis of the defence-growth relationship. They are the poorer or peripheral economies in the EU and show some similar characteristics with Greece and Turkey.

In the Deger model, human capital can be incorporated into the model. In the Feder model, this thesis isolated human capital and it improved the empirical results. The Deger model with human capital variables offers scope for future work. Human capital can be proxied as the enrolment rate, schooling and educational expenditure. Although economic growth is often necessary for development, it is also insufficient. It is possible that policies which aid economic growth may have a harmful effect on economic development (Deger, 1986).

This thesis has added to our knowledge of defence-growth relationships. For Turkey, it has presented results similar to Benoit. However, these results were not supported for Greece, suggesting that empirical work in this field is sensitive to the choice of country for analysis.

APPENDICES

APPENDICES

APPENDIX 2.1

Additional Literature Review

Introduction: This Appendix provides some important empirical evidence on defence-growth studies which are not reported in Chapter 2.

A2.1. Smith (1980)

Under the Keynesian demand side model, the effect of demand spending on investment was examined with 14 large OECD countries. Cross sectional and time series estimations were employed to examine the crowding-out effect of defence spending. The model of the study is derived from the conventional Keynesian model that is $Q-W=Y=C+I+M+B$. In this equation Q is potential output, Y is actual output, W is the gap between actual and potential output, C is consumption, I is investment, M is defence spending and B is balance of payments. C and I include both government and a civilian sector. The equation is divided by Q is give $i=1-w-c-m-b$. After some transformation the final form of equation is derived:

$$i=(1-\alpha_0)-(\beta-\alpha_1)u+\alpha_2 g-\alpha_3 m \qquad \textbf{(A2.1)}$$

where u is unemployment rate, g is the growth rate of actual output and α_i are consumption share function parameters. In the above equations, if defence expenditures rise, then this crowds out investment. Except for two countries, Smith found a significant negative relationships between defence spending and investment. The coefficient on the defence spending term is significantly different from zero and near -1, it shows strong negative association. In brief, defence spending has negative effect on investment and hence growth for developed countries.

A2.2 Frederikson and Looney (1983)

Frederikson and Looney investigated defence growth relationships using the Benoit's method. They used the same sample and the same time period. The main difference is that they divided the sample countries according to their economic position. Their prediction was that in relatively poor countries a negative relationship between defence spending and growth is expected. On the other hand the richer countries have positive relationships. The sample countries were divided into four groups but two groups are important, the other two groups have less importance from authors point of view. Group one countries were named as the resource abundant and group two countries named resource constrained. Group one is relatively developed (or rich) countries and group two is relatively poor. They found a positive coefficient for group one countries and negative coefficient for group two as predicted.

Group 1

$$G=(1.77)+(0.16)I+(0.12)Aid+(0.22)Def \qquad R^2=0.89 \qquad \textbf{(A2.2)}$$

Group 2

$$G=(4.72)+(0.15)I+(0.19)Aid-(1.22)Def \qquad R^2=0.76 \qquad \textbf{(A2.3)}$$

R^2 is in both equations higher than in Benoit's study. Eventually they concluded that defence spending will have a positive effect in "resource unconstrained" countries (education, linkages with industry etc.), on the contrary, in countries with lack of foreign exchange and government revenues, defence spending will reduce growth.

Frederikson and Looney's study can be criticised in that they used the same method as Benoit, hence the same shortcomings prevailed. In the study, capital inflow variable is only used as bilateral aid. Furthermore, Benoit's sample countries were divided into two groups (actually four), so the findings came from very small samples. Group two include only nine countries (Grobar & Porter 1983).

A2.3 Lim (1983)

This paper was presented in 1983. Due to Benoit's controversial findings, Lim reexamined the relationship between defence spending and economic growth with 54 LDCs in the period of 1965-1973. The sample countries consisted of 21 African, 13 Western Hemisphere, 11 Asian and 9 Middle Eastern and Southern European LDCs. An explicit Harrod-Domar growth model was employed by the study. The general form of Harrod-Domar growth model is:

$$Yg=f(IOCR, I/Y) \qquad \textbf{(A2.4)}$$

where, Yg denotes the growth rate of the real GDP; IOCR is the incremental output-capital ratio, and I/Y is investment GDP ratio. Under the closed Harrod-Domar economy a higher defence spending will create a lower investment (i.e. when D/Y (defence burden) increase, then I/Y will decrease), hence a lower growth rate of output (Yg). The relationships between defence and investment are I/Y=f(D/Y) and they are negatively correlated. When the foreign capital inflow isolated the model, the equation will be I/Y=f(D/Y, F/Y), where, F/Y is the foreign capital inflow to GDP ratios. In this case, F/Y is positively correlated with I/Y but D/Y is negatively correlated. The final form of equation is

$$Yg=f(IOCR, D/GE, F/S) \qquad \textbf{(A2.5)}$$

Where Y_g denotes the growth rate of real GDP, IOCR is the incremental output capital ration, D/GE is the share of defence spending in government expenditure. F/S is the deficits on current account to gross national savings ratios. Instead of F/Y, F/S is preferred. It is expected to bring a more direct effect. In addition, government expenditure (GE) replaced total output Y because. a defence sector better is represented by government sector. The least square regression method was the estimating model. After the empirical test, the regression coefficient for D/GE is negative and statistically significant, this means in contrast to Benoit's work defence spending had negative impact on growth. Alexander(1990) criticised this study in that the equation was not enough to explain the growth rate of output. Lim omitted crucial variables such as labour and technology and human capital (Alexander 1990).

A2.5 Faini, Annez and Taylor (1984)

This paper was presented in 1984. The defence-growth relationship was empirically examined with 69 LDCs in the period of 1952-1970. Ordinary least square (OLS) estimation was used to estimate the coefficients. Their paper concluded that defence spending has negative effect on growth, furthermore, when defence spending is increased, savings and investment shares in GDP decrease and a greater tax burden will occur and also economic activity will shift from agriculture toward manufacturing sectors. In addition, under the Indian case with time series estimations negative effect of defence spending on growth was found. During the study, the authors used basic structuralist principles. Instead of aggregate growth, they emphasised the disaggregated structure of the economy, hence they took a series of variables into their equation. The equation is:

$$X=a+b_1 logY+b_2(logY)^2+b_3(logP)+b_4(logP)^2+b_5F+b_6d \qquad \textbf{(A2.6)}$$

where X denotes the share in GDP of a number of disaggregated variables. X is dependent variable on per-capita income(Y). population(P), capital inflow from abroad(F) and the defence burden "d" (defence spending in GDP). A significantly negative coefficient was found for the defence burden. The negative effect of defence spending on agriculture is destructive for developments. Structuralist theory gives a big importance on agricultural bottlenecks as an obstacle to growth (Deger & Sen 1995). The serious critique to Faini et al. (1984) paper came from Stewart(1991) in that Faini *et al.* assumed there is no nonmilitary public spending and main result was misstated. The methodology was also criticised by Stewart. Faini *et al.* did not show the equation can be derived from their structural model and connection appears rather tenuis (Stewart, 1991).

A2.6. Landau (1986)

Landau carried out a very extensive study in 1986. He investigated many kinds of variables related to economic growth for LDCs between 1960 and 1980. Only one part of his study examined the impact of defence spending on economic growth. Cross section time series estimation with OLS was employed. He found that defence spending had no impact on economic growth or it has very little impact. Landau's study included very large number of variables and well-defined criteria to find out appropriate results but his econometric formulation seems insufficient (Ram 1995).

2.7. Rasler and Thompson (1988)

Rasler and Thompson brought a different aspect for defence-growth relationships. They examined two systems or hegemonic leaders in nineteenth century Great Britain and in twentieth centuries United States. Defence spending is a form of insurance for the hegemonic leaders and it has some costs. The leader provides protection for other capitalist states. Therefore, the cost of defence for the leader is likely to be higher. Systematic leadership involves very high protection cost such as armed forces, the financing of allies, foreign aid and the cost associated with maintaining the international economy. The historical leaders in economic growth (Britain and United States) exhibit lower rates of investment and growth than more recent newcomers like Japan. Rasler and Thompson's model for systematic leadership was:

$$\frac{I}{Y}=\alpha_0+\beta_1\frac{M}{Y}+\beta_2\frac{Y_1}{Y_{t-1}}+u \qquad \textbf{(A2.7)}$$

where I/Y represents annual change in fixed domestic capital investment as a proportion of GDP, M/Y is annual change in defence spending as a proportion of GDP, and final term is annual change in GDP per capita, and α is constant, β's are coefficient. In this equation capital investment formation(I/Y) is dependent variable and defence burdens and the economic growth is independent variables. They added to model systematic or hegemonic leadership. The empirical study showed that defence burden coefficient was insignificant for the nineteenth century system leader (GB). The coefficient of the defence burden was statistically significant and negative for the twentieth century leader (US). In conclusion, they found some evidence of adverse effect of defence spending on investment and hence growth.

A2.8. Stewart (1991)

Stewart investigated the defence-growth association. OLS estimation method with pooled data for African and Latin American countries were employed. The model of study was derived from Faini, Annez and Taylor model. Unlike Faini et al.(1984) model, the author isolated non-defence component on the model which is G=GD+GN (G is total government spending, GD is defence spending, GN is non-defence spending). The study showed that there is no evidence to support higher defence burdens creating a lower economic growth.

However, higher defence spending is stimulative but non-defence spending is more stimulative. After reformulation of Faini et al. (1984) model, Stewart found positive effect of defence spending on economic growth in contrast to Faini *et al.* (1984) because the model is improved after adding non-defence government spending. Faini *et al.* Work seriously flawed by a factor to control for non-defence public spending and omission of lagged defence burden variable (Stewart, 1991).

A2.9. Landau (1994)

He investigated the defence-growth relationships using traditional (ad hoc) growth model. Cross-sectional estimation method employed a full sample of 71 LDCs in the period of 1969-89. He hypothesised a negative resource use effect, defence spending diverts resources from productive sectors to defence, positive security effect and efficiency effect, secures and peaceful environment helps output growth. The model used in this study is:

$$Y=f(L,N,Kp,Kh,T,E) \quad \textbf{(A.2.8)}$$

where Y is growth rate, L is labour, N is labour resources, Kp is physical capital, Kh is human capital, T is technology and E is efficiency. Based on above equations, econometric form of equation is:

$$Y=\alpha_1 M+\alpha_2 M^2+\alpha_3 NM+\alpha_4 G+\alpha_5 C+\alpha_6 P+\alpha_7 D+\alpha_8 L+\alpha_9 DPI+\alpha_{10} O \quad \textbf{(A2.10)}$$

Where; α_i: constants coefficients

M: defence spending as share of GNP

M^2: M squared

NM: average M of neighbouring countries

G: growth rate

C: % change terms of trade

P: per capita product

D: foreign debts as share of GDP

L: life expectancy

DPI: the dummy for political instability

O: oil exports as share of GNP per cent

At low level of defence expenditure, increased defence spending will be associate with faster economic growth due to security and policy efficiency. This is measured by M (defence share in GNP) and beyond certain level, the impact of increasing defence spending on growth will be negative (resource effect). This is measured by M^2. M is predicted positive and M^2 is predicted negative. The Landau model also considered neighbouring countries' defence spending and he found a large positive effect of the neighbours' defence spending on the country's own growth. Their results from the study are that no evidence of a negative relationship was found between defence spending and economic growth.

The existing studies showed that majority of demand side and demand and supply side model uncovered a negative impact of defence spending on economic growth. The main source for this result is a defence sector diverts resource away from other productive sectors (crowding out of investment, export, education and health). In these models, demand side suggest a negative impact and supply side suggest a positive effect on growth, but the net effect seems negative (Deger, 1986a. 1986b; Deger and Smith, 1983; Scheetz. 1991). Although these models provide amore complete pictures of defence growth relationship, they have been criticised for not being strong based on theory and then relying on ad hoc justification (Dunne and Nikoladou, 1998). However. these models over come problem of exogenity and simultancity.

A2.10. Ram (1986)

Ram used a supply based model which had been developed by Gershon Feder(1983). Ram study did not focus on defence spending, but it focussed on government size effect on growth and economic performance. A large sample of 115 countries in the period of 1960-1970 and 1970-1980 were used and cross sectional time series estimation is employed. In the model, assumed economy includes two sectors, the government sector(G) and a non-government sector(C). Two sectors can be written as C=C(Lc, Kc, G) and G=G(Lg, Kg) where K and L denote labour and capital respectively and lowercase denotes sectoral inputs. This model consists of both a network of externalities among sectors and productivity differences. In the equation, government sector implies positive externalities ($\delta G/\delta C$) for the non-government sector. Ram's study concluded that government size has a positive effect on growth and economic performance and positive externality effect of government size on the rest of the economy. Hence defence spending also has a positive impact on growth. Two problems arise from Feder-Ram model in that the theoretical analysis ignores the interaction between the demand and supply side of the economy and it is difficult to fix externalities among sectors (Sandler & Hartley 1995).

A2.11. Atesoglu and Mueller (1990)

Atesoglu and Mueller empirically investigated defence -growth association using United States data for 1949-89. In the study, the economy is assumed two sectors as civilian and defence. Further assumed, the defence sector is a relatively less competitive part of the economy and model include both externality effect and productivity difference. The aggregate production function for each sector is:

$$D = D(K_d, L_d) \tag{A2.10}$$

$$C = C(K_c, L_c, D) \tag{A2.11}$$

And Q=D+C is aggregate output. Total capital and labour consist of:

$$L = L(L_d, L_c) \tag{A2.12}$$

$$K = K(K_d, K_c) \tag{A2.13}$$

he final form of model which is developed by Feder(1983):

$$\frac{dQ}{Q} = ck\frac{I}{Q} + cl\frac{dL}{L}\frac{L}{Q} + \left(\frac{\delta}{1+\delta} - \pi\right)\frac{dD}{D}\frac{D}{Q} + \pi\frac{dD}{D} \tag{A2.14}$$

where dQ/Q denotes the growth of real output, I/Q is investment ratio, (dL/L)(L/Q) is employment growth effect, (dD/D(D/Q) is defence spending growth effect, dD/D is growth in real defence spending and ck, c_1, [$\delta/(1+\delta)$-Π] and Π are empirical parameters to be estimated. The findings were a positive and significant relation between defence spending and economic growth in the US. Instead of a burden, defence sector is an engine of economic growth, so that if defence spending is reduced after the cold war, growth will be affected negatively but the adverse effect will not be very large from the authors point of view. The findings of positive effect of the defence sector in the USA might be valid because the USA spends a higher proportion to R&D and this cause technological improvement. Many technological improvements originally comes from defence sector and also the USA is a major arms exporter country. These exports may help the USA economic growth.

A2.12. Huang and Mintz (1991)

The study used the same sample and the same model with Huang and Mintz (1990) but externality and relative productivity components isolated into three sector model, then they assumed that non-defence sector and defence sector affect the production of C with constants elasticities of θ_n and θ_m respectively. Then three sector model was:

$$C=C(L_c, K_c, N, M)=N^{\theta n}M^{\theta m}\Phi(L_c, K_c) \quad \textbf{(A2.15)}$$

This time again the authors employed ridge regression method for the same reason. After the study the findings are consistent with earlier (Huang-Mintz 1990) study. Addition of the externality and relative productivity effect into three sector Feder-Ram model did not change the conclusions that defence spending does not have a significant externality effect on economic growth and also productivity effect is insignificant. However, a non-defence government sector has a significantly positive externality effect. The findings of Huang and Mintz were contrary with Atesoglu and Mueller (1990). They used same sample country of the USA and the similar time period but the findings were contrary. The reason for this might be the form of Feder model. Atesoglu and Mueller used two sector model while Huang and Mintz used three sector model as defence, non-defence government and civilian sector. Inclusion of a non-defence sector into defence sector and little difference in the time period resulted no effect of defence spending in the US economic growth.

A2.13. Adams, Behrman and Boldin (1991)

Adams. Behrman and Boldin investigated defence-growth relationships in 1991 with the sample of LDCs in the period of 1974-86 and employed cross sectional time series estimation. The study extended Ram(1986) and Biswas and Ram(1986) model. The government sector was separated as defence and non-defence sectors. Like an export sector, it is assumed government sector has its own separate production function and it creates externality to non-government and non-export sector. The final form of model is:

$$\frac{\dot{Y}_c}{Y}=\frac{\dot{Y}}{Y}-\frac{G}{Y}\frac{\dot{G}}{G}=\alpha\frac{I}{Y_c}+\beta\frac{\dot{L}}{L_c}+\left(\frac{\delta}{1+\delta}+N_x\right)\frac{\dot{X}}{X}\frac{X}{Y_c}+NG\frac{\dot{G}_c}{G_c}\frac{G_c}{Y_c}+PG\frac{\dot{GP}}{GP}\frac{GP}{Y_c} \qquad \textbf{(A2.16)}$$

Where Yc is civilian GDP, the NG and PG terms indicate measures of the externality effects of the two components of government spending on non government GDP. Empirical results of study showed that there is no statistically significant impact from a defence sector on growth, although the export sector has significantly positive effect on growth.

A2.14. Biswas (1993)

Biswas study intended to replicate of the empirical part of the earlier Biswas-Ram(1986) study. The study analysed defence-growth relationships with a sample of 74 LDCs in the period of 1981-89. The traditional model and the Feder-Ram model were employed on the study. The model for neoclassical production function is:

$$\dot{Y}=\beta_1\frac{I}{Y}+\beta_2\dot{L}+\beta_3\dot{M} \qquad \textbf{(A2.17)}$$

Where the dot represents rates of growth (Y over the dot is rate of growth of total output-GDP), L is for labour and M is for defence spending. I/Y is the investment-output ratio. β_1 shows the marginal product of capital and β_2 shows the elasticities of output with respect to labour and β_3 shows elasticities of output with respect to defence spending. For this model, a significantly positive effect of a defence sector on economic growth was found.

The model for augmented neoclassical form is comprised to the two sectors(defence and civilian). The model considers externalities that flow from a defence sector to a civilian sector. The model was:

$$\dot{Y}=\alpha\frac{I}{Y}+\beta\dot{L}+\left(\frac{\delta}{1+\delta}-\theta\right)\dot{M}\frac{M}{Y}+\theta\dot{M} \tag{A2.18}$$

Where, I/Y and M/Y are the investment-output ratio and defence spending-output ratio respectively. θ is the elasticity of civilian output with respect to defence output and δ shows factor productivity. This model provides the externality effect and the relative factor productivity separately.

The empirical result of the augmented model also has a positive effect of defence spending on growth, but externality effect and factor productivity differentials are not clear. Both results (conventional and augmented) had positive effects in contrast to earlier Biswas-Ram(1986) study. It had found no significant effect of defence spending on economic growth. This study used the same model but a more recent data set. It implies that defence spending become to effect economic growth positively in LDCs. However, no significant externality effect or factor productivity differentials are found. It is possible that high correlation between the two defence variables lowers the estimation results.

A2.16. Jeording (1986)

He investigated economic growth and defence spending using Granger causality tests. Causality is an important problem when using OLS estimations. To find out sufficient results the problem of causality must be sorted out. Without priori information, one cannot say whether high defence causes high growth or vice versa. The direction of causality is very important because there is nothing to do if high growth "causes" high defence spending. In other words, defence spending should be independent variable (Deger 1986). Granger causality tests show whether the present value of X is related to the past value of X and some other series Z. If the past values of time series X on Z are better estimators of X than the past value of X, the Z Granger causes X. The tests can be indeterminate or no causality can be found or causality may be in both directions (Sandler & Hartley 1995). Previous studies generally employed OLS estimations that $G=\alpha X+\beta M+\varepsilon$ where G denotes growth, α and β are coefficient, X is a vector of explanatory variables, M is defence spending. These models are suitable, if defence spending is econometrically independent variable, otherwise the results will not be appropriate. To find out Granger causality between defence spending and economic growth, Jeording employed the following equations using data from SIPRI 1960-1975 and from US ACDA 1967-1976 with 57 LDCs.

$$M_t=\alpha+\beta(L)M_{t-1}+\gamma(L)G_{t-1}+\theta(L)I+\lambda(L)GS+\varepsilon_t \qquad \textbf{(A2.19)}$$

Where M denotes military spending, G is growth rate, I is investment, GS is government spending and θ(L) and λ(L) are fifth degree polynomials in the lag operator, γ(L) and β(L) are fourth degree polynomials. After the Granger causality test for 57 LDCs, it is found that defence spending is not a strongly independent variable relative to economic growth. In the light of the Jeording's findings, previous studies should be reexamined which implicitly or explicitly assumed defence spending is an independent variable of economic growth.

A2.17. Chowdhury (1991)

He conducted Granger causality test for defence-growth relationships using time series data from 55 LDCs. Causality is tested for each country with defence burden measuring the share of GDP devoted to defence and with economic growth measured by the growth rate of GDP. The causality problem was rarely mentioned in the defence-growth literature. Initially the important study was Jeording(1986) who employed a cross country analysis. Chowdhury employed time series analysis to identify the distributed lag relationship between defence and growth. Granger causality tests indicate whether the current value is related to the lagged value. If there are two values of X and Y and X related to Y then Y can be better predicted by using X variable. For the study, the equations are:

$$X_t=\sum_{i=1}^{m} a_i x_{t-i}+\sum_{j=1}^{n} b_j y_{t-1}+e_1 t \quad \textbf{(A2.20)}$$

$$Y_t=\sum_{i=1}^{k} c_i y_{t-i}+\sum_{j=1}^{p} d_j x_{t-j}+e_2 t \quad \textbf{(A2.21)}$$

Where e_1 and e_2 are assumed to be independent and identically distributed. Granger causality between defence(x) and growth was tested $b_j=0$, $j=1...n$ and $dj=0$ $j=1...p$

The results of the study were no causality for 30 countries, negative effect of defence spending on economic growth for 15 countries and economic growth causing high defence spending for seven countries, and finally bidirectional causality for 3 countries. The results show little evidence of unidirectional positive causal flow from defence spending to economic growth. Ram(1995) pointed out that regression specification error test is more suitable than Granger causality tests for this kind of empirical study (Ram 1995).

A2.18. Chen (1993)

Chen study is based on causality between defence spending and economic growth for the case of mainland China in the period of 1950-1991. Recent econometric techniques of unit root and cointegration were employed. The findings of this study strongly suggest that defence spending and economic growth were not cointegrated and they do not posses a long run equilibrium relationship. He suggests that defence spending is related to non-economic factors for China.

A2.19. Madden and Haslehurst (1995)

Madden and Haslehurst analysed Australian economic growth and defence spending causal relationships in light of the Chowdhury's (1991) study. Chowdhury applied Granger causality test to investigate defence-growth causal relationships and the results suggested that the association between growth and defence spending cannot be generalised. However, over of the half sample no causal relationships were found. Madden and Haslehurst employed the same analysis for Australian case. After the Granger causality test they found no causal relationships between defence spending and economic growth.

A2.20. Ahmed A. A. Asseery (1996)

Asseery investigates causality between Iraq defence spending and economic growth. This study was also supported by new econometric techniques of unit root and cointegraton. The time period for this study is 1950-1980. This study is important because defence spending dominate the Iraqi economy. The result showed that the economic growth over the period of estimation was heavily depending on defence spending and it is negative.

As a result of causality studies, there is no consensus among studies. While Chen (1993) and Madlen and Haslehurst (1995) found no causal relationship between defence spending and economic growth, Chowdhury (1991) suggest that causality run from growth to defence. On contrary Asseery found that defence spending causes economic growth. Jeoerding (1986) findings are inconclusive. It suggests that causal relationship is not certain among countries.

APPENDIX 4.1

DATA: List of Series and Descriptive Statistics

Introduction: This appendix presents the various series used for estimation and descriptive statistics.

Table A4.1.1 List of Series Used in Estimation (Turkey)

Year	GNP	I	HI	M	L	P	AR
1954	6301207	912322	182540	344606	11208000	23206000	-
1955	7377714	1042549	189242	377293	11633000	23859000	-
1956	7658300	1059334	207532	364756	11805000	24442000	610000
1957	8594457	1116218	200950	356402	12197000	25252000	605000
1958	8789983	1119464	186259	335565	12550000	25983000	481000
1959	9535923	1336899	236056	430181	12913000	26735000	507000
1960	8495000	1252667	272288	401667	12417000	27509000	510000
1961	8953333	1299000	352288	453000	12534000	28233000	507000
1962	8676857	1265143	345636	425714	12651000	28933000	520000
1963	9557143	1523571	419926	451000	12769000	29655000	529000
1964	8913750	1375000	460012	430375	12888000	30394000	526000
1965	9591250	1403625	468719	477625	12357000	31151000	511000
1966	11427500	2017750	531385	499500	12509000	31934000	552000
1967	11275556	1960222	552762	510667	12533000	32750000	550000
1968	12498889	2244556	611019	573222	12591000	33585000	564000
1969	12489000	2180700	549589	539500	12617000	34442000	607000
1970	13363636	2620455	659583	567000	12583000	35321000	625000
1971	14769231	2561000	936338	652846	12843000	36215000	615000
1972	16054000	2733333	869295	664067	13137000	37132000	561000
1973	17212778	3077778	1063255	677333	13909000	38072000	563000
1974	17795833	3833333	963203	659625	12407000	39036000	574000
1975	19841111	4447037	1172537	1118519	14387000	40078000	584000
1976	21093750	4937188	1167610	1271594	14594000	40915000	674000
1977	21822500	4675000	1414075	1244750	15070000	41768000	771000

Year	GNP	I	HI	M	L	P	AR
1978	22649123	3719298	1423121	162088	15276000	42640000	721000
1979	22448980	3591837	1316093	951714	15505000	43530000	698000
1980	22175000	3755000	1164926	928280	15702000	44438000	717000
1981	23077465	4985915	1036284	1102349	15839000	45470000	741000
1982	24196676	4662050	929749	1240416	16006000	46690000	769000
1983	24950324	4518359	1559437	1202458	16169000	47860000	824000
1984	26438849	4733813	1009783	1155459	16420000	49070000	815000
1985	27797000	5960000	916521	1235000	16699000	50310000	814000
1986	30053435	7512214	958046	1425954	17010000	51430000	860000
1987	32285006	8098126	1189301	1365491	17402000	52560000	879000
1988	33493839	8068931	1203699	1261738	17668000	53710000	847000
1989	34143859	7641354	1581806	1434182	18005000	54890000	780000
1990	37262161	8775457	2127334	1798677	18364000	56100000	769000
1991	37380759	11663176	2346046	1927957	18420000	57330000	804000
1992	39775838	12732978	2825602	2109576	18600000	58580000	704000
1993	44315521	15535781	3160749	2385179	18702000	59870000	686000
1994	42040800	12287699	2191450	2184662	19169550	61180000	811000

Investment for the 1991-1994 is taken from new GNP series. Therefore, Investment/GNP variable after 1991 are calculated using new GNP series. (GNP new series: 1990: 84592243; 1991:84886777; 1992: 90324672; 1993: 100646138; 1994: 95480283).

- GNP: Real Gross Natioanl Product (1985 constant prices; million Turkish Liras)
- I: Real Gross Fixed Investment (1985 constant prices; million Turkish Liras)
- HI: Real educational expenditure in the general budget (1985 constant prices; million Turkish Liras)
- M: Real defence expenditure (1985 constant prices; million Turkish Liras)
- L: Employed labour force (person)
- P: Population (person)
- AR: Armed Forces (person)

Table A4.1.2. Descriptive statistics of variables (Turkey)

Variable	Mean		Standard deviation	
	Level	1st difference	Level	1st difference
Growth	0.05028	-0.005697	0.05997	0.09333
Investment	0.1875	-0.001112	0.04136	0.03385
Labour	0.01364	-0.0003301	0.01680	0.02185
Human capital	0.04946	0.0004979	0.01454	0.01051
Defence size	0.002295	-0.0002490	0.005942	0.008348
Defence externality	0.05558	-0.004588	0.1443	0.2075

Table A4.1.3. Correlation matrix (Turkey)

Correlation Matrix						
	Growth	Investment	Labour	Human capital	Defence size	Defence externality
Growth	*1.000*	**0.6527**	**0.3368**	**0.4565**	**0.6366**	**0.5855**
Investment	0.3844	*1.000*	**0.1911**	**0.2108**	**0.5191**	**0.4733**
Labour	0.3257	0.1904	*1.000*	**0.1236**	**0.09335**	**0.1030**
Human capital	0.1548	0.1728	-0.005507	*1.000*	**0.3531**	**0.3408**
Defence size	0.5137	0.3982	-0.01727	0.2147	*1.000*	**0.9884**
Defence externality	0.4708	0.3915	-0.001520	0.2078	0.9897	*1.000*

bold faces represents correlation matrix for 1st differences

APPENDIX 4.2.

Further Empirical Results

Introduction: This Appendix reports more regression results which were not presented

Chapter 4

Table A4.2.1. Regression with different proxy of investment variable (Turkey)

Dependent variable: Economic Growth				
	1	2	3	4
Constant	-0.01 (-0.36)	0.01 (0.03)	0.01 (0.38)	0.03 (1.03)
Investment	0.20 (0.97)	0.11 (0.58)	0.05 (0.24)	-0.03 (-0.12)
Labour	1.09** (2.30)	1.25** (2.72)	0.76 (1.51)	0.78 (1.55)
Defence size	4.66*** (3.24)	4.51*** (3.22)	3.44*** (3.74)	3.54*** (3.88)
R^2	0.39	0.38	0.45	0.45
DW	1.96	2.01	1.36	1.40

t statistics in parenthesis
* significant at least 10%
** significant at least 5 %
*** significant at least 1 %
1. Investment variable is proxied with gross fixed investment of IMF/IFS data (1955-1994)
2. Investment variable is proxied with gross fixed capital formation of IMF/IFS data (1960-1994)
3. Investment variable is proxied with gross fixed investment of SPO (State Planning Organisation of Turkey; 1969-1993) data
4. Investment variable is proxied with fixed investment excluding housing of SPO (State Planning Organisation of Turkey; 1969-1993) data

Table:A4.2.2. Regression with Different Proxy of Defence Expenditure Variables (Turkey)

Dependent variable: Economic Growth				
	1	2	3	4
Constant	-0.01 (-0.36)	-0.04 (-0.99)	-0.04 (-1.02)	-0.04 (-1.00)
Investment	0.21 (0.97)	0.40* (1.84)	0.40* (1.87)	0.39* (1.82)
Labour	1.09** (2.30)	1.05** (1.99)	1.04** (1.98)	1.04** (1.97)
Defence size	4.66*** (3.24)	1.50 (0.83)	1.71 (0.97)	1.59 (0.97)
R^2	0.39	0.24	0.25	0.25
DW	1.96	2.21	2.20	2.20

t statistics in paranthesis
* significant at least 10%
** significant at least 5 %
*** significant at least 1 %
1. Defence variable is measured with SIPRI defence expenditure data (1955-1994)
2. Defence variable is measured with share of MOD (Ministry of Defence) expenditure in the Tukey's Central Government Budget (1955-1992)
3. Defence variable measured with share of MOD and Gendermeria forces expenditure in the Turkey's Central Government Budget (1955-1992)
4. Defence variable measured with share of total security expenditures (including MOD, Gendermeria forces, Security forces, Coast guard and Ministry of Interior) in the Turkey's Central Government Budget (1955-1992)

Table A4.2.3. Regression of level variables with lags (Turkey)

Dependent variable: Economic Growth				
	Equation (4.7)		Equation (4.9)	
	Coefficient	t statistics	Coefficient	t statistics
Constant	0.01	0.29	-0.01	-0.41
Investment	0.76***	2.97	0.79***	3.12
Investment_{-1}	-0.66***	-2.77	-0.73***	-3.03
Labour	0.88**	2.03	0.86**	2.01
Human capital	-	-	0.70	1.39
Defence size	3.23**	2.41	2.77**	2.03
R^2	0.50		0.53	
DW	1.84		1.83	
LM Serial Correlation χ^2	0.334 probobality: 0.8807		0.169 probability: 0.9186	

* significant at least 10% level
** significant at least 5 % level
*** significant at least 1 % level

In this regression three lags were introduced for all variables; then insignificant lags were omitted individually; finally, only the lagged investment variable gave significant results. It implies that lagged investment is negatively linked with economic growth.

Table A4.2.4. Regression with different proxy of human capital (Turkey)

Dependent variable: Economic Growth+				
	1	2	3	4
Constant	0.02 (0.43)	-0.01 (-0.47)	-0.01 (-0.28)	0.10 (-1.44)
Investment	0.37 (1.34)	0.41* (1.82)	0.29 (1.40)	0.32 (1.55)
Labour	0.99** (2.05)	1.11** (2.43)	1.14** (2.45)	0.81* (1.73)
Human capital	-0.56 (-0.93)	-1.62* (-1.94)	-3.41* (-1.70)	3.94 (1.26)
Defence size	4.34*** (2.93)	4.27*** (3.05)	4.64*** (3.14)	4.55*** (3.22)
R^2	0.40	0.45	0.44	0.41
DW	1.92	2.02	2.02	2.12

t statistics in parenthesis
* significant at least 10%
** significant at least 5 %
*** significant at least 1 %
1. Human capital variable is proxied with primary school enrollment/population ratio (1955-1994)
2. Human capital variable is proxied with secondary school enrollment/population ratio (1955-1994)
3. Human capital variable is proxied with higher education enrollment/population ratio (1955-1994)
4. Human capital variable is proxied with armed forces/population ratio (1956-1994)
[for comparison, labour force data were also employed instead of population in the all above ratios, but the results were very similar therefore only the regressions with using population are reported]

+lags also introduced all regressions but they were insignificant therefore they are not reported.

Table A4.2.5. Regression with First Differences of Investment, Labour and Human Capital (Turkey)

Dependent Variable Economic Growth				
	Equation 4.7	Equation 4.8	Equation 4.9	Equation 4.10
Constant	0.04*** (5.74)	0.04*** (5.80)	0.41*** (5.79)	0.04*** (5.83)
Investment (first diff.)	0.61*** (2.82)	0.57** (2.63)	0.60*** (2.78)	0.57** (2.60)
Labour force (first diff)	0.90*** (2.93)	0.88*** (2.89)	0.87*** (2.82)	0.86*** (2.78)
Human capital (first diff.)	-	-	0.63 (0.91)	0.57 (0.83)
Defence size	3.31*** (2.74)	12.91 (1.60)	2.88** (2.21)	12.00 (1.46)
Defence externality	-	-0.39 (-1.20)	-	-0.37 (-1.12)
R	0.53	0.55	0.54	0.56
DW	1.79	1.72	1.84	1.75
F statistic	13.469***	10.593***	10.268***	8.536***

t statistics in parenthesis
* significant at least 10%
** significant at least 5 %
*** significant at least 1 %

APPENDIX 5.1.

Further Data and Empirical Results

Introduction: This appendix presents the various series used for estimation and descriptive statistics in Chapter 5 and regression results which were not reported in the Chapter.

Table A5.1.1a List of Series Used in Estimation (Turkey)

Year	GNP	S	B	M	GS	INF
1955	7377714	841115	-201433	377293	906625	13.9
1956	7658300	947610	-111724	364756	1024715	16.2
1957	8594457	1043305	-72913	356402	1032889	17.7
1958	8789983	1042992	-76472	335565	1019479	19.5
1959	9535923	1045982	-290717	430181	1192840	23.1
1960	8495000	1015667	-237000	401667	1084500	1.3
1961	8953333	1026333	-272667	453000	1266667	0.5
1962	8676857	927286	-337857	425714	1273429	2.9
1963	9557143	1057143	-428571	451000	1057143	3.6
1964	8913750	1188750	-250000	430375	1075000	-1
1965	9591250	1316250	-125000	477625	1187500	5.4
1966	11427500	1877500	-212500	499500	1375000	7.1
1967	11275556	1895667	-97222	510667	1384222	6.6
1968	12498889	2032667	-245222	573222	1565111	2.5
1969	12489000	2018500	-204000	539500	1546800	8.3
1970	13363636	2480091	-397909	567000	1701727	9.5
1971	14769231	2376000	-559231	652846	1927538	17
1972	16054000	2720667	-586667	664067	2133333	15.5
1973	17212778	3323889	-488889	677333	2388889	21
1974	17795833	3379167	-1166667	659625	2208333	26.9
1975	19841111	3507778	-1555556	1118519	2851852	11.4
1976	21093750	3843750	-1440625	1271594	3343750	17.3
1977	21822500	3147500	-1775000	1244750	3800000	28.5
1978	22649123	3122807	-877193	162088	3491223	53.6
1979	22448980	3132653	-908163	951714	3346939	75.1

Year	GNP	S	B	M	GS	INF
1980	22175000	2635000	-1655000	928280	2200000	90.3
1981	23077465	4323944	-1151408	1102349	3031690	34.1
1982	24196676	4257618	-722992	1240416	2753463	27.4
1983	24950324	3600432	-1542117	1202458	3140389	28.1
1984	26438849	3998561	-969784	1155459	2825899	46.4
1985	27797000	5446000	-760000	1235000	3139000	41.7
1986	30053435	6764885	-809924	1425954	3505344	27.5
1987	32285006	8900221	-638368	1365491	3998897	39.3
1988	33493839	10530470	474192	1261738	4038628	60.8
1989	34143859	8859948	-718694	1434182	5367862	65
1990	37262161	9420612	-2183033	1798677	7133221	49.6
1991	37380759	9924033	-1434660	1927957	6377491	52.6
1992	39775838	11364540	-1609350	2109576	7044400	67.1
1993	44315521	13915889	-3448454	2385179	7822688	62.5
1994	42040800	13212227	563872	2184662	6718493	149.6

Sources: IMF/IFS yearbooks (various years), SIS, Turkey (1994; 1996), OECD Labour Force Statistics Yearbooks (various years), SIPRI yearbooks (various years), US ACDA (1994; 1995; 1996)

- Y: Real Gross National Product (1985 constant prices; million Turkish Liras)
- S: Real Gross savings (1985 constant prices; million Turkish Liras)
- M: Real defence expenditure (1985 constant prices; million Turkish Liras)
- B: Real balance of trade (1985 constant prices; million Turkish Liras)
- GS: Real government spending (1985 constant prices; million Turkish Liras)
- INF: Inflation rate
- EXRT: Real exchange rate
- L: Employed labour force (person)
- GRE: Share of defence expenditures in Greece's GDP
- NATO: Average share of defence burden of NATO countries

Table A5.1.1b List of Series Used in Estimation (Turkey)

Year	ArmImp	ArmImp(95)	WorldEx	EXRT	GRE	NATO	L
1955	-	-	87	981	5.18	5.3	11633
1956	-	-	97	881	5.98	5.1	11805
1957	-	-	104	788	5.07	4.9	12197
1958	-	-	100	639	4.82	4.6	12550
1959	-	-	106	559	4.91	4.6	12913
1960	-	-	118	1500	4.93	4.4	12417
1961	-	-	122	1500	4.29	4.5	12534
1962	-	-	128	1286	4.08	4.7	12651
1963	-	-	140	1286	3.86	4.5	12769
1964	-	-	157	1125	3.62	4.4	12888
1965	-	-	170	1125	3.50	4.2	12357
1966	-	-	192	1125	3.58	4.2	12509
1967	214	868	200	1000	4.35	4.4	12533
1968	210	817	222	1000	4.69	4.3	12591
1969	240	891	255	900	4.79	4.0	12617
1970	250	881	298	1350	4.75	3.9	12583
1971	260	871	333	1077	4.69	3.9	12843
1972	210	674	397	933	4.56	3.8	13137
1973	160	486	553	778	4.10	3.5	13909
1974	250	699	820	577	4.28	3.7	12407
1975	260	664	843	556	6.83	3.8	14387
1976	320	773	950	516	6.90	3.7	14594
1977	140	318	1076	481	7.03	3.6	15070
1978	230	486	1245	439	6.70	3.6	15276
1979	190	370	1604	357	6.28	3.5	15505
1980	330	589	1920	446	5.67	3.5	15702
1981	380	620	1899	466	6.97	3.7	15839
1982	500	768	1752	512	6.85	3.8	16006
1983	550	811	1712	605	6.28	3.5	16169
1984	525	744	1817	637	6.53	3.5	16420
1985	500	686	1848	574	6.97	3.5	16699
1986	700	936	2034	577	6.14	3.4	17010

Year	ArmImp	ArmImp(95)	WorldEx	EXRT	GRE	NATO	L
1987	1200	1556	2391	561	6.27	3.4	17402
1988	1100	1376	2729	604	5.19	3.2	17668
1989	1200	1440	2965	463	4.65	3.2	18005
1990	1200	1381	3379	380	4.72	3.1	18364
1991	1200	1328	3477	414	4.38	3	18420
1992	1000	1077	3723	426	4.58	2.9	18600
1993	1200	1260	3712	444	4.53	2.8	18702
1994	1100	1128	4222	886	4.54	2.8	19169

Sources: IMF/IFS yearbooks (various years), SIS, Turkey (1994; 1996), OECD Labour Force Statistics Yearbooks (various years), SIPRI yearbooks (various years), US ACDA (1994; 1995; 1996)

- ArmImp: Arms imports of Turkey (current million US$)
- ArmImp(95): Arms imports of Turkey (1995 prices; million US$)
- WorldEx: World exports Average (current billion US$)
- EXRT: Real exchange rate
- L: Employed labour force (person)
- GRE: Share of defence expenditures in Greece's GDP
- NATO: Average share of defence burden of NATO countries

Table A5.1.2. Estimation Results (Level) (Turkey)

	Exogenous variables	OLS	2SLS
Growth equation	Constant	-24075000 (-9.05)***	-24346000 (-7.14)***
	S	0.77 (5.34)***	0.48 (1.98)*
	B	-0.52 (-1.66)	-0.58 (-0.99)
	M	3.80 (2.89)***	5.74 (2.38)**
	L	2.51 (10.71)***	2.48 (7.96)***
	Diagnostic tests	R^2: 0.99 DW: 0.42	1102840
Saving Equation	Constant	-2471300 (-6.61)***	-2227200 (-4.90)***
	M	1.93 (1.38)	5.97 (2.41)**
	B	1.01 (3.49)***	1.70 (3.00)***
	Y	0.29 (4.10)***	0.12 (1.00)
	INF	-13931 (-1.55)	-17244 (-1.46)
	Diagnostic tests	R^2: 0.93 DW: 0.69	11274400
Balance of trade equation	Constant	-1492900 (-2.94)***	-1569000 (-2.99)***
	M	-2.36 (-3.27)***	-3.15 (-2.95)***
	Y	0.10 (2.70)**	0.14 (2.57)**
	EXRT	1205 (2.91)***	1231 (2.94)***
	DUM60	-490140 (-0.78)	-476390 (-0.76)
	DUM70	-587640 (-0.96)	-1569000 (-1.03)
	Diagnostic tests	R^2: 0.53 DW: 2.08	564560
Defence equation	Constant	377000 (1.09)	377000 (1.10)
	PCI	0.25 (5.95)***	0.25 (6.04)***
	GRE	53208 (2.06)**	53208 (2.09)**
	NATO	109400 (-1.55)	-109400 (-1.15)
	DUMCYP	184640 (1.49)	184640 (1.51)
	DUMKUR	-55265 (-0.32)	-55265 (-0.33)
	Diagnostic tests	R^2: 0.96 DW: 0.89	112755

t statistics in the parenthesis

For 2SLS estimation; loglik=--2038.11 T=39 and LR test of over-identifying restrictions: $Chi^2(22)$ =72.76 [0.0000]

Y= real gross national product

S= real gross saving,

B= real balance of trade,

M= Real defence expenditure,

L= Employed labour force.

PCI= Per capita income,
INFRT= Inflation rate.
EXRT= Real exchange rate,
GRE= Greek military expenditures as a share of GDP
NATO= Average share of defence burden of NATO countries (excluding Greece and Turkey) (first difference)
DUMKUR= Dummy variable for conflict between Kurdish separatist and Turkey. This dummy takes a value of one for the years 1989-1994.
DUMCYP= Impulse dummy variable for year 1975 to absorb shock change in defence spending due to war between Turkey and Cyprus.
DUM60= Impulse dummy variable for year 1960 to absorb shock change in the exchange rate
DUM70= Impulse dummy variable for year 1970 to absorb shock change in the exchange rate
Notes: All computations in this study have been carried out by PC-GIVE 8.0 and PC-FIML 8.0 (See Doornik and Hendry, 1994; 1995)

Table A5.1.3. Correlation of Residuals (Turkey)

	ΔY	ΔS	ΔB	ΔM
ΔY	1000			
ΔS	-0.1766	1000		
ΔB	-0.07750	-0.5120	1000	
ΔM	-0.3384	-0.3453	0.2915	1000

For 2SLS estimation

Table A5.1.4. Estimates of Balance of Trade Equation Using Arms Imports (Turkey)

Dependent variable: Balance of Trade (1967-1994)				
	Level		First difference	
	Coefficient	t statistics	Coefficient	t statistics
Constant	-1.60*	-1.94	5.61**	2.74
ArmImp	-1.51	-0.35	-2.42	-0.75
Y	-0.21***	-3.03	-0.38***	-2.93
EXRT	3118***	4.33	3681***	2.96
WORLDEX	2.08*	1.92	1.04	0.88
DUM70	-1.36*	-1.80	-2.12**	-2.24
Trend	2.74***	3.19	-	-
R^2	0.58		0.61	
DW	1.82		2.20	

* significant at least 10%
** significant at least 5 %
*** significant at least 1 %

ArmImp: Growth rate of arm imports (US ACDA 1995 US million $)
Y: real gross national product
B: real balance of trade
EXRT: Real exchange rate
DUM70: Impulse dummy variable for year 1970 to absorb shock change in the exchange rate
WorldEx: Growth rate of World exports
Notes: All computations in this study have been carried out by PC-GIVE 8.0 and PC-FIML 8.0 (See Doornik and Hendry. 1994; 1995)

Table A5.1.5. The Engle-Granger First Stage (Long-run) Estimation for Defence Equation (1955-1994) (Turkey)

	Constant	PCI	GRE_{-1}	$NATO_{-1}$	CYP	DUMKUR	Trend
M	-596940***	2.44***	27848	3144.3	185270	451360***	9214.7
t statistics	-3.30	2.85	0.89	0.68	1.25	3.58	1.17
Statistics							
R^2	0.95		F statistics		111.82***		
DW: 075		DF: -3.127		ADF: -4.443			

* significant at 10%
** significant at 5%
*** significant at 1%

Table A5.1.6. The Engle-Granger Second Stage (Short-run and ECM) Estimation for Defence Equation (1955-1994) (Turkey)

Dependent Variable ΔM			
Explanatory Variables	Coefficient	t statistics	probability
Constant	-2938.2	-0.22	0.82
ΔPCI	2.34***	4.92	0.00
ΔGRE_{-1}	33666*	1.81	0.07
$\Delta NATO_{-1}$	-2073.4	-1.20	0.23
CYP	286430***	3.97	0.00
DUMKUR	119750***	3.84	0.00
RES_{t-1}	-0.45***	-4.44	0.00
Summary Statistics		Diagnostic	
R^2	0.78	AR 1- 2F(2, 29)	2.47
DW	1.42	ARCH 1 F(1, 29)	0.28
SE	67536.3	NORM $chi^2(2)$	0.57
F (3, 31)	19.288	Xi^2 F(21, 9)	0.26
		RESET F(1, 30)	0.06

Where PCI is per capita income, GRE is Greek defence burden,NATO is average NATO's defence burden excludin Greece and Turkey, CYP is Cyprus dummy and DUMKUR is Kurdish dummy variable, RES is Residuals from cointegrating regression and Δ represents first differences of variables.
* significant at 10%
** significant at 5%
*** significant at 1%

Table A5.1.7 Turkey's Economic Growth and Defence Burden (1924-1996)

Year	Economic Growth (%)	Defence Burden (%)	Year	Economic Growth (%)	Defence Burden (%)	Year	Economic Growth (%)	Defence Burden (%)
1924	14.8	2.7	1948	25.8	5.1	1972	9.2	3.4
1925	12.9	4.1	1949	-5.0	5.7	1973	4.9	3.3
1926	18.2	3.5	1950	9.4	4.5	1974	3.3	3.2
1927	-12.8	4.6	1951	12.8	4.0	1975	6.1	3.3
1928	11.0	3.9	1952	11.9	4.5	1976	9.0	3.6
1929	21.6	3.0	1953	11.2	4.4	1977	3.0	3.7
1930	2.2	3.7	1954	-3.0	5.2	1978	1.2	3.1
1931	8.7	3.8	1955	7.9	6.1	1979	-0.5	3.3
1932	-10.7	3.5	1956	3.2	4.4	1980	-2.8	3.8
1933	15.8	3.7	1957	7.8	3.6	1981	4.8	3.5
1934	6.0	4.6	1958	4.5	4.0	1982	3.1	2.8
1935	-3.0	4.6	1959	4.1	4.0	1983	4.2	3.2
1936	23.2	4.0	1960	3.4	3.7	1984	7.1	2.9
1937	1.5	4.4	1961	2.0	4.4	1985	4.3	2.7
1938	9.5	4.5	1962	6.2	4.1	1986	6.8	2.8
1939	6.9	7.6	1963	9.7	3.9	1987	9.8	2.5
1940	-4.9	11.4	1964	4.1	4.2	1988	1.5	2.2
1941	-10.3	10.2	1965	3.1	4.1	1989	1.6	2.6
1942	5.6	7.6	1966	12.0	3.8	1990	9.4	2.8
1943	-9.8	5.9	1967	4.2	3.8	1991	0.4	3.0
1944	-5.1	8.3	1968	4.1	3.8	1992	6.4	3.3
1945	-15.3	4.5	1969	4.3	3.4	1993	8.0	3.0
1946	31.9	5.3	1970	4.4	3.4	1994	-5.5	3.0
1947	4.2	6.4	1971	7.0	3.8	1995	8.0	3.1
						1996	7.1	3.2

Sources: SIS Turkey (1994; 1996). Ministry of Finance (1993; 1995) and SPO (State Planning Organisation) Turkey (1998)

APPENDIX 6.1.

Greece

Introduction: This appendix presents the various series used for estimation and descriptive statistics for Greece.

Table A6.1.1 List of Series Used in Estimation (Greece)

Year	GNP	I	M	P	GDP DEF
1958	2856	539	135	8170000	3.30
1959	2927	627	141	8260000	3.35
1960	3063	798	148	8330000	3.45
1961	3420	774	144	8400000	3.50
1962	3583	783	143	8450000	3.56
1963	4003	757	151	8480000	3.55
1964	4352	905	154	8510000	3.66
1965	4861	1052	171	8550000	3.69
1966	5366	1139	189	8610000	3.80
1967	5651	1126	241	8720000	3.90
1968	5990	1360	275	8740000	4.00
1969	6622	1600	311	8770000	4.10
1970	7079	1644	330	8790000	4.30
1971	7686	1893	352	8830000	4.40
1972	8420	2278	374	8890000	4.60
1973	9040	2467	361	8930000	5.50
1974	8688	1873	360	8960000	6.70
1975	9219	1865	612	9050000	7.50
1976	9883	2035	662	9170000	8.60
1977	10247	2282	698	9270000	9.70
1978	10853	2527	708	9360000	11.00
1979	11238	2818	685	9450000	13.10
1980	11478	2686	630	9640000	15.40

Year	GNP	I	M	P	GDP DEF
1981	11463	2480	776	9730000	18.40
1982	11445	2233	766	9790000	23.00
1983	11349	2277	706	9850000	27.40
1984	11538	2130	753	9900000	33.00
1985	11814	2269	830	9930000	38.80
1986	11945	2233	742	9960000	45.60
1987	11917	2063	754	9980000	52.10
1988	12445	2720	653	10000000	72.30
1989	12912	2956	608	10040000	82.80
1990	12867	3028	612	10090000	100.00
1991	13328	2845	588	10200000	118.00
1992	13378	2744	617	10310000	135.30
1993	13343	2600	605	10354000	154.30
1994	13536	2541	615	10430000	171.20

Sources: IMF/IFS Yearbooks, SIPRI Yearbooks

- GNP: Real Gross Natioanl Product (1990 constant prices; billion Greek Drachmas)
- I: Real Gross Fixed Investment 1990 constant prices; billion Greek Drachmas)
- M: Real defence expenditure 1990 constant prices; billion Greek Drachmas)
- P: Population (person)
- GDP DEF: Greece's GDP deflator (1990=100)

Table A6.1.2. Descriptive Statistics of Variables (1958-1994) (Greece)

Variable	**Mean**		**Standard deviation**	
	Level	**1st difference**	**Level**	**1st difference**
Growth	0.04427	-0.0001556	0.04063	0.04046
Investment	0.2303	-0.0001911	0.03154	0.02599
Labour	0.006864	-0.00002535	0.003955	0.004140
Defence size	0.002021	0.00005502	0.006440	0.008858
Defence externality	0.04848	0.001136	0.1390	0.1903

Table A6.1.3. Correlation Matrix (Greece)

Correlation Matrix					
	Growth	Investment	Labour	Defence size	Defence externality
Growth	*1.000*	**0.5065**	**0.1787**	**0.1348**	**0.1545**
Investment	0.6167	*1.000*	**-0.002549**	**-0.1063**	**-0.09852**
Labour	-0.06585	0.08738	*1.000*	**0.03133**	**0.09445**
Defence size	0.1991	0.02661	0.1537	*1.000*	1.000
Defence externality	0.2155	0.01878	0.1592	0.9840	*1.000*

bold faces represents correlation matrix for 1st differences

APPENDIX 6.2.

Introduction: Regression Results: This Appendix presents more regression results which are not reported in Chapter 6

Table A6.2.1. Regression with Proxy of Labour Force (1964-1994) (Greece)

Dependent variable: Economic Growth					
	1	2	3	4	5
Constant	-0.13 (-3.28)***	0.13 (-3.39)***	-0.12 (-3.23)***	0.01 (0.18)	0.05 (1.24)
Investment	0.74 (4.09)***	0.74 (4.14)***	0.71 (4.17)***	0.41 (2.30)**	0.30 (2.11)**
Labour	0.50 (1.43)	0.58 (1.65)	0.43 (1.29)	0.23 (0.78)	0.07 (0.31)
Defence size	1.18 (1.41)	-4.82 (-1.03)	1.09 (1.39)	0.23 (0.30)	-0.09 (-0.16)
Defence externality	-	0.28 (1.31)	-	-	-
Cyprus dummy	-	-	-0.06 (-2.10)**	-	-0.09 (-4.13)***
Trend	-	-	-	-0.002 (-3.54)***	-0.003 (-5.31)***
R^2	0.46	0.50	0.540	0.63	0.78
DW	1.06	1.18	0.94	1.58	1.39

t statistics in paranthesis
* significant at least 10%
** significant at least 5 %
*** significant at least 1 %
Note: Labour force data were taken fromvarious issues of OECD Historical Statistics
1. Using equation (6.11)
2. Using equation (6.12)
3. Using equation (6.11) with Cyprus dummy
4. Using equation (6.11) with trend
5. Using equation (6.12) with trend and Cyprus dummy

The variables used in the estimation were measured as follows: Economic growth ($\Delta Y/Y$): Dependent variable of the model is measured as the annual rate of growth of output. In order to do this, the difference between current value of real GNP and previous year real GNP is divided by the previous years real GNP. Labour force ($\Delta L/L$): growth rate of labour force. Growth rate is calculated as explained above. Investment (I/Y): Investment

GNP ratio. Real gross fixed capital of Greece is divided by previous year's real GNP. Defence size (ΔM/Y): The difference of real military expenditure between current and previous years are divided by the previous year real GNP. Defence externality (ΔM/M): Real growth rate of defence expenditure. It is calculated as in the above variables.
Notes: All computations in this study have been carried out by PC-GIVE 8.0 (See Doornik and Hendry, 1995)

Table A6.2.2. Regression with Proxy of Labour Force (First Difference) (Greece)

Dependent variable: Economic Growth 1965-1994			
	1	2	3
Constant	-0.002 (-0.49)	-0.002 (-0.48)	-0.001 (-0.26)
Investment (1st diff.)	1.07 (5.12)***	1.06 (4.98)***	0.88 (3.15)***
Labour (1st diff.)	-0.23 (-1.03)	-0.21 (-0.90)	-0.19 (-0.80)
Defence size (1st diff.)	1.15 (2.11)**	0.03 (0.01)	-0.19 (-0.06)
Defence externality (1st diff.)	-	0.05 (0.40)	0.06 (0.46)
Cyprus dummy	-	-	-0.03 (-0.98)
R^2	0.50	0.51	0.52
DW	2.20	2.20	2.19

t statistics in paranthesis
* significant at least 10%
** significant at least 5 %
*** significant at least 1 %
Note: Labour force data were taken fromvarious issues of OECD Historical Statistics
1. Using equation (6.11)
2. Using equation (6.12)
3. Using equation (6.11) with Cyprus dummy

The variables used in the estimation were measured as follows: Economic growth (ΔY/Y): Dependent variable of the model is measured as the annual rate of growth of output. In order to do this, the difference between current value of a real GNP and previous year real GNP is divided by the previous years real GNP. Labour force (ΔL/L): growth rate of labour force. Growth rates is calculated as explained above. Investment (I/Y): Investment GNP ratio. Real gross fixed capital of Greece is divided by previous year's real GNP. Defence size (ΔM/Y): The difference of real military expenditure between current and previous years are divided by the previous year real GNP. Defence externality (ΔM/M): Real growth rate of defence expenditure. It is calculated as in the above variables.
Notes: All computations in this study have been carried out by PC-GIVE 8.0 (See Doornik and Hendry, 1995)

APPENDIX 6.3.

Introduction: This appendix presents the various series used for estimation of Deger type multi-equation model.

Table 6.3.1. List of Series Used in Estimation (Greece)

Year	GNP	S	B	M	POP	INFRT	PCI	TUR	NATO
1958	2856	315	-276	135	8170000	0.63	239	3.82	4.60
1959	2927	364	-305	141	8260000	-2.52	354	4.51	4.60
1960	3063	348	-441	148	8330000	1.55	368	4.73	4.40
1961	3420	494	-397	144	8400000	2.41	407	5.06	4.50
1962	3583	474	-354	143	8450000	1.49	424	4.91	4.70
1963	4003	549	-304	151	8480000	-0.86	472	4.72	4.50
1964	4352	656	-410	154	8510000	4.93	511	4.83	4.40
1965	4861	683	-550	171	8550000	-3.29	568	4.98	4.20
1966	5366	839	-395	189	8610000	8.51	623	4.37	4.20
1967	5651	808	-410	241	8720000	3.14	648	4.53	4.40
1968	5990	897	-515	275	8740000	0.65	685	4.59	4.30
1969	6622	1178	-583	311	8770000	0.00	755	4.32	4.00
1970	7079	1265	-581	330	8790000	3.88	805	4.24	3.90
1971	7686	1464	-609	352	8830000	4.08	870	4.42	3.90
1972	8420	1820	-683	374	8890000	5.88	947	4.14	3.80
1973	9040	2211	-967	361	8930000	24.07	1012	3.94	3.50
1974	8688	1555	-804	360	8960000	31.34	969	3.71	3.70
1975	9219	1549	-897	612	9050000	7.95	1018	5.64	3.80
1976	9883	1840	-791	662	9170000	13.68	1077	6.03	3.70
1977	10247	1804	-835	698	9270000	13.89	1105	5.70	3.60
1978	10853	1995	-743	708	9360000	10.57	1159	5.13	3.60
1979	11238	2216	-849	685	9450000	20.59	1189	4.24	3.50
1980	11478	2119	-592	630	9640000	28.66	1190	4.19	3.50
1981	11463	1622	-727	776	9730000	22.75	1178	4.78	3.70
1982	11445	1605	-1153	766	9790000	17.37	1169	5.13	3.80
1983	11349	1628	-1153	706	9850000	19.74	1152	4.82	3.50

Year	GNP	S	B	M	POP	INFRT	PCI	TUR	NATO
1984	11538	1823	-953	753	9900000	20.05	1165	4.37	3.50
1985	11814	1676	-1381	830	9930000	20.37	1189	4.44	3.50
1986	11945	1598	-1031	742	9960000	18.44	1199	4.74	3.40
1987	11917	1326	-876	754	9980000	9.79	1194	4.23	3.40
1988	12445	1788	-1114	653	10000000	10.09	1244	3.77	3.20
1989	12912	1622	-1431	608	10040000	12.88	1286	4.20	3.20
1990	12867	1419	-1640	612	10090000	17.65	1275	4.83	3.10
1991	13328	1639	-1554	588	10200000	17.90	1306	5.16	3.00
1992	13378	1569	-1354	617	10310000	12.13	1297	5.30	2.90
1993	13343	1448	-1343	605	10354000	12.03	1289	5.38	2.87
1994	13536	1504	-1267	615	10430000	8.64	1297	5.20	2.80

Sources: IMF/IFS yearbooks (various years); SIPRI yearbooks (various years).

- GNP: Real Gross Natioanl Product (1990 constant prices; billion Greek drachmas)
- S: Real Gross savings (1990 constant prices; billion Greek drachmas)
- B: Real balance of trade (1990 constant prices; billion Greek drachmas)
- M: Real defence expenditure (1990 constant prices; billion Greek drachmas)
- POP: Greek population
- INF: Inflation rate
- PCI: Per capita income (1990 constant prices; thousand Greek drachmas)
- TUR: Share of defence expenditures in Turkey's GDP
- NATO: Average share of defence burden of NATO countries

APPENDIX 6.4.

Introduction: Further Regression Results (Deger Model)

Table A6.4.1. OLS Estimation Results (1958-1994) (Greece)

Share Estimation			Level Estimation		
	Exogenous variables	**Share of variables**		**Exogenous variables**	**Level**
Growth equation ($\Delta Y/Y$)	Constant	0.05 (0.90)	Growth equation (Y)	Constant	-25324 (-13.36)***
	(S/Y)	0.52 (2.71)**		(S)	1.93 (11.76)***
	(B/Y)	0.004 (0.01)		(B)	-0.78 (-2.45)**
	(M/Y)	-1.76 (-0.10)		(M)	0.80 (1.39)
	($\Delta P/P$)	-0.16 (-0.10)		(POP)	3302 (13.76)***
	Diagnostic tests	R^2: 0.37		Diagnostic tests	R^2: 0.99
		DW: 1.51			DW: 1.09
Saving Equation (S/Y)	Constant	0.12 (3.56)***	Saving equation (S)	Constant	272.24 (2.13)**
	(M/Y)	0.21 (0.55)		(M)	0.02 (0.05)
	(B/Y)	0.40 (2.01)**		(B)	0.65 (2.44)**
	($\Delta Y/Y$)	0.67 (5.65)***		(Y)	0.15 (3.15)***
	INFRT	0.002 (4.85)***		(INFRT)	19.84 (2.84)***
	Diagnostic tests	R^2: 0.61		Diagnostic tests	R^2: 0.80
		DW: 0.81			DW: 0.96
Defence equation (M/Y)	Constant	0.04 (3.09)***	Defence equation (M)	Constant	-165.75 (-1.78)
	PCI	-0.0001 (-2.68)**		PCI	0.03 (0.43)
	TUR	0.001 (0.36)		TUR	40.40 (2.05)**
	NATO	0.00001 (1.60)		NATO	0.29 (7.10)***
	DUMCYP	0.015 (2.01)**		DUMCYP	98.18 (1.57)
	Diagnostic tests	R^2: 0.62		Diagnostic tests	R^2: 0.94
		DW: 0.43			DW: 0.66

t statistics in the parenthesis
Y= real gross national product
S= real gross saving
B= real balance of trade
M= Real defence expenditure
P= Population
PCI= Per capita income
INFRT= Inflation rate
TUR= Turkish military expenditures as a share of GDP
NATO= Average share of defence burden of NATO countries (excluding Greece and Turkey)
DUMCYP= Cyprus war dummy. The dummy took value of one between 1975 and 1981 and zero elsewhere..
Notes: All computations in this study have been carried out by PC-GIVE 8.0 and PC-FIML 8.0 (See Doornik and Hendry. 1994; 1995)

APPENDIX 7.1.

List of Series Used in Estimation

Introduction: This Appendix presents the data set used in Chapter 7

Table A7.1.1. Turkish Disaggregated Data

Year	EQU	PER	INRS	OTH	TDEF
1975	25.2	-	-	-	1118519
1976	28.5	-	-	-	1271594
1977	21.9	-	-	-	1244750
1978	18.5	-	-	-	1162088
1979	9.1	-	-	-	951714
1980	4.7	-	-	-	928280
1981	9.4	-	-	-	1102349
1982	10.8	-	-	-	1240416
1983	10.1	-	-	-	1202458
1984	13.1	-	-	-	1555459
1985	13.6	36.9	7.3	41.8	1235000
1986	17.9	33.3	6.1	42.6	1425954
1987	21.2	34.7	5.9	38.3	1365491
1988	22.5	35.6	4.5	37.5	1261738
1989	18.5	42.3	4.0	35.2	1434182
1990	20.7	46.1	3.4	29.8	1798677
1991	22.7	48.5	2.8	26.0	1927957
1992	24.8	48.7	3.5	23.0	2109576
1993	22.9	54.5	2.9	19.7	2385179
1994	29.3	51.0	2.6	17.1	2184662
1995	29.7	50.9	2.5	16.9	2410347
1996	30.8	46.2	3.0	19.9	2734156
1997	32.6	43.7	3.0	20.7	-

Sources: NATO Review (various issues)

- EQU represents Turkish equipment spending share in the total defence spending
- PER represents Turkish personnel spending share in the total defence spending
- INFR represents Turkish infrastructure spending share in the total defence spending
- OTH represents Turkish other operational spending share in the total defence spending
- TDEF is real Turkish defence spending (1985 constant million Turkish Liras)

Table A7.1.2. Greek Disaggregated Data

Year	EQU	PER	INFRS	OTH	TDEF
1977	20.3	-	-	-	698
1978	18.1	-	-	-	707
1979	17.7	-	-	-	685
1980	18.8	-	-	-	629
1981	20.5	-	-	-	776
1982	17.0	-	-	-	766
1983	15.9	-	-	-	705
1984	15.3	-	-	-	752
1985	14.5	59.6	3.1	23.3	830
1986	15.8	61.8	1.9	20.5	742
1987	17.2	61.7	1.9	19.2	754
1988	23.3	58.2	2.3	16.1	653
1989	21.9	61.5	2.6	14.0	608
1990	21.8	63.7	3.3	11.2	612
1991	20.3	64.4	1.7	13.6	588
1992	23.4	61.4	2.4	12.8	617
1993	24.7	62.2	2.6	10.5	605
1994	24.4	63.0	0.6	12.0	615
1995	19.8	63.3	1.9	14.9	626
1996	21.1	61.2	1.5	16.2	658
1997	19.4	62.2	2.1	16.2	-

Sources: NATO Review (various issues)

●EQU represents Greek equipment spending share in the total defence spending
●PER represents Greek personnel spending share in the total defence spending
●INFR represents Greek infrastructure spending share in the total defence spending
●OTH represents Greek other operational spending share in the total defence spending
●TDEF is real Greek defence spending (1990 constant billion Greek Drachmas)

APPENDIX 7.2.

Further Regression Results

Introduction: This Appendix presents some more regression results which were not reported in Chapter 7.

Table A7.2.1. OLS Regression Results using Equipment Spending and Non-equipment Spending Variables Separately (Turkey)

Dependent Variable LY (1975-1996)		
	Coefficient	t statistics
Constant	-0.25 (-0.32)	-7.38 (-0.94)
LI	0.10 (1.97)*	0.19 (4.74)***
LL	0.90 (1.96)*	1.17 (2.68)**
LEQU	0.03 (2.00)*	-
LNEQU	-	0.01 (0.22)
Trend	0.02 (2.13)**	0.01 (1.13)
R^2	0.99	0.99
F	664.33***	538.31***
DW	1.75	1.58

Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending and NEQU is non-equipment defence spending. L represents natural logarithms.

Table A7.2.2. OLS Regression Results using Four Different Types of Defence Spending (Turkey)

Dependent Variable LY		
	Coefficient	t statistics
Constant	1.77	0.06
LI	0.21	1.23
LL	0.72	0.44
LEQU	-0.06	-0.44
LPER	-0.02	-0.22
LINFRS	-0.01	-0.17
LOTH	0.06	0.42
Trend	0.03	0.63
R^2	0.98	
F	42.86***	
DW	2.58	

Y is GDP, I is gross fixed investment, L is labour, EQU is defence equipment spending, PER is personnel spending, INFRS is spending on infrastructure and OTH isother operational defence expenditures. L represents natural logarithms.

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