

**DEFENCE SPENDING AND ECONOMIC GROWTH:
A CASE STUDY OF GREECE AND
COMPARISON WITH SPAIN AND PORTUGAL
(1960-1996)**

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■ ABSTRACT

This thesis provides a case study of the economic effects of military expenditure in Greece and a comparison with two other similar countries, Portugal and Spain. Greece provides a particularly valuable focus for empirical investigation since for many years it has been allocating a relatively high proportion of its national income to defence, much higher than other countries in NATO and EU. It is also situated in a complex geostrategic environment (the Balkans) and has many security concerns, in particular the confrontation with Turkey. At the same time, the Greek economy has gone through periods of high economic growth as well as periods of stagnation and has been the poorest member of the EU for the last two decades. Lack of a consensus on the economic effects of defence spending as well as the limited amount of research on the issue in newly industrialised economies intrigued the author and led to this research on whether high military expenditure has contributed to this poor economic performance.

In this way the thesis contributes to an ongoing debate in the literature and provides a valuable additional case study. It provides a further contribution by comparing the results of the analysis for Greece with two similar economies, Spain and Portugal, giving insights into the transferability of results across countries. In undertaking this analysis, a systematic empirical approach is taken which employs three different methodologies: a Granger causality analysis, a supply-side analysis and a demand and supply analysis, all enriched with advanced econometric techniques.

Overall, the results for Greece suggest that the high military burden has been harmful to economic performance and has made a significant contribution to the backwardness of the economy. While the results for Portugal and Spain show some differences, they do not contradict the overall conclusion for Greece. Portugal shows a clear negative effect of military burden while the results for Spain are much less clearcut.

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AUTHOR'S DECLARATION

Papers based on the work in this thesis have been published and presented at international conferences. Specifically:

A paper based on Chapter 5 is forthcoming as 'The Econometrics of Arms Races' in *Defence and Peace Economics*. Another paper based on Chapter 5, is forthcoming as 'Arms Race Models and Econometric Applications' in Levine, P., Sen, S. & Smith, R. (eds) (2000), *The Arms Trade, Security and Conflict*, Harwood Academic Publishers. Also available as *Economics Discussion Paper*, No. 74, Middlesex University Business School, July 1999.

A paper based on Chapter 6, is forthcoming as 'Defence Spending and Economic Growth: A Causal Analysis for Greece and Turkey' in *Defence and Peace Economics*. Also available as *Economics Discussion Paper*, No. 56, Middlesex University Business School, December 1998.

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INTRODUCTION

The seminal study of Emile Benoit (1973,1978) and its “provocative findings” that defence spending stimulates economic growth in less developed countries (LDCs) was the starting point for a lot of research activity on the economic effects of defence spending. Despite the number of studies since then, no conclusion has been reached and the debate on the empirical question “does defence spending promote or hinder growth” is still on. Most of the studies deal with cross-section analyses of large groups of countries trying to find universal patterns for the defence-growth relationship applicable to all places and times which is likely to be disappointing. As Chan (1985) mentioned, “the claims to generality based on the results of such a search tend to entail substantial costs in empirical sensitivity and specificity”, (Chan, 1985, p.433). Until now most research on the economic effects of military expenditure in individual countries has focused either on economies at the forefront of development or alternatively on less developed countries. So far, there has been almost absence of studies addressing the effect of military expenditure on economies that are at an intermediate level of development like for example, Greece, Portugal and Spain.

These three Mediterranean countries are examples of semi-industrialised economies, that have followed a very similar pattern of development, have all emerged from dictatorships in the mid-1970s and are characterised as the “peripheral countries” of the European Union. Despite the economic similarities, though, their military spending have followed quite different patterns. Concentrating on the period 1960-1996, Greece has always spent more on defence than the two other countries, with Portugal being a high defence spender until 1974 (by which year the colonial wars as well as the dictatorship had ended) and Spain allocating a small share of its GDP on defence throughout this period. Among the three, only Greece - even after the end of the Cold War - continues to allocate a significant share of its GDP for defence (in 1996 military burden for Greece was 4.5% compared to 2.8% for Portugal, 1.5% for Spain, and 2.9% for NATO for the same year). Furthermore, Greece faces important security considerations, the long-term hostility and turmoil with its neighbouring country Turkey, not to mention the unstable environment of the Balkans where it is situated. What makes the Greek security considerations even more complicated is the fact that both Greece and its adversary, Turkey, are members of the same alliance (NATO). Being the poorest member of the EU and struggling to improve its economic condition, high defence spending would seem irrational if it were not for these security considerations.

But does high military spending in Greece contribute to the poor economic performance of the country? And is this also the case for Portugal and Spain, two countries that share many common characteristics with Greece? These questions form the basis of this thesis, which takes an empirical approach to investigating the

economic effects of military expenditure in Greece and later considers a comparison with the two similar countries.

Before providing the structure of the thesis it is important to consider three methodological issues. First, the use of a case study approach is considered as more appropriate than the cross-country comparative approach for examining the economic effects in a country like Greece that has features of both developed and underdeveloped countries. The case study allows to take into consideration all the specific information which is unique for the country. Incorporation of this information in an empirical model reduces possible misspecification and leads to a more insightful explanation of the results. Second, the empirical investigation of the defence-growth relationship in Greece does not rely on a single model but rather on three different types of models based on different theoretical grounds to provide a more coherent and completed analysis of the issue. Third, the application of the same models over the same period (1960-1996) on two countries that share many common characteristics with Greece provides a valuable comparison and a unique way of examining the economic effects of defence spending in similar economies, as differences in sample period, data and model specification that usually lead to diversity in results are overcome while at the same time misspecification is reduced by accounting for structural breaks.

This thesis, therefore, makes an important contribution to understanding a very significant but under-researched topic not only in the Greek economy but in all three Mediterranean economies (Greece, Spain and Portugal).

As usual, prior to any empirical investigation a consideration of what economic theory and previous empirical studies have to say about the economics of militarism is necessary. Chapters 2 and 3 survey the theoretical and empirical literature on the topic while they discuss some methodological and military data issues. It becomes evident that in recent years there is a tendency for empirical studies to be based on a well-grounded theory and to rely on more advanced econometric techniques. Despite that, review of the empirical studies indicates that there is still no consensus on the defence-growth relationship mainly because of the differences in specification, in data used and time periods examined. Chapter 4 gives a background analysis of the Greek politics, economy and military spending, defence industries and security considerations. It is not difficult to realise that a country like Greece with poor economic performance and an underdeveloped defence industry continues to spend a lot on defence because of its security concerns - the general unstable environment of the Balkans where it is situated but basically the perceived threat from its Eastern neighbour country, Turkey. It becomes evident then that the evolution of military spending in Greece must be understood in conjunction with the perceived external threat from Turkey. So, prior to investigating the economic effects, it seems sensible to investigate the determinants of military expenditure in Greece. This is done in Chapter 5 which first discusses the most commonly used models for the determinants of military expenditure, and then employs an arms race model and a general model of aggregate demand. In the first case the existence of an arms race between Greece and its potential enemy Turkey is investigated to see if each country's spending is influenced by the other's. Application of the widely used but poorly performing Richardson model brings out its many deficiencies and possible ways to deal with them are suggested. Specifically, a Vector Error Correction Model

(VECM) representation of the Richardson model that uses the notion of cointegration is proposed and extensively analysed within the Johansen framework. In the second case - a general model of aggregate defence spending - the demand for military expenditure is modelled in the Neoclassical framework by defining a welfare function which is maximised subject to resource and security constraints. This is then estimated by the Ordinary Least Squares (OLS) method.

Once the demand for military expenditure is estimated, investigation of the defence spending-economic growth relationship follows in Chapters 6, 7, and 8. Each of these chapters develops and estimates three different models to provide a more comprehensive analysis of the defence-growth relationship itself but also to show how different model specifications lead to different empirical results. Specifically, Chapter 6 starts off by the atheoretical Granger causality approach which aims to show the causation between the two variables (military burden and economic growth). This is analysed within a Vector Autoregression (VAR) framework taking into consideration the existence of a long-run relation between the variables by testing for cointegration as well as possible structural breaks. Once the endogeneity or exogeneity of the variables in question is established the development and estimation of two structural models is considered. Chapter 7 specifies a widely employed supply-side model - the Feder-type model - which is based on a Neoclassical production function. Unlike most of the previous studies that employ a restrictive version of the model (i.e. the economy consisting only of two sectors, the civilian and the military), here four sectors are assumed (the civilian, military, government and export) after non-nested tests suggested that the less restrictive form is preferred to the more restrictive. Furthermore, this model identifies both the size

(total) effect of each sector, as well as the externality effects and the relative productivity differences. The method of estimation is OLS. Chapter 8 specifies a demand and supply model consisting of four equations (growth, savings, trade balance and military expenditure). Each individual equation is estimated by OLS and Two Stage Least Squares (2SLS) initially. At a later stage all four equations form a system which is estimated by a system method, Three Stage Least Squares (3SLS), to deal with problems of simultaneity and high covariances.

Once the empirical estimation of the three models for Greece is completed, the impact of military spending on economic growth in Spain and Portugal is considered. Chapter 9 provides the necessary background analysis of the Portuguese and Spanish economies which brings out many similarities with the Greek economy but more importantly considers the unique features that need to be taken into account in the empirical models. The next stage is to apply the models developed for Greece on Portuguese and Spanish data taking into account specific structural breaks. This is done in Chapter 10 which provides empirical estimations for Portugal and Spain of the Granger causality approach, the Feder-Ram model and the demand and supply simultaneous equation model. In the same chapter a comparison with Greece based on each different model as well as overall takes place. Finally, Chapter 11 discusses the main conclusions as well as the limitations of the study and it makes some suggestions for future research on the issue.

THEORETICAL APPROACHES TO THE ECONOMICS OF MILITARY EXPENDITURE

2.1. Introduction

Defence spending is considered to be a public good¹ and its main objective is to provide national security and to protect national interests. As a part of government expenditure, it constitutes a significant share of global resources but despite its significant size, its economic impact has only recently been an issue of analysis in economic theory. And although the determination of a country's defence budget is the result of political choices within certain economic constraints that the country faces, it is not uncommon for resource-constrained countries (like LDCs) to spend a large proportion of their national income on defence in the name of national security (the common justification that policy makers provide). Obviously then, the level of military expenditure is influenced apart from economic factors, also by the extent each country perceives external threat, as well as by moral issues, the aggressiveness, imperialistic views and the ideology of each nation.

¹ As a public good, defence is non-rival (there is no additional cost when extra members are added to the population) and non-excludable (it is either impossible or too costly to exclude any individual from the benefits or disbenefits of defence), Ridge & Smith (1991).

It then follows, that military expenditure is not a purely economic issue but rather a mixture of economic, political, strategic, psychological, cultural and even moral aspects and as a result its theoretical analysis becomes very difficult. Although economic theory doesn't have an explicit role for military spending as a separate economic activity, there are four basic theoretical approaches (the Keynesian, the Neoclassical, the Liberal and the Marxist) that explain military expenditure from different points of view².

2.2. The Keynesian School of Thought

Keynesians consider the state as an institution that stands above classes and represents the general interest of the society and military expenditure as a form of public spending that increases aggregate demand, employment and other economic variables and, through various effects, leads to economic growth. So, in the Keynesian framework, the state appears as proactive and interventionist, using military expenditure to increase output through multiplier effects when aggregate demand is ineffective (Dunne, 1995). Faini, Annez and Taylor (1984) also mention that if aggregate demand is low relative to potential supply, increases in military expenditure can lead to increased capacity utilisation, increased profits and hence, increased investment and economic growth.

In the empirical literature, Keynesian demand-side models are widely used to explain the relationship between defence spending and economic growth. In such a model,

² See also, Smith (1977), Georgiou (1983), and Dunne (1990, 1995).

actual output, Y , or potential (full employment) output, Q , is the sum of the component real demands for goods and services, i.e.

$$Y=Q-W=C+I+M+B$$

where W is the gap between actual and potential output, C is the consumption expenditure, I the investment expenditure, M the military expenditure and B the trade balance. Empirical work within this demand-concentrated framework tends to find a negative relationship between military expenditure and economic growth (through the crowding out of savings or investment). The basic disadvantage of this theory is that it focuses on demand-side issues and fails to consider supply-side issues (technology spin-offs and externalities). Smith and Smith (1980) were the first to include explicit production functions in order to overcome this problem of concentrating on the demand side only. Extensive analysis of Keynesian models is given in the next chapter.

2.3. Neoclassical School of Thought

Neoclassicals see defence spending as a pure public good supplied by the state, which recognises some well-defined national interest that it seeks to protect. So, in the Neoclassical framework the state can appear as a rational actor that tries to maximise national interest by balancing opportunity costs and security benefits of military expenditure.

In setting up a model, it is assumed that there is a well-defined social welfare function that the state wishes to maximise subject to a set of constraints. For Neoclassicals potential enemy (threat) is considered to be external to the state. In the empirical work, supply-side models of the defence-growth relationship within the neoclassical framework, derive from the aggregate production function. National output (Y) can be expressed as a function of inputs (labour, capital) and technology which is usually proxied by military expenditure,

$$Y=f(L,K,T_c)$$

A widely used supply-side model is the one developed by Feder (1982) and further elaborated by Ram (1986) and Biswas and Ram (1986)³ who considered military expenditure as an exogenous variable and estimated its dynamic real effects on output.

Supply-side models usually tend to find a positive relationship between defence and growth as they allow for some positive effects through technological developments generated in the military sector, "*unless the defence sector has a strong negative productivity effect compared with the other sectors*", (Sandler & Hartley, 1995). The advantage of this theory is that it allows the development of consistent formal models⁴. Smith argues that Neoclassical literature has very poor explanatory power because it fails to deal with the complexity and uncertainty of international relations

³ An extensive analysis of this model is presented in the empirical literature review that follows.

and the conflicting interest of groups within society. Georgiou (1983) argued that in this way Neoclassicals ignore the militarism whose origin is internal to the socio-political system.⁵ In addition, Dunne (1996) has criticised Neoclassical models for *“being ahistoric, for placing unrealistic requirements of computation and information on the ‘rational actors’, for concentrating on the supply-side and for ignoring internal political and military factors”* (Dunne, 1996, p.445).

2.4. The Liberal School of Thought

The liberal or institutional approach regards the Military Industrial Complex (MIC) as the central point in explaining military expenditure. The MIC is a powerful interest group that benefits from defence spending and thus, has an incentive to exaggerate international conflicts and to hinder attempts to settle disputes by non-military means. According to Rosen (1973), the MIC justifies its existence by manipulating - not always consciously - the fear of an external threat and it arises because the superpowers devote a considerable proportion of GNP to military expenditure.

Liberals consider peace as desirable and militarism (in the form of a war) or peacetime arms production as irrational and immoral with no significant economic

⁴ Simple Neoclassical models have little role for inertia, which is exemplified in a random walk model, common in time series. At least part of this can be captured by developing models to take account of habit and durability.

⁵ Some authors (Berthlemy, Herrera and Sen, 1995), introduced military expenditure into endogenous growth models.

role⁶. They neglect the economic role of military expenditure by avoiding asking questions about the relation between military expenditure and standard economic variables; they regard military expenditure in terms of politics only (removal or political control of the MIC)⁷. Among them only Melman (1985) and Dumas (1986) do not neglect the economic role of military expenditure and think of it as a burden⁸.

Smith (1977), criticised the liberal explanation of military expenditure which concentrates on the concept of MIC, as being compatible with an explanation that sees wars as being an accident rather than as the outcome of inter-state rivalry⁹. To illustrate this he used the following example:

“The Vietnam war can be explained by a liberal as being a ‘mistake’ generated almost unintentionally by the MIC (politicians seeking re-election, generals seeking promotion, firms seeking profits) which distorted the ‘true’, class-free national interest” (Smith, 1977, p.64).

In the long-run, even if military expenditure is harmful for the economy as a whole, it still benefits vested interests (business and professionals with specialised skills in military production). These groups may exert influence on the formulation and execution of national policy. Melman (1971) stressed the harmful effects of military

⁶ Melman (1985) and Rosen (1973) argue that military expenditure is influenced by the MIC while Allison (1971) and Halperin (1974) argue that it is influenced by the bureaucratic process within the state.

⁷ See Fine (1993) for a critical review of the literature on the “Military Industrial Complex”.

⁸ Melman (1985) and Dumas (1986) attempted to show how military spending and the presence of a “Military Industrial Complex” can contribute to a country’s declining productivity and international competitiveness.

⁹ Hartley and McLean (1978) comment on Smith (1977) and test the hypothesis of rivals and allies for the UK, US and USSR without finding a strong association of UK or US defence spending with that of the USSR. They propose a policy model for the UK (paying particular attention to the political party being in power) where UK defence spending is determined by economic, political and strategic variables. Their results indicate that UK defence spending is positively affected by GNP per capita, political and strategic factors and negatively by unemployment and the balance of payments.

expenditure on the American economy which are loss of competitiveness, development of bureaucracies, reduction of productive investment and the appearance of the MIC.

2.5. Marxist School of Thought

Marxists consider militarism and military expenditure as a social phenomenon with a historical aspect and they focus on the socio-political and strategic aspects of military expenditure and not so much on the economic ones. They argue that defence spending stimulates economic growth by preventing crises or by acting as an informal industrial policy. The classical Marxist position¹⁰ about military expenditure was developed by Lenin, Luxembourge and Kautsky. Marx himself had little to say about militarism. Engels was the one to provide some analysis of militarism - though not systematic - in his work *Anti-Duhring*. He claimed that militarism is a social and political phenomenon which has economic consequences and that in the long-run military expenditure leads to economic growth through new methods of labour and organisation of production that are first developed in the army. In discussing the army and the navy, Engels (1977) says:

¹⁰ Georgiou (1983) in analysing the different theoretical approaches on military expenditure, he considers that Marxist school of thought encompasses four approaches namely: (i) Marx and Engels, (ii) Rosa Luxembourge, (iii) Underconsumptionism and Permanent Arms Economy theory and (iv) recent non-underconsumptionists.

“Force, nowadays, is the army and navy and both as we all know to our cost are devilishly expensive. Force, however, cannot make any money... Force is conditioned by the economic order, which furnishes the resources for the equipment and maintenance of the instruction of force. Also, the army’s and navy’s armaments, composition organisation, tactics and strategy depend above all on the stage reached at the time in production and communications” (Engels, 1977, p.187-88).

Lenin (1916) in accordance with the Marxist position claimed that total wars and capitalist exploitation of the world stigmatised imperialism, which is the highest level of capitalism, and ruled-out any non-economic disarmament process without the advent of socialism.

Rosa Luxemburg (1913) was the first Marxist to deal explicitly with the political economy of military expenditure. In her work, *The Accumulation of Capital*, she argued that military expenditure is very useful for the development of capitalist economies because it works as a catalyst of primitive accumulation, as an instrument of colonial domination and finally as a hegemonic factor of capitalist countries’ struggle to divide up the world. She claimed that the economic effect of militarism or the way in which militarism affects capitalism depends on the form that military expenditure takes.

She considered that military expenditure could take two forms: (i) salaries of the army personnel and state officials and (ii) production of weapons. Then she assumed that in both cases military expenditure is financed by indirect taxation paid by the working class. For the first case - where military expenditure takes the form of salaries for military personnel - she argued that there would be no change in the reproduction of social capital as a whole. The capitalist sector does not benefit by

this form of military expenditure because - according to her - the demand for goods produced by capitalists as well as the rate of profit remain the same. Rowthorn (1980) claimed that she must have explicitly assumed that the reduction in the consumption of the working class invoked by the indirect taxation, is exactly matched by the increase in consumption of state officials and army personnel.

In the second case - where military expenditure takes the form of weapons production - she employed a numerical example using Marx's scheme of expanded reproduction, and she argued that the development of an arms sector creates a secure market for modern products and the rate of profits is increased. This happens because the indirect taxes paid by the working class can be thought of as a decrease in wages which leads to higher profits.

With regard to the operation of the Military Industrial Complex (MIC) and the pursuit of profit by individual firms, Marxists suggest that they are constrained by the "laws of motion" of the system and the interests of capitalists as a class. So, Marxists basically reject the theory of MIC as the explanation of militarism and they claim that militarism is economically functional for capitalism as a whole and not just for those groups that are directly involved in militarism.

Smith (1977), in analysing the economic and strategic role of military expenditure from a Marxist perspective, claimed that military expenditure has a necessary but also contradictory role in the maintenance of the capitalist system¹¹. He considered

¹¹ But see critique by Hartley & McLean (1978)

this type of expenditure necessary for the maintenance of the system but at the same time involving high economic costs. In an article in 1983, Smith highlighted the importance of the linkages between the political, economic and strategic aspects of the military demands. These linkages integrate the military into a more general theory of society. For Marxist writers, capitalist states use military expenditure to meet economic needs.

While Marxists generally focus on the socio-political and strategic aspects of military expenditure and not on the economic ones, there is a strand of the Marxist school -- the underconsumptionist -- that regards the purely economic functions of military expenditure.

2.5.1. The Underconsumptionist Approach

Many left-wing writers use a Keynesian or underconsumptionist framework to argue that military expenditure is necessary to offset a tendency towards stagnation within capitalism. The underconsumptionist approach within the wider Marxist framework, developed by Baran and Sweezy (1966), claims that as a capitalist economy grows richer, the available surplus grows beyond that absolutely necessary for consumption and investment. So, mature capitalist economies need defence spending to fight underconsumption because this sort of public spending allows the absorption of surplus without increasing wages, it maintains profits, and thus, it prevents realisation crises. These economies will benefit by military expenditure since unemployment will be reduced but this positive effect will end once the economy

reaches full-employment. So, within the underconsumptionist framework, military expenditure will be beneficial to growth when the economy is in disequilibrium. Smith (1977) tried to test the basic assumption of underconsumptionism (that there should be a relationship between the share of military expenditure in income and the level of prosperity) for a cross-section of 10 year averages, but failed to find this relationship.

2.5.2. The Permanent Arms Economy

Another strand within the general Marxist approach very similar to the underconsumptionist theory, is the one basically influenced by Kidron (1970) who claimed that post-war arms spending stabilised capitalism. Although he claimed that military expenditure affects positively profits, capitalist technology and demand for labour, he focused on the threat of overproduction.

Gottheil (1986), criticised Marxist literature on military expenditure as being inconsistent with Marx's analysis of capitalism. This aspect provoked a debate mainly among him, Riddel (1986), Cypher (1987b) and Miller (1987).

2.6. Channels of Military Expenditures

Reviewing the theoretical approaches on military expenditure one gets a flavour of the different ways through which it can affect economic growth. Following Deger's (1986) classification, the following channels through which military expenditure affects economic growth can be identified: a) the direct and indirect spin-offs b) the reallocation of resources and c) the creation of new resources.

2.6.1. Spin-offs

The spin-offs can take the form of additional aggregate demand creation or the form of modernisation. Military expenditure can have a positive effect on economic growth when aggregate demand is initially inadequate relatively to potential supply, since it can generate the extra demand by increased utilisation of capital stock as well as by greater employment of labour. In this case, apart from short-run multiplier effects, long-run growth can also be achieved. So, an increase in demand that results in more efficient capital utilisation can lead to an increase in the profit rate, which in turn will stimulate investment and finally increase the growth rate (Deger, 1986).

The modernisation effect of defence spending lies on the fact that many technological improvements and spin-offs arise from the defence sector which is usually highly engaged in R&D. If these technical improvements and other spin-offs can be applied to the civilian sector, growth is promoted. Very often and especially in LDCs, part of military expenditure is used to provide a social infrastructure (roads, airports, communication networks) and in this way growth is affected positively.

Also, in LDCs military expenditure provide training, technical skills and education to a segment of population engaged in the army. If the skills obtained while in the army can later be applied outside the military there will be a positive impact on the civilian sector. Opponents of the modernisation effects doubt the usefulness of these capital intensive technologies since most of these security-related objectives are not usually beneficial to civilian needs as they may not have useful application in the civilian sectors. As for the infrastructure provided by the military, Smith and Smith (1980) argue that again it might be of little relevance to civilian needs justifying it by the following example: "*i.e. roads may be built in remote areas where civilians will never use them or communication networks may exclude civilian use*" (Smith & Smith, 1980, p.8). Furthermore, training and technical skills that soldiers might obtain are likely to be of no use to them after their military service is over.

2.6.2. Reallocation of Resources

The reallocation of resources is considered to be the second mechanism through which defence spending affects economic growth. A negative effect is supported here, since an increase in defence spending -- given the amount of an economy's savings -- will reduce investment and thus retard growth. In other words, defence may divert resources away from public and private investment that are more growth promoting than defence. If defence competes for resources intended for private investment, then any crowding-out of private investment will have a long-run impact on economic growth. If in addition, a nation imports much of its arms (like Greece for example), then defence activities can lead to an adverse balance of payments that

can have a negative impact on potentially growth-promoting capital inflows. Defence sector may also limit growth through inefficient bureaucracies and excess burdens created by taxes used to finance the military expenditure.

Furthermore, as Rothschild (1973) claimed, defence can retard growth by diverting resources from the export sector. The export sector is often a stimulus to growth as it tends to employ advanced technology and efficient management techniques in order to compete abroad. In many LDCs the export sector is more technologically advanced than other sectors of the economy. In some LDCs (Brazil, India) defence production is in the export sector using technologically advanced methods. So, for these countries, defence instead of diverting resources from the export sector, it rather adds more resources to it and promotes growth through technical change.

2.6.3. Creation of New Resources

The third mechanism through which defence affects growth is the creation of new resources through inflation which is brought about by increased military expenditure. This is particularly likely to happen in aggregate supply-constrained economies (like LDCs) where military expenditure is inflationary. Through inflation defence may lead to an increase in profitability which in turn may lead to higher investment and thus, growth. *“On the other hand, expectations of continuous inflation may cause a spending boom, ‘conspicuous consumption’ and investment in low-priority sectors that have little growth potential”* (Smith & Smith, 1980, p.7). Finally, it is worth mentioning that military expenditure helps to maintain internal and external security

and this secure environment attracts foreign investment, and thus, growth is promoted.

Empirical studies (reviewed in the next chapter) usually attempt to capture most or all of these influences that defence spending may have on economic growth. Before moving on to reviewing the empirical studies, it is worth mentioning the problems that one faces when dealing with military figures as well as the various sources for this type of data.

2.7. Military Data Problems

The reliability of military data is often questioned as military figures are usually questioned for their reliability as they are estimated using available information and this available information can often be what is made available by the government. As Smith (1983) claimed “*military figures usually serve to disinform the general public or are used as tools of crude propaganda to support a particular government view and policy*”. One can always get military data from primary sources such as government publications of each country. It is worth mentioning Scheetz (1992) efforts to collect military data for Argentina, Chile, Paraguay and Peru which revealed large errors in the data published by international sources. But this can be extremely difficult, time-consuming and may not be worth the effort. The main problem connected with individual efforts to collect military data from primary sources arise from the secrecy that is involved around military figures and the

governments' tendency to lie about defence spending for reasons of national security and internal politics. Another problem arises from the method by which imports or exports that have to do with military uses are reported, as they are not exactly separated from those intended for civilian uses, and as a result the reporting of military exports or imports is very difficult. For example, there is no separation between imported or exported goods with dual use (military or civilian), such as aircraft which are not separated into military and civilian. Other problems arise because items included in military expenditure may vary from country to country, some items can be put under other headings (i.e. paramilitary forces may be put under the Ministry of Internal Affairs) or the price basis¹² used to deflate military figures may also differ among countries. Finally, when the conversion of national currencies into a common currency (usually the US \$) is needed, the choice of the conversion method (based on current exchange rate parities or average exchange rate of a particular year) may affect military figures. SIPRI for example uses average exchange rate of a particular year from the IMF (International Monetary Fund).

Another basic problem that one faces when trying to analyse military expenditure is that of measurement. As Blackaby (1987) and Dunne (1990) stress, unlike other government expenditures it is impossible to quantify the objective of military expenditure. The government spends on armed forces, weapons and soldiers in order to provide security through military capability. While forces and spending can be measured, capability and security cannot. Military capability of a state is determined in quantitative terms (the size of the armed forces and weapons) and in qualitative

¹² Only in a few developed countries there is a military price index. The US uses a deflator for

terms (personnel training and weapon sophistication proxied by military expenditure per soldier). Of course, other factors completely unquantifiable, such as the psychology of the soldiers and their boldness, play an important role in military capability. In empirical analysis, commonly used proxies of military expenditure apart from their absolute value (level), include the share of military expenditure in GDP (military burden) and military expenditure per capita.

2.7.1. Military Data Sources

The main secondary international sources for military expenditure data are the following:

SIPRI Yearbook (Stockholm International Peace Research Institute) based in Stockholm. It collects data from published National statistics and uses the NATO definition of military expenditure as a guideline:

“Where possible, the following items are included: All current and capital expenditure on the armed forces, in the running of defence departments and other government agencies engaged in defence projects as well as space projects; the cost of paramilitary forces and police when judged to be trained and equipped for military operations; military R & D, tests and evaluation costs; and costs of retirement pensions of service personnel, including pensions of civilian employees. Military aid is included in the expenditure of the donor countries. Excluded are items on civil defence, interest on war debt and veterans’ payments. Calendar year figures are calculated from fiscal year data where necessary, on the assumption that expenditure takes place evenly throughout the year” (SIPRI Yearbook, 1992, p.269)

Military Balance published by IISS (International Institute for Strategic Studies) based in London. It collects data from published national statistics and also uses

military goods, for example.

some national information but gives quite inadequate time-series. *World Military Expenditure and Arms Transfers*, US Arms Control and Disarmament Agency in Washington. ACDA's figures are a combination of published data and confidential information (CIA figures) but has been criticised for promoting government views. International Monetary Fund (IMF) data is solely based on annual volunteer government reports and as such they are not considered to be very reliable. Other sources include NATO (North Atlantic Organisation), UN (United Nations), OECD (Organisation for Economic Co-operation and Development), BICC (Bonn International Centre for Conversion), CAAT (Campaign Against Arms Trade), Safeworld, PRIO (Peace Research Institute in Oslo). Each of these organisations also uses data from the other.

Depending on the different definition for military expenditure that each of the above organisations use, there are small or big differences in the data they provide, and sometimes the deviations from one source to the other are huge. For example, for 1989 SIPRI reports an increase of world military expenditure of 0.9% while IISS and ACDA report an increase of 15.5% and 1.3%, respectively. Or for 1991, ACDA reports a reduction in military expenditure of -2.6% while SIPRI and IISS report an increase of 2.3% and 4.7%, respectively. In the 1992 SIPRI Yearbook, the authors do warn that despite the increase in the quantity of information provided relative to the past, with an increasing number of sources, there has been a decline in the quality of this data and its reliability has gone down (Dunne, 1998).

2.8. Conclusions

Reviewing the theoretical approaches to the economics of military spending suggests that defence can be growth promoting in the Keynesian context since it can boost aggregate demand when it is relatively low compared to aggregate supply or fight underconsumption in the Marxist context. Furthermore, in the Neoclassical framework, defence spending can stimulate growth through modernisation (due to advanced technologies that arise from defence) and other spin off effects. On the other hand, it is equally possible for defence to crowd-out resources that could be used by other sectors and could be more growth promoting or that the technological improvements do not find applications in other sectors. In these cases, defence spending would retard growth. Obviously, defence spending is unlikely to have the same economic effects in developed capitalist economies and in less developed or developing countries. In developed countries, where aggregate demand is usually lower than the potential aggregate supply, military expenditure can have the Keynesian effect of boosting aggregate demand and leading to higher economic growth or according to the Marxist theory, military spending can fight underconsumption and again promote growth. But in less developed countries insufficient demand rarely constitutes a problem. Rather, it is constraints on the supply-side that impose problems in these economies. LDCs, as it has already been argued, might benefit in terms of infrastructure and advanced technologies that arise from defence, however, this will be the case only if the infrastructure created by defence is beneficial for civilian uses and the technologies can be applied outside the military sector. Finally, in countries with developed indigenous arms industries and arms exports, defence is likely to have a growth promoting effect in contrast to those

countries that rely on huge military imports, and thus, retard their growth through adverse effects on their trade balance.

Since the aforementioned theories can only point the ways and channels through which defence spending can affect economic growth, empirical analysis is the only way to test the theories, despite the problems associated with military data. Given the different ways that military expenditure can affect countries characterised by different level of economic development and by different arms production capabilities, it is very important for the empirical studies to pay particular attention to these features. In the following chapter, which provides a review of the empirical studies on the defence-growth relationship as well as considering some methodological issues that arise, it appears that these features are not always taken into consideration.

EMPIRICAL STUDIES ON THE DEFENCE-GROWTH RELATIONSHIP

3.1. Introduction

Since no theory can state with certainty that defence spending promotes or hinders growth, this difficult task is necessarily assigned to empirical analysis. The investigation of the defence-growth relationship was initiated by Benoit's work (1973, 1978) and followed by some studies that found mistakes in his methodology and others that employed a different methodology. The fact is, as Neuman (1979) argued, that *"despite the volume of writing on the subject, we still do not know whether there is a causal relationship between military expenditures and development, much less what this relationship is"* (Newman, 1979, p.478).

While there are a variety of ways to classify the empirical studies into groups (chronologically, in alphabetical order, in terms of methodologies employed, theoretical framework or findings), it is thought that the most comprehensive way would be to group them according to their theoretical underpinnings. Thus, the empirical studies¹ will be reviewed as follows: the Benoit study is considered as a

¹ Under no circumstances the empirical review of the studies presented should be considered as exhaustive. The categories of studies reported here, help the analysis that is required in this thesis.

separate category because this is the seminal study followed by other ad-hoc single equation models. Next the atheoretic approach of statistical causality between defence and growth is reviewed and then the structural models, specifically Keynesian demand-side models, Neoclassical supply-side models, and finally ending with the combination of the two (demand and supply models).

3.2. The Benoit Study

Benoit's work (1973, 1978) on defence-growth relationship was the starting point for much research in the area. His work involved a cross-section correlation analysis of 44 LDCs for the period 1950-1965. His finding, that there is a positive correlation between military burden and economic growth came in contrast to his expectations and to the supposition made by economists at the time - that defence spending reduces the resources available for investment, and thus, slows down growth. He agreed that defence burden may have adverse effects on growth rates since military expenditure may take resources that would otherwise be employed in more productive civilian investment.

He estimated that an increase of 1% in military burden would reduce civilian growth rate by 0.25%. But he claimed that "the negative effects of defence (income shift, productivity effect and investment effect) were more than compensated for by the stimulation provided by the military sector". The stimulation can include modernisation of the economy, efficient organisation of the production, provision of

There are other types of models i.e. Macroeconomic and World models (see Leontief & Duchin, 1983) and structuralist models (see Kaldor, 1983) which are beyond the scope of the present study.

economic infrastructure (roads, dams, communicational facilities), technical training and useful skills. He acknowledged that the main determinant of the size of the military burden was likely to be strategic (the provision of national security) and that the importation of weapons could harm economic growth. He didn't believe, however, that the opportunity cost of increased military expenditure was a foregone investment but less conspicuous consumption, welfare expenditure or imported luxuries.

His econometric work was based on a single equation and thus it did not account for the interrelationship between defence, growth and other variables. So, his work can be considered as partial since he didn't take into account the multiple conduits through which one variable affects another. Furthermore, Benoit admitted the possibility of defects in his data although he claimed that the defects were random and could not affect the strong correlations that he discovered. He, himself, also discussed the possibility that the simple correlation between defence and growth might have been "spurious". That is other factors influencing both defence and growth may have acted in such a way as to bring about this correlation and that's why he added "bilateral aid" and "investment rate" to the defence burden as regressors.

Benoit's work was strongly criticised² by many researchers in the area. The main points of criticism are the following:

² Ball (1983) provided a detailed critique of Benoit's work undermining the conclusions drawn.

- he failed to provide an explicit framework of analysis and to use functional relationships that were consistent with his hypothesis (Lim, 1983)³
- he used unreliable data taken from a wide sample of structurally different economies and he chose the variables on ad-hoc justifications (Alexander, 1990⁴; Ball, 1983)
- he failed to account for the interrelationship between variables (Deger and Smith, 1983).

Benoit's study forced many researchers to investigate the same relationship. Most of the subsequent studies are based on the Keynesian and Neoclassical theoretical framework which allow the development of consistent formal models but there are also studies that rely on more or less ad-hoc specifications. While Neoclassical models concentrate on supply-side (modernisation, positive externalities from infrastructure, technological spin-offs), Keynesian models concentrate on demand-side (crowding-out of investment, exports, education, health). That is why Neoclassical models tend to find positive effects of defence on growth while Keynesian ones find negative effects. The most influential studies are those which allow for the interactions between demand and supply influences, captured in simultaneous-equation models. Table 3.1, gives an overview of the studies.

³ Lim (1983) suggested that Benoit's results must be treated with some scepticism "as they were obtained with the use of functional relationships that were inconsistent with the hypothesis to be tested and with the use of variables that were incorrectly measured. Also, he did not specify explicitly his framework of analysis. However, from his formulation of the problem it seems that he was implicitly testing the hypothesis that there is a trade-off between defence and economic growth within a Harrod-Domar model".

⁴ Alexander (1990) criticised this because in that way the form of the regression equation does not derive from any coherent theory but simply from an ad-hoc justification of the variables used. He also claimed that these two variables are not sufficient to control for all other influences on growth and that they shouldn't enter a growth equation in the manner specified.

3.3. Other Ad-hoc Models

Using the same methodology as Benoit (correlation analysis) and an ad-hoc equation, Rothschild (1973), tried to explain the relationship between growth and military spending for 14 OECD countries over 1956-1969. His conclusion was that increased military spending reduces exports and thus economic growth. But his conclusion should be treated with caution since he used a limited data base, his methodology consisted of simple correlations and the correlation coefficients were statistically insignificant.

Frederiksen & Looney (1982, 1983) and Looney & Frederiksen (1986) attempted to re-examine the defence-growth relationship by taking into account the great differences in an individual country's international borrowing capacity. Each of these studies used a factor and discriminating analysis to classify their sample of LDCs into resource constrained and resource unconstrained and estimated ad-hoc single equations for the total sample and for each group (constrained - unconstrained) separately. Dependent variable was GDP and the independent included investment, external debt, military expenditure, external capital flows and the growth in public sector consumption. In all three studies, the results indicated a positive effect of military expenditure on growth only for the resource unconstrained countries but this was either insignificant for the resource constrained countries (Frederiksen & Looney, 1982; Looney & Frederiksen, 1986) or negative (Frederiksen & Looney, 1983). What is more interesting is that the Frederiksen & Looney (1983) study which found a negative effect of defence on growth for the resource-constraint countries used Benoit's sample and model. A study for Greece by Kollias (1995b) employed advanced econometric techniques, cointegration and error correction

model, on an ad hoc equation to find a positive effect of defence on growth for the period 1963-1990. But despite the advanced techniques, his model can be criticised for not relying on a theoretical framework but rather on ad-hoc justifications. Of course this criticism applies to all the ad-hoc models mentioned before.

Ad-hoc single equation models that focus on human capital have been estimated by Dixon and Moon (1987) for a sample of 116 countries over the period 1969-1971, finding ambiguous effects of military indicators on basic human needs and by Looney (1992) also finding mixed results for the effect of military burden on education for a cross section of 96 LDCs over 1974-84. Dommen & Maizels (1988) instead of testing the effect of military spending on growth, tested the effect of military regimes, obviously assuming that military regimes tend to spend more on defence than non-military regimes. Their results suggested a negative effect of military regimes on economic growth for a cross section of 38 LDCs over the period 1978-80.

3.4. Causality Analysis

The aforementioned studies rely on the implicit assumption that defence is causally prior to economic growth or in econometric terms, that defence is an exogenous variable⁵. Without a clear theoretical perspective, however, it could be equally plausible for economic growth to precede defence. Instead of simply assuming exogeneity or endogeneity of the defence variable in the growth equation, the

⁵ A discussion of the notion of exogeneity with reference to causality is presented in Appendix H. The approach followed here is the one most commonly used in the defence economics literature.

investigation of the statistical causality between the two variables has attracted the interest of many researchers. The presence and direction of a causal relationship is directly addressed by employing Granger causality tests⁶. According to these tests, the information for the prediction of the variables defence and growth is contained only in the time series of these variables and there are four possible outcomes for their causal ordering: uni-directional causality from defence to growth and vice versa, bi-directional causality between them and lack of any causal ordering. Joerding (1986) using Granger causality tests, but in a multivariate model (containing also investment and government spending), investigated the direction of causality between defence spending and growth for a pooled sample containing 15 observations (1962-77) from 57 LDCs. He found unidirectional causality from growth to defence suggesting that defence should not be considered as exogenous. But his study can be strongly criticised for pooling all 57 countries into one sample and thus, suggesting that any causal relationship found by his analysis is common to all countries. A somewhat simplistic and unreal assumption given the differences in the socioeconomic structure of each country. Furthermore, the choice of the lag length was made on an ad hoc basis (no criteria were used) and a common lag structure (4 years) was assumed for all countries which again is incorrect because it is unlikely to be the same for all countries. And as Looney (1991) pointed out:

“The results of Granger causality tests depend critically on the choice of lag length. If the chosen lag length is less than the true lag length, relevant lags may be omitted, causing bias. If the chosen lag is greater than the true lag length, irrelevant lags may be included, causing estimates to be inefficient”, (Looney, 1991, p.44)

⁶ Detailed analysis of the Granger causality tests is presented in Chapter 6.

Chowdhury (1991) determined the appropriate lag length based on Akaike's (1969) minimum final prediction error but did not find any causality for most of the 55 LDCs over 1961-87 and he stressed that the defence-growth relationship cannot be generalised across countries⁷. On the other hand, LaCivita and Frederiksen (1991) found a feedback relationship between defence spending and economic growth for most of the 21 countries that they examined over the period 1952-1982, suggesting that neither defence nor growth should be considered exogenous. Looney (1991) studied India, Pakistan and South Asia over 1958-88 finding that for Pakistan military expenditures have a negative impact on growth while for India he found "possible effect of military expenditure on growth".

Granger's definition of causality has been operationalised in various ways, the most common being a vector autoregression⁸ (VAR) specification in which each variable is regressed on lags of all variables in the system, including itself (Sims, 1980). The VAR specification has become increasingly popular in the applied econometrics in recent years, its main advantage being that such models are dynamic specifications, free of economic assumptions imposed a priori. *"Thus, they allow for the testing of causal linkages without the need to first construct arguments and develop hypotheses justifying those linkages"* (Georgiou et al, 1996). Under a VAR specification Kusi (1994) could not find a dominant result across 77 LDCs for causality between defence and growth, indicating again the need for case studies. Case studies that employed a VAR methodology to test for Granger causality among the two variables

⁷ In fact, maximum lag length might be calculated as an average across the sample; there is a trade-off between the advantage of pooling (increased power) with contamination of the test by nuisance parameters (which reduce the power). In the limit, this should not be a problem.

tend to find no evidence of a causal relationship between the two variables. For example no causality was found by Kinsella (1990) for the US, by Madden & Haslehurst (1995) for Australia, by Chen (1993) for China, by Kollias & Makrydakis (1997a, 1998) for Turkey and Greece respectively.

Granger causality tests have been widely criticised (Jacobs et al, 1979) for being sensitive to a wide variety of factors, including structural changes over the period examined, stationarity of the variables and cointegration across the variables. Ram (1995) warned that: "*inferences based on these tests can be problematic and several notes of caution seem warranted even if one overlooks the inferential uncertainties inherent in such tests*" (Ram, 1995, p.263). But once those factors (structural breaks, stationarity and cointegration) are controlled and accounted for (as will be the case here), these tests can be informative and useful for the specification of the structural models.

3.5. Demand-Side Models

In the Keynesian framework empirical studies employ the national income identity to estimate a consumption, savings or investment equations. Smith (1980a), using data for 14 large OECD countries between 1954-1973, tested the hypothesis of "crowding-out" - that the principal cost of military expenditure is foregone investment. He derived his model as a savings function but the estimated equation was regarded as a reduced form. His hypothesis of a trade-off between the shares of

⁸ Causality analysis should really be undertaken in the VAR system and not in a so called, structural system. For the advantages of the VAR approach vis-à-vis the structural one, see: Sims, C.A. (1980),

military expenditure and investment in GDP was made in the sense that the coefficient of military expenditure is significantly less than 0 and not significantly different from -1. Estimates based on time-series, country cross-sections and pooled data, gave results that were robust and indicated that the coefficient of military expenditure was -1. Thus, an increase in the share of military expenditure comes necessarily from an equivalent reduction in investment share⁹. But Smith (1980a) also pointed out that this does not necessarily apply in LDCs where the spirit of militarism and nondemocratic internal repression helps the government to increase defence at the expense of the social wage.

Faini, Annez & Taylor (1984) using a particular type of demand-side Keynesian and structuralist model, found that defence has negative effect on growth for 69 countries - mainly LDCs - over some or all of the period 1952-1970. Specifically, an increase of 10 percentage points in defence burden leads to a reduction of annual growth by 0.13%. They also found that defence spending is associated with lower savings and investment shares of GDP, higher tax burden and a shift in economic activity from agriculture towards the manufacturing sector.

Keynesian single equation models for Greece have been estimated by Antonakis and Karavidas (1990) over 1950-1985 and 1958-1986, finding a negative relationship between military expenditure and other aggregates in the economy (in particular that the principal opportunity cost of defence was a foregone investment), and thus, they

Freeman et al (1989).

⁹ Smith (1980a) claimed that in developed countries for a given level of national output, the share of "social wage" (private consumption and publicly provided goods for social consumption) is relatively inflexible. Public opinion and institutional pressure from trade unions prevent governments in these

concluded that military expenditure constitutes a burden on the economy. Another author, Kollias (1995a) after estimating traditional single-equation Keynesian models over the period 1963-1990, found that military expenditure in Greece can have stimulative effects through aggregate demand generation, but his results did not provide a strong conclusion about the defence-growth relationship, as both investment and savings were found to be adversely affected by military expenditure. Chletsos and Kollias (1995) ended up with similar findings for the period 1974-1990. They based their model on a typical Keynesian national income equation. Total consumption depended on military expenditure as a percentage of GDP, on indirect taxes as a share of GDP and on GDP. Total investment depended on the budget deficit as a share of GDP, the lagged value of GDP, military burden, and a dummy for elections. Military burden depended on the ratio of per soldier spending of Greece/Turkey, GDP, a dummy for wars and a dummy for elections.

The significance of the last study lies on the fact that it accounted for the heterogeneity of military expenditure. The authors estimated the three equations using disaggregated data for a) wages and allowances to military personnel b) procurement and construction, as well as using total military expenditure. In this way they could capture any differences in economic effects for the various components of military expenditure because, as Grobar and Porter (1989) point out, the heterogeneity of military expenditure is responsible for the different effects of military expenditure on the economy. Each form of military expenditure (R&D, domestic arms production, imports, construction, wages and salaries, retired military

countries to reduce the proportion of social wage in national income. This does not happen in LDCs, though.

personnel) influences the economy through different channels. In addition, although the use of disaggregated military data is beneficial for empirical studies and future research should focus on the effects that each component of military expenditure may have on economic growth, the availability of such data is limited to the last two decades for most countries. This makes it difficult if not impossible to use advanced econometric techniques.

3.6. Supply-Side Models

In the Neoclassical theoretical framework empirical models are based on an aggregate production function. A widely employed supply side model for the defence-growth relationship is based on Feder's model (1982) of the role of exports in growth. Feder (1982) formulated a production function that related economic growth to investment, labour force growth, and export growth, to examine the relationship and the externalities that arise between the export sector and the non-export sector in LDCs. Ram (1986) used the same model to examine the relationship between the government sector and the non-government sector in 115 countries. Biswas and Ram (1986) were the first to adopt Feder model (1982) to investigate the relationship between the military and non-military sectors, as well as to assess the externality effect of the military sector and the factor productivity variation between the two sectors. Their augmented model was based on the Neoclassical production function and their estimates suggested that there was no significant externality effect of military sector on civilian output and also that there was no statistically significant factor productivity difference across the two sectors. They concluded that military expenditure neither promotes nor retards growth in LDCs. After them, many

versions of the Feder model have been developed (including more than two sectors, defining very complex externalities) for both developed and LDCs with most of the studies employing cross-sectional methods.¹⁰

The best example of a multisectoral Feder-type model that “suffers” from a very complex set of externalities is Alexander’s (1990) study for 9 industrial countries over the period 1974-84. Aiming to “remedy Biswas and Ram’s model which failed to include some relevant variables, and thus, failed to include important economic linkages”, he assumed that the economy consists of four mutually exclusive and exhaustive sectors: the defence sector, the government sector, the exports sector and the rest of the economy. From the four production functions he derived and estimated a single reduced form equation, concluding that the gross effect of military expenditure on growth is neither significantly positive nor negative, although the defence sector is less productive than the ‘rest’ of the economy. While his study can be considered as an important development of the Feder model, it can be criticised for two main deficiencies. First, his aim to capture the externality effect of some sectors on others as well as the possibility of inter-sectoral productivity differentials made the model very complicated and specifying such a complex set of externalities among sectors (i.e. the non-military sector could influence both the defence, the export and the civilian sector while the defence and export sector could influence only the civilian sector) meant that some coefficients (such as the coefficient of the non-military government sector), were so complex they could not be interpreted. Second, as Mintz and Stevenson (1995) point out, he proxied non-military

¹⁰ Also see, Ward et al (1991), Ward & Davis (1992), Huang & Mintz (1990, 1991), Atesoglou & Mueller (1990), Ward, Davis and Chan (1993).

government expenditure by government consumption, overvaluing government consumption by the amount of military consumption. In this way, he ignored the assumption of mutually exclusive and exhaustive sectors. Finally, the significantly negative effect of investment on economic growth contrasts with the predictions of economic theory and indicates a misspecified model.

An important issue that arises from the Feder model (particularly when the augmented model is in question) is that of multicollinearity. The issue of dealing with multicollinearity by employing a k-class ridge regression is discussed in Huang and Mintz (1990, 1991). Both studies employed a three sector Feder model for the US over the period 1952-88, however, the first one (1990) considered only the overall effect while the subsequent one (1991) also accounted for the externality and relative productivity effects. Reporting results for both ridge and OLS estimators, they noticed that although there were no significant differences in the results themselves, collinearity was reduced under the ridge regression. They concluded that the overall effect of defence in the US was not significant and the same applied to the externality or factor productivity effect of defence spending on growth when the augmented model was considered. On the other hand, a three sector model by Ward & Davis (1992) for the same country (US) over a similar period (1948-90) found negative overall effect with positive externalities and negative productivity for the defence sector. Furthermore, Ward et al (1995)¹¹ found a negative overall effect for the US but over a longer time period (1889-1991). The different results obtained for the same country (especially for those studies that examined similar time periods)

¹¹ Ward et al (1995) apart from the US also studied Japan for which they found a positive effect of the defence sector on economic growth.

might be attributed to the slightly different specification of the externality and overall effect terms. Although for the size effect, the Feder-type composite term $\left(\dot{M}\frac{M}{Y}\right)$ is most commonly employed, there are some studies that use $\left(\frac{\Delta M}{Y_{-1}}\right)$, i.e. Huang & Mintz (1990), Ward et al (1993), Ward et al (1995), Sezgin (1997) and for the externality term instead of $\left(\dot{M}\frac{C}{Y_{-1}}\right)$ some studies use just \dot{M} , ie. Biswas & Ram (1986), Ward et al (1993), Sezgin (1997), Antonakis, (1997). But Ram (1995) warns that different proxies for the defence variable can lead to very different conclusions, and he says:

“While the Feder type composite term $\left(\dot{M}\frac{M}{Y}\right)$ shows no significant overall effect of defence, the \dot{M} version shows a strong positive effect and the M/Y version suggests a significant negative effect.It is possible that the Feder type term reflects the overall effect, the \dot{M} version indicates the externality effects, and the M/Y version reflects the demand-side consequences of diversion of resources from other uses” (Ram, 1995, p.267).

But he also warns that the suggested interpretation is only a conjecture and has some obvious limitations.

Most of the studies that employ a Feder-type methodology avoid the ridge regression as a remedial solution for multicollinearity, as its usefulness to dealing with multicollinearity has been widely contested (see, Kennedy, 1986) and usually report results with this caveat. Ward et al (1991) found a positive effect of defence spending on growth for India using an augmented Feder-type model over the period 1950-1987 while Linden (1992) estimating the same type of model, but only with

two sectors, for 13 Middle Eastern countries over 1974-1985 and found negative effects. McMillan (1992) applying the same model to South African data over the period 1950-1985 found a negative size effect of defence on growth but also some positive externalities. The study by Biswas (1993) for 30 LDCs over 1981-89 by the use of an augmented Neoclassical model gave positive results. In a case study for Taiwan over the period 1961-1988, Ward, Davis and Chan (1993) with the same methodology found positive size effects of the defence sector on economic growth but negative externalities.

Mintz and Stevenson (1995) applied an augmented Feder-type, 3-sector model to 103 countries (developed and LDCs) over the period 1950-85. They faced some problems in deriving values for non-military government spending.¹² The approach they followed was to subtract the SIPRI figures for military expenditure from the Summers and Heston government consumption data. The conclusion was that there was no short-run relation between military expenditure and growth and no externality effect.¹³

An important development of the Feder-type model is found in Macnair et al. (1995) study that allowed for the influence of defence “spillin” externalities¹⁴ (externalities that arise from one country’s NATO allies) and applied it to a sample of ten NATO

¹⁸The approach that Alexander (1990) followed to derive values for non-military government spending was to use government consumption as a proxy for non-military government consumption. But in this way as Mintz and Stevenson (1995) stressed government consumption is overvalued by the amount of military consumption.

¹³ Mintz and Stevenson (1995) also reported estimates using Alexander’s (1990) method.

¹⁴ By introducing the defence “spillin” externalities, Macnair et al (1995) tried to examine whether defence expenditure of a nation’s allies affect the nation’s own defence and civilian sectors in either a positive or negative way.

allies over the period 1951-88. Using a variety of error components models, they reported both pooled time-series and cross-sectional estimations of the model. Their results are generally consistent with Benoit's finding of a positive association between defence spending and economic growth in developing countries while defence "spillins" had a small negative effect. Murdoch, Pi, Sandler (1997), following the above study used cross-section and time-series data for two well-defined LDCs cohorts - Asian and Latin American market economies - with similar economic, political or regional characteristics. Their empirical estimations are based on a three-sector Feder-Ram model containing a civilian (private) sector, a military and a non-military one. The empirical findings indicate that private investment, defence spending and other forms of public sector spending are growth promoting in the context of a purely supply-side Feder-Ram analysis. But both these studies (probably because of multicollinearity concerns) looked only at the overall effect of the defence sector, missing out the externality and relative productivity effects.

A quite ad-hoc assumption was made in Alexander's (1995) four-sector model in which, instead of using growth in real output as the dependent (as the Feder-type model postulates), he used growth in real non-defence output. But if defence output is to be deducted from total output then surely the output of the government and export sector should also be deducted. The approach taken in this study is not satisfactorily justified. Under this assumption, Alexander (1995) concludes that there is no significant effect of defence on growth of non-military output for 11 OECD countries. Another attempt to develop the Feder-type model, this time by

incorporating human capital¹⁵ proxied by education, was made by Sezgin (1997) who employed a two-sector model for Turkey over the period 1949-1993. His results, however, were not improved by adding the education variable (which was insignificant) and suggested that defence spending in Turkey helps economic growth although externalities from defence sector to the rest of the economy were negative.

There are three studies using a Feder-type analysis for Greece, the first two (Antonakis, 1997 and Sezgin, 1998b) employing a two-sector augmented model and the third one (Antonakis, 1999) employing a four-sector model. The first one by Antonakis (1997) found a negative effect of defence on growth for Greece over the period 1958-91 and the second one by Sezgin (1998b) who found an insignificant effect over a similar period. The first study found problems of dynamic misspecification and introduced lags in the dependent variable and in the military terms, which then gave the significant negative effect, while the latter study suffers from serial correlation and very low explanatory power. Both of these studies for Greece are, however, too “restrictive” as they only allow for two sectors in the economy (civilian-military) and this can lead to misspecification, as will be shown in Chapter 7. The third and very recent study for Greece by Antonakis (1999) overcomes the last shortcoming by allowing for four sectors in the economy. Despite that, there are a number of problems with the paper which call the results into question. For a start, having specified all the variables (apart from investment) in growth rates, Antonakis (1999) investigates their stationarity properties. Although he does not report results for the unit root tests, he claims that all the variables reject

¹⁵ He claimed that the main weakness of the Feder model is that it assumes that the production function consists only of physical capital and labour, and thus, the very significant human capital

the hypothesis of no unit root, in other words, all the variables are non-stationary. This is rather strange given that the variables are already in growth rates. Nevertheless, based on this conclusion (that all the variables are integrated of the same order) he proceeds to test for cointegration. Both the CRDW and ADF statistics point to the existence of cointegration. The way he proceeds after that is questionable. He follows a general-to-specific methodology (introduces an ARDL model) and gradually imposes parameter restrictions to find the “preferred equation”. This “preferred equation” contains no term for the government sector and bears little relation to the Feder-type model that was specified initially.

Several shortcomings arise from the fact that these Feder-type models concentrate on the supply-side. Firstly, they ignore the demand-side, assuming that it stays in equilibrium with the supply constraints of the economy. Second, high collinearity between the two terms of each sector (growth rate and share in GDP) is inevitable, and, *“the estimates may not provide a good feel for the magnitude of the externality effect and/or the productivity differences andas is common with most single equation models, there are some measurement and data problems and there may be ‘feedback’ from the dependent variable to some of the regressors”* (Ram, 1995, p.260). Third, they assume that the production function consists only of physical capital and labour and so exclude human capital, which can comprise native ability and talent as well as education and acquired skills¹⁶. Furthermore, as will be shown in the analysis that follows, the two-sector model appears too restrictive, suggesting that government and export sectors should also be included.

which includes native ability, talent as well as education and acquired skills is omitted.

The main advantage of the Feder-type model is that it is well based on theory, it considers externalities between sectors and may explain both the size effect of defence expenditure and the externality effects as well as factor productivity differentials. Furthermore, it needs relatively less data than other models (which solves many problems when dealing with developing countries) and includes the supply constraints which are likely to be important for developing economies.

3.7. Demand and Supply Models

Obviously, Keynesian demand-side models concentrate on demand while Neoclassical supply-side models concentrate on supply. In order to overcome the problem of concentrating on one side only, efforts have been made to include both influences in a model. Demand-side influences are captured in a Keynesian aggregate demand function while supply-side influences are captured in a growth equation derived from a production function. These models hypothesise possible direct effects of defence on growth through Keynesian demand stimulation and other spin-off effects and negative indirect effect through reductions in savings or investment, balance of payments, education, and health. The relative strength of the positive and negative influences of defence spending determine the net impact of military expenditure.

These models, thus, account for supply-side influences (technological spin-offs, positive externalities from infrastructure) and demand-side factors (crowd-out of

¹⁶ Sezgin (1997) proxied human capital by educational expenditure but “the results were not improved suggesting that educational expenditure was not a good proxy”.

investment, exports, education or health). Such effects are interdependent and interrelated and the best way of modelling them is by using a simultaneous equation model (hereafter SEM), most commonly consisting of a growth equation, a savings or investment equation, a trade balance equation and a military burden equation. Although these models provide a more complete picture of the defence-growth relationship by accounting for the interrelationships between the variables, they have been criticised for not being strongly based on theory and thus, relying on more ad-hoc justifications (Sandler and Hartley, 1995). But this is more than compensated for by the advantages that they offer in overcoming problems of exogeneity, simultaneity and causality that are problematic for single equation methods.

SEMs specify each individual channel of impact from military expenditure to growth and then identify whether each separate impact effect is positive or negative. *“It is therefore possible to quantify as to how military spending affects growth in addition to providing an answer to the standard question as to whether the aggregate effect is positive or negative”* (Deger and Sen, 1995, p.291).

This framework was developed by Smith and Smith (1980) to examine the defence-growth relationship in a group of LDCs as well as in a group of OECD countries. Specifically, they developed a Keynesian three-equation model with a production function and found an insignificant direct but a negative indirect effect of military expenditure on growth for 50 LDCs for 1965-1973, with a significantly negative effect for the developed countries. Their model consisted of a production function that included employment, capital stock, and a total factor productivity term; an equation that related changes in capital stock to growth, military expenditure and the

rate of unemployment; and an equation that related the growth in total factor productivity (R&D as a percentage of GDP) to military expenditure. According to their results, the R&D effect of military expenditure was positive for the OECD countries but this positive effect was dominated by a negative effect on investment and when both factors were taken into account, military expenditure resulted in lower economic growth. Although, they initially estimated each equation separately by OLS to avoid the possibility of simultaneity or feedback from the left hand side variables to the right hand side ones (which leads to a correlation between the right hand variable and the error term and causes the OLS estimates to be biased and inconsistent) they also estimated the system of equations by 3SLS. This method is a system estimation procedure which simultaneously estimates the equations. For example, if the system consists of the following equations:

$$G = a_0 + a_1 M + a_2 S$$

$$S = b_0 + b_1 M + b_2 G$$

where G is GDP growth, M the military burden and S the savings ratio. When the equation is estimated as part of a system, the effect of M on G is not given just by the coefficient of M in the growth equation, because a change in M also changes savings which feeds back to G. The total effect of a change in M on G can be obtained by substituting the savings equation into the growth equation (above), to give:

$$G = a_0 + a_1 M + a_2 (b_0 + b_1 M + b_2 G) \text{ or}$$

$$G = \left[\frac{a_0 + a_2 b_0}{1 - a_2 b_2} \right] + \left[\frac{a_1 + a_2 b_1}{1 - a_2 b_2} \right] * M$$

Deger and Smith (1983) and Deger (1986) further developed the Smith and Smith (1980) model and applied it to 50 LDCs. Both studies represented the aggregate demand and the spin-off effects of military expenditure in a growth equation in which the rate of growth was made a function of the savings ratio, the defence burden and other variables (per capita income and foreign capital flows as a percentage of GDP). The effects of the reallocation of resources and creation of new resources were captured in a savings equation, in which savings-income ratio was made to depend on the defence burden and the average annual growth of GDP. A third equation had military burden depend on government spending as a proportion of GDP. The system was then estimated by 3SLS to account for the simultaneity and high covariance between the equations. They concluded that, while there was a positive direct effect of defence spending on economic growth, this was outweighed by a negative indirect effect through reduced savings, to give a negative overall effect. In other words, military expenditure on the supply side affected growth positively while on the demand-side, they affected savings, and thus, investment negatively, with the overall effect being negative.

Scheetz (1991) extended the model by including a fourth equation for the trade balance in the system. He investigated the effect of defence on growth in four Latin America countries over 1969-1987. Both the time-series and the pooled results suggested a negative macroeconomic impact of military burden on growth. A negative effect was also strongly supported by the time series results from 13 Sub-Saharan African countries in Dunne & Mohammed (1995), who augmented the system of equations by including an equation for education. However, their cross-section and pooled results suggested no significant effects of military burden on

economic variables. They concluded “...*there is no evidence of military spending having a positive effect in our sample, with the aggregate results and individual country results suggesting that there are substantial costs*” (Dunne & Mohammed, 1995, p.341).

Roux (1996) estimated a simultaneous equation model consisting of four equations for South Africa over the period 1960-1990 but his results were disappointing and he concluded that military expenditure did not affect economic growth in either direction. Finally, a three-equation simultaneous equation model was estimated for Greece by Antonakis (1997) over the period 1960-1990. His conclusion was that “*the combined effect of military expenditure on the output growth rate is negative, independently of the level of significance used in calculating of the relevant multiplier*” (Antonakis, 1997, p.89).

Table 3.1. provides a comprehensive, though not exhaustive, list of previous studies.

Table 3.1. Empirical Studies for the Defence-Growth Relationship (in alphabetical order)

Author	Model	Time Period	Country	Main Conclusion
1. Alexander (1995)	4 sector Feder-type model	1966-1988 Pooled	11 OECD	Insignificant effect of defence on growth when the dependent is growth in non-defence output instead of total output
2. Alexander (1990)	4 sector Feder-type augmented model	1974-1985 Pooled	9 DCs	No significant effect of defence on growth
3. Antonakis (1999)	4 sector Feder-type model	1960-1993 Time-series	Greece	Negative effect of defence on growth
4. Antonakis (1997a)	Keynesian SEM with supply side (3 equations)	1960-1990 Time-series	Greece	Negative effect of defence on growth
5. Antonakis (1997b)	2 sector Feder-type augmented model	1958-1991 Time-series	Greece	Negative effect of defence on growth
6. Antonakis & Karavidas (1990)	Keynesian single equations	1950-1985 Time-series	Greece	Negative effect on investment, and thus, on growth
7. Atesoglou & Mueller (1990)	2 sector Feder-type model	1949-1989 Time-series	USA	Defence has a small positive effect on economic growth

Table 3.1. (continued)

Author	Model	Time Period	Country	Main Conclusion
8. Balfoussias & Stavrinou (1996)	Macroeconomic model (disarmament scenarios)	1960-1992 Time-series	Greece	Small positive effect of disarmament
9. Benoit (1973, 1978)	Ad-hoc equation (seminal study)	1950-1965 Cross-section	44 LDCs	Positive and significant effect of defence on growth
10. Biswas (1993)	2 sector Feder-type augmented model	1981-1989 Cross-section	74 countries (of which 30 LDCs)	Positive effect of defence on growth
11. Biswas & Ram (1986)	2 sector Feder-type augmented model	1960-1977 & 1970-1977 cross-section	58 LDCs	No significant effect of defence on growth
12. Chen (1993)	Granger causality tests	1950-1991 Time-series	China	No causality between defence and growth
13. Chletos & Kollias (1995)	Keynesian national income equation	1974-90 Time-series	Greece	Positive effect on growth but negative on investment
14. Chowdhury (1991)	Granger causality tests	1961-1987 Time-series	55 LDCs	No causality between defence and growth for most of the countries

Table 3.1. (continued)

Author	Model	Time Period	Country	Main Conclusion
15. Cohen et al (1996)	3 equation neoclassical model	1960-1992 Time-series	Israel	Positive effect of reduction in defence spending through the effect in investment
16. Deger (1986)	Keynesian SEM with supply side (3 equations)	1965-1973 Cross-section	50 LDCs	Positive effect on growth but negative indirect effect via savings. Negative overall
17. Deger & Smith (1983)	Keynesian SEM with supply side (3 equations)	1965-1973 Cross-section	50 LDCs	Positive direct effect on growth but negative indirect effect through savings. Negative overall
18. Dixon & Moon (1987)	Ad-hoc single equation including basic human needs variable	1969-1971 Cross-section	116 countries	Ambiguous effect of military indicators on basic human needs
19. Dommen & Maizels (1988)	Ad-hoc equation	1978-1980	38 LDCs	Negative effect of military regimes on growth
20. Dunne & Mohammed (1995)	Keynesian SEM model with supply side (5 equations)	1967-1985 Time-series/ Cross-section and pooled	13 countries	Insignificant effect of military spending on growth

Table 3.1. (continued)

Author	Model	Time Period	Country	Main Conclusion
21. Faini et al (1984)	Demand-side Keynesian model	1952-1970 Cross-section	69 mainly LDCs	Negative effect of defence on growth for the LDCs
22. Frederiksen & Looney (1983)	Benoit's model and sample	1950-1965 Cross-section	44 LDCs (4 groups)	Negative effect for the resource-constrained but positive for the resource-rich
23. Frederiksen & Looney (1982)	Benoit's model (ad-hoc)	1970-1978 Cross-section	90 LDCs	Positive effect for the resource-rich, neutral for the resource-poor countries
24. Huang & Mintz (1991)	3 sector Feder-type augmented model	1952-1988 Time series	USA	No significant externality or factor productivity effect on growth
25. Huang & Mintz (1990)	3 sector Feder-type model	1952-1988 Time-series	USA	No significant effect of defence on growth
26. Joerding (1986)	Granger causality tests	1962-1977 Time-series	57 LDCs	No evidence of causality from defence to growth but evidence for causality from growth to defence

Table 3.1. (continued)

Author	Model	Time Period	Country	Main Conclusion
27. Kinsella (1990)	Granger causality tests	1943-1989 Time-series	USA	No causality between defence and growth
28. Kollias (1995a, 1995b)	Ad-hoc single equation (cointegration and ECM)	1963-1990 Time-series	Greece	Positive effect of defence on growth through aggregate demand generation but negative through investment and savings
29. Kollias & Makrydakis (1998)	Granger causality tests (VAR, ECM)	1955-1993 Time-series	Greece	No causality between defence and growth
30. Kollias & Makrydakis (1997a)	Granger causality tests (VAR, ECM)	1954-1993 Time-series	Turkey	No causality between defence and growth
31. Kusi (1994)	Granger causality tests (VAR)	1971-1988(89) Time-series	77 LDCs	No dominant result
32. LaCivita & Frederiksen (1991)	Granger causality tests	1952-1982 Time-series	21 countries	Feedback relation between defence and growth
33. Landau (1986)	Neoclassical production function (many variables)	1960-1980 Cross-section	65 LDCs	Defence burden has little effect on growth of per capita income

Table 3.1. (continued)

Author	Model	Time Period	Country	Main Conclusion
34. Lim (1983)	Harrod-Domar growth model	1965-1973 Cross-section	54 LDCs	Defence has a negative effect on growth
35. Linden (1992)	2 sector Feder-type model	1974-1985	13 Middle Eastern	Negative effect of defence on growth
36. Looney (1991)	Granger causality tests	1958-1988 Time-series	India, Pakistan	Negative effect of defence on growth for Pakistan but positive for India
37. Looney & Frederiksen (1986)	Ad-hoc single equations	1970-1982 Cross-section	52 LDCs	Positive effect of defence on growth for resource-unconstrained/insignificant for resource-constrained
38. Macnair et al (1995)	3 sector feder-type model (with spillin externalities from allies)	1951-1988 pooled	10 NATO allies	Positive effect of defence on growth
39. Madden & Haslehurst (1995)	Granger causality tests		Australia	No causality between defence and growth
40. McMillan (1992)	Augmented neoclassical model	1950-1985 Time-series	South Africa	Negative effect of defence on growth but positive externalities

Table 3.1. (continued)

Author	Model	Time Period	Country	Main Conclusion
41. Mintz & Stevenson (1995)	3 sector Feder-type augmented model	1950-1986 Time-series	103 (DCs & LDCs)	No significant effect of defence on growth for most of the countries
42. Murdoch et al (1997)	3 sector Feder-type model (Error components)	1954(1974)-1988 Time-series	2 groups of LDCs (Asia & Latin America)	Positive effect of defence on growth
43. Rothschild (1973)	Ad-hoc equation	1956-1969	14 OECD	Increases in military spending reduce exports, and thus, economic growth
44. Roux (1996)	Keynesian SEM with supply-side (4 equations)	1960-1990 Time-series	South Africa	No significant effect of defence on growth
45. Scheetz (1991)	Keynesian SEM with supply-side (4 equations)	1969-1987 Time-series & pooled	Argentina, Peru, Chile, Paraguay	Negative impact of defence on economic growth
46. Sezgin (1997)	2 sector Feder-type augmented model (including human capital)	1949-1993 Time-series	Turkey	Positive overall effect of defence on growth but negative externalities
47. Smith (1980a)	Keynesian model of investment	1954-1973 Time-series & pooled	14 OECD	Negative effect defence spending on investment

Table 3.1. (continued)

Author	Model	Time Period	Country	Main Conclusion
48. Smith & Smith (1980)	Keynesian SEM with supply-side (3 equations)	1965-1973 Cross-section	50 LDCs	Insignificant direct but negative indirect effects of defence spending
49. Ward et al (1995)	3 sector Feder-type model	1889-1991 Time-series	USA, Japan	Negative effect for the US but positive for Japan
50. Ward et al (1993)	2 sector Feder-type augmented model	1961-1988 Time-series	Taiwan	Positive overall effect of defence on growth but negative externalities
51. Ward & Davis (1992)	3 sector Feder-type model	1948-1996 Time-series	USA	Negative effect on growth but positive externalities
52. Ward et al (1991)	3 sector Feder-type augmented model	1950-1987 Time-series	India	Positive effect of defence on growth

3.8. Methodological Issues

Comparing Benoit's studies (1973, 1978) with recent ones, one can easily note a quality change in terms of methodologies employed and theoretical specification of the models. While studies in the 1970s and the 1980s relied on correlation analysis, factor and discriminant analysis and very simple regression analysis most recent studies rely on more advanced econometric techniques (OLS, 2SLS, 3SLS, IV, AR, ARDL, Cointegration, ECM) applied either to single-equation models, simultaneous-equation models or macroeconometric and world models. Most of the recent studies avoid a reliance on ad-hoc specifications and tend to be based on well-specified theoretical frameworks - usually the Keynesian or the Neoclassical framework analysed previously, which allow the development of consistent formal models. The variables included in a model represent the direct and indirect channels (analysed in the previous chapter) through which military expenditure affects economic growth. Also, investigation of the causality between defence and growth, instead of assuming exogeneity or endogeneity of the defence variable in the growth equation, has lately been enriched by advanced econometric techniques (Joerding, 1986; Chowdhury, 1991; Kollias & Makrydakis, 1997a). And although different methodologies and different theoretical frameworks can lead to quite noticeable differences in the results, there are two very important methodological issues that arise when examining the defence-growth relationship that can also lead to conflicting results and misinterpretation of these results. These issues which are analysed below, involve the country versus the cross-country studies and the developed versus the less developed country studies.

3.8.1. Country versus Cross-country Studies

Empirical work may involve cross-section or pooled data analyses, which look at the different or common characteristics of groups of nations, and time-series analysis, which examines the influence of military expenditure within one country¹⁷. While cross-section studies provide general conclusions on long-term effects, time-series are more relevant in investigating short-term effects for policy purposes and decision-making in a national setting (Balfoussias and Stavrinou, 1996).

Many authors have criticised the methodology of cross-country analysis as this type of analysis requires a high degree of homogeneity among the countries examined. Ward et al (1991) claimed that cross-sectional analysis fails to capture the dynamic element of the relationship between defence spending and the economy. As Kusi (1994) indicated, the effects of military expenditure can not be generalised across countries since these, among other things, may depend on the sample period and the level of the socioeconomic development of the country concerned. This is an important observation which is taken into account in this thesis.

Summarising the criticism against cross-country studies we can say that:

- Countries are different
- It is difficult, if not impossible, to find countries at the same time in the same economic circumstances. While some of the sample countries are in recession others may be expanding and growing. According to Ram (1995) “*While the*

¹⁷ Some of the most important case-studies in the literature are the following: Benoit (1973) for Argentina, India, Israel, Mexico, South Korea, United Arab Republic; Deger and Sen (1983) for India; Faini, Annez, Taylor et al (1984) for India; Atesoglou and Mueller (1990) for USA; Scheetz

rate of return to capital might be fairly similar across countries, labour productivity may differ dramatically, especially if the sample includes countries at very different levels of development” (Ram, 1995, p.264). So, choosing cross-country sample periods needs careful attention due to different economic situation.

- Externality effects of military expenditure may vary from country to country. These effects may be seen after a lag (Deger and Sen, 1995).

To find robust evidence for the defence-growth relationship, cross-country studies should be supported with individual country studies (Ram, 1995), and as Chan (1985) suggested *“future research will profit more from discriminating diachronic studies of individual countries”*. He also stressed that:

“The results based on cross sectional designs are less trustworthy, as this approach is inherently limited in its applicability to inform us about causal relationships. To tackle questions such as the impact of military expenditure on economic performance we need dynamic analysis to determine temporal leads and lags, the reciprocal influences among the variables, and the over-time changes in the empirical parameters”, (Chan, 1985, p.407).

3.8.2. Developed versus Less Developed Countries

An important factor that must be taken into consideration when the defence-growth relationship is examined, is whether a country faces a constraint on the demand or on the supply side. Depending on this, defence spending can have different effects on

(1991) for Argentina, Chile, Paraguay and Peru; Roux (1996) for South Africa, Sezgin (1997) for Turkey, Antonakis (1997) for Greece, Kollias (1995, 1996) for Greece.

economic growth. Constraints on the demand side are more likely to exist in developed capitalist economies while constraints on the supply side are usually met in developing and less developed countries. In developed countries, defence spending can increase aggregate demand and lead to a fuller utilisation of labour and capital and in this way growth can be promoted. In contrast, “...in LDCs defence spending can impose additional burdens on the economy by compounding existing production bottlenecks (especially in the key engineering and capital goods areas), and thus, lead to lower economic growth” (Chan, 1985, p.420).

Furthermore, in countries with indigenous arms production and arms exports, defence is likely to have different effects than in those countries with huge military imports (Alexander, 1990). A domestic developed defence industry which is usually engaged in R&D and high level technologies, can provide externalities and spin-off effects to other industries and other sectors in the economy, thus, promoting growth. In addition if the country exports arms this may be growth promoting. On the other hand, countries without an indigenous arms industry (like Greece for example) that rely heavily on arms imports are unlikely to experience such positive spin offs. On the contrary, it is more likely that they will experience lower economic growth because of the adverse effect of arms imports. Defence spending might result in higher government deficit, which in turn can reduce business investment and consumer demand, and so, retard growth. It is obvious, then, that before attempting any empirical analysis, one must determine whether a country is developed or less developed and whether it has indigenous arms production or not, as these two factors can have a considerable influence on the economic effects of defence spending.

3.9. Conclusions

From surveying both the theoretical and empirical literature on the defence-growth relationship it becomes evident that the economic impact of defence spending depends on the relative importance of each of the channels through which defence spending operates in the economy. Chan (1985) in his review of the literature on the consequences of military expenditure, cautions analysts that differences in their data bases, country samples, and research designs can contribute to inconsistent and confusing research findings. Despite the huge controversy in the empirical results and the lack of a general conclusion on the relationship between defence spending and economic growth, one can observe that supply-side models tend to support a positive effect of defence on growth (through modernisation, and other spin-offs), while demand-side models tend to support a negative effect (via crowding-out of investment, exports). Studies using a combination of the two types of models (demand and supply), tend to find positive direct effects of defence on growth and negative indirect effects, through savings and trade balance, with a most commonly negative net effect.

On the other hand, when it comes to the more “atheoretic” Granger causality approach, empirical evidence is almost equally divided between interdependence, mutual dependence and one-sided dependence between defence spending and growth. It is not possible to specify a common finding. What also becomes apparent from reviewing the studies is that in developed countries the economic effects of military spending on growth are quite different to those in LDCs. Developed countries may benefit from military expenditure, through increases in aggregate demand and increased utilisation of capital and labour, or they may be

worse off if defence spending crowds-out investment from other sectors that are potentially more productive than the military. Also, if a country has domestic arms production and arms exports it is more likely to be positively affected by military expenditure than those countries that have high arms imports.

Once again the importance of studying individual countries becomes evident. A researcher must have good knowledge of a country's background to be able to build a complete model that is not only consistent with a certain theory but most importantly takes into account those specific characteristics that are unique to the country. If these unique characteristics are not taken into account, there is a great possibility for misspecification of the model (failing to account for structural changes, political or strategic factors) leading to misinterpretation of the results obtained. Investigating the defence-growth relationship in Greece under three different empirical specifications will provide a more insightful approach to the issue and at the same time will overcome all the shortcomings that arise from cross-sectional studies. The next chapter provides a background analysis of the Greek economy.

GREECE: POLITICS, ECONOMY, SECURITY

4.1. Introduction

Greece constitutes a particularly interesting case for investigating the defence-growth relationship as it is a small, newly industrialised country, with many economic problems and security concerns, that even after the end of the Cold War continues to spend a significant share of its GDP on defence. Situated in an interesting geostrategic point in the European continent, the south of the Balkan peninsula, it is the only EU country that does not have borders with any of the member-countries. It is bounded on the North by the Former Yugoslavic Republic of Macedonia (FYROM) and Bulgaria, on the Northwest by Albania, on the East by Turkey and the Aegean Sea and on the Southwest by Mediterranean, the Sea of Crete and the Ionian Sea. Its small size and its geographic location have always made Greece an economically extroverted country heavily dependent on international economic relations. But these same characteristics have also always attracted the attention from Great Powers with vested interests in the eastern Mediterranean.

The 1960s and early 1970s was a period of uninterrupted growth and economic prosperity for all the industrialised West. By the mid-1970s the situation had

changed due to the international recession and the world energy crisis. The international economic crisis coincided with the collapse of the dictatorship in Greece and the Turkish invasion of Cyprus (1974). The transition towards parliamentary democracy led to internal political and economic changes and the desire for international recognition became apparent. Greece was the first of the Mediterranean “New Democracies” to consider membership of the European Community (joining the Community in 1981) as the way to strengthen its economic and political situation.

One important aspect of the economic development of Greece that has not attracted much interest from researchers is defence spending. This potentially constitutes a huge burden on the economy, (5.6% of GDP during the last decade compared to NATO’s average of 3.5% for the same period) and may bear some responsibility for the delayed progress of the Greek economy.

4.2. Political History

Until the late 1950s Greece was an underdeveloped country, with low productivity agriculture and a very weak industrial sector; a situation partly attributed to the Greek Civil War (1944 - 1949) between the left and the right (see Curtis, 1994). The end of the Civil War resulted in the defeat and banning of the communists and the establishment of a political system which added anti-communism to Greek party politics¹. The end of the Civil War also found Greece in a very difficult political and

¹ During the Civil War (1946-49), Greece was ruled by a coalition of the two main political parties, the People’s Party (right) and the Liberals (centre), under a Liberal Prime minister.

economic situation which was quickly overcome by massive aid from the United States. To conform with the rules for dispensation of Marshall Aid, Greek governments had to draft comprehensive medium to long-term plans, the first systematic attempts to promote economic development and financial stability (Alogoskoufis, 1995). An important aspect of economic policy at the time was the participation of the Greek Drachma in Bretton Woods. In the meanwhile the US and the army had become important forces in Greek politics and Greece became tied to Western organisations such as OEEC, the Council of Europe and, in 1952, NATO. The 1952 constitution, which declared Greece a parliamentary democracy with a monarch, was followed by a decade of domination by the right-wing parties. The Papagos² government lifted many price and imports controls, drastically devalued the drachma in 1953 and reduced interest rates. It also introduced accelerated depreciation for tax purposes, legislation to protect and attract foreign capital, and measures to control the bureaucracy. However, labour and credit markets remained under firm government control (see Alogoskoufis, 1995).

Papagos successor, Constantinos Karamanlis, renamed Papagos party as National Radical Union (ERE) and ruled Greece from 1956 to his electorate defeat in 1963. His government had paid special attention to the improvement of the economic infrastructure and the development of industrialisation. In 1963, the Centre Union, party of George Papandreou won the elections³. The new government, which was in power for only two years, paid special attention to educational reforms and the

² The 1950 inconclusive elections were followed by two and a half years of weak coalitions until the Greek Rally (evolved from the People's party) led by Alexandros Papagos, won the elections of 1952 and governed the country until his death in 1955.

³ The Centre Union Party evolved from the Liberal Party.

welfare state. A brief period of alternative governments resulted in a constitutional crisis over the role of the military; the political instability resulted in the military coup of 21 April 1967 which led to a military dictatorship. The military government was in power for 7 years (1967-1974) and it collapsed immediately after the Turkish invasion of Cyprus in 1974, which followed the Athens instigated coup against the elected president of the Cypriot Republic.

In 1974, after democracy was restored, Karamanlis ruled the country for seven years as the leader of New Democracy (a new party he founded which evolved from ERE). In 1975 a new constitution was promulgated to establish Greece as a republic with a political structure modelled on that of France (Curtis, 1994). In 1979, the treaty of Accession to EC was ratified by the Greek parliament and in 1981, Greece became a full member of the EC - which is considered to be a big achievement of the Karamanlis government. During the Karamanlis years (1974-1981), there was a significant expansion in the role of the state in the economy with many nationalisations taking place. Also, there were large increases in defence and general government expenditure, as well as in real wages due to the emergence of powerful labour unions. In late 1981 the Socialist party of Andreas Papandreou (PASOK) was elected, while Karamanlis was elected as President of the Republic. The party (PASOK) was reelected in the mid-1985 elections, with its leader Papandreou continuing nationalisations and strengthening price controls. During his rule, (1985-89) a number of financial scandals and personal humiliations became public, while public deficits and debts were greatly increased and the balance of payments deteriorated, reaching a crisis point in 1985 and 1989 (Jouganatos, 1992).

A Stabilisation Program was adopted in 1986-87 that introduced austerity measures that were eased in 1989-90 (as it is common for pre-election periods).

The years 1989-90 were characterised by political instability, as while the general election of June 1989 placed the relatively conservative New Democracy Party (ND) first, it did not hold the majority of seats in Parliament. As a result, the leader of ND, Konstantinos Mitsotakis, could not form a government and an interim government⁴ was formed under an unusual coalition between ND and the Alliance of the Left and Progress. Two general elections followed within seven months. The result of the first was identical to that of June 1989, leading to another interim government. This time the interim government that aimed to mend the economy was headed by Xenofon Zolotas, an economist and former governor of the Bank of Greece. But the general election of April 1990 gave ND the majority of seats in Parliament. Its leader Konstantinos Mitsotakis had to deal not only with the problems that the economy was facing but also with pressing issues in Cyprus and in Greek-Turkish relations. He ruled the country until 1993, when the general election placed PASOK under the rule of Andreas Papandreou. After his death, the Socialist party won the elections of 1996 again with Constantinos Simitis as the prime minister governing the country since then. The Simitis' government main concern is to achieve the "convergence criteria" of the EMU.

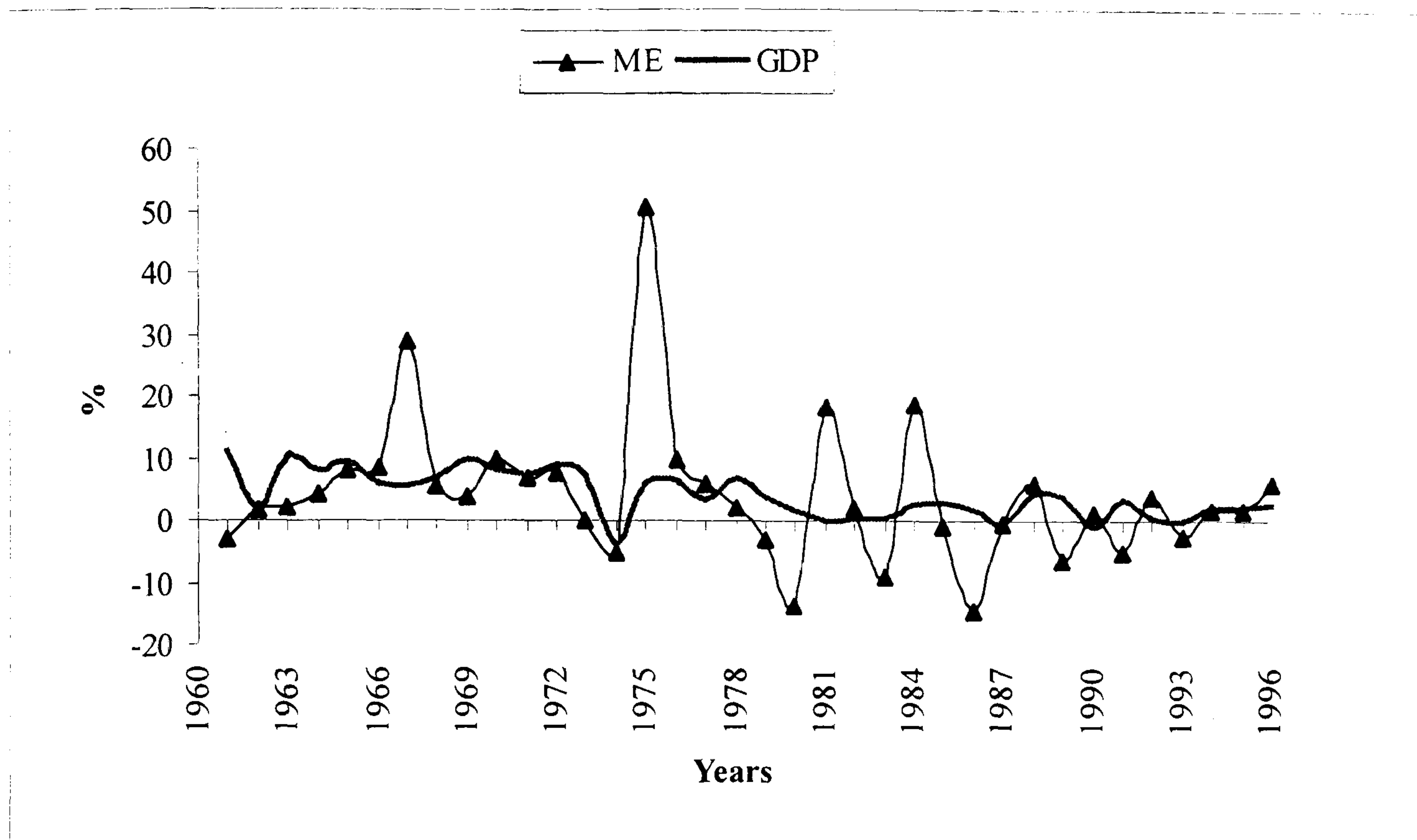
⁴ Tzannis Tzannetakis, a highly regarded member of Parliament from ND, was selected as prime minister of the interim government whose purpose was to prosecute the officials accused of financial scandals during the PASOK administration as well as to improve relations with the US (Jouganatos, 1992).

4.3. Defence Spending and Economic Performance

In the 1960s the Greek economic structure faced important qualitative changes. In 1962 for the first time, the contribution of the industrial sector to national output was greater than that of agriculture (Kollias, 1996). During 1961-1970, Greece allocated an average of 4.3% of GDP to defence yearly and achieved an annual average growth rate of GDP equal to 7.6% - well above the European average (see Figure 4.1.). The annual average of inflation for this period was very low at 3.1. Despite the economic growth social conditions declined during this period. The emigration that had begun in the late 1950s continued into the 1960s (about 452,000 Greeks left between 1963-67). Also crowding into big cities gave rise to increased demand for social security and better income distribution (Curtis, 1994). In 1963, Makario's demand for reduction in the powers of the Turkish minority in Cyprus provoked a lot of tension on the island and it was at that time that Turkey threatened an invasion to defend Cypriot Turks. United States intervention prevented an invasion in early 1964 when United Nations' peacekeeping forces entered the island to prevent war and have remained on the island ever since.

The 1970s brought developments on the economic and defence fronts. The impressive growth rates of the previous decades started to decline, as the structural weaknesses of the Greek economy became apparent. Despite the fact that the annual average growth rate fell to 4.7% (in comparison to 7.6% of the previous decade) it was still well above the average of EC countries. Military burden was increased to 5.75% of GDP.

Figure 4.1. Real Growth of Greek Military Expenditure and GDP*



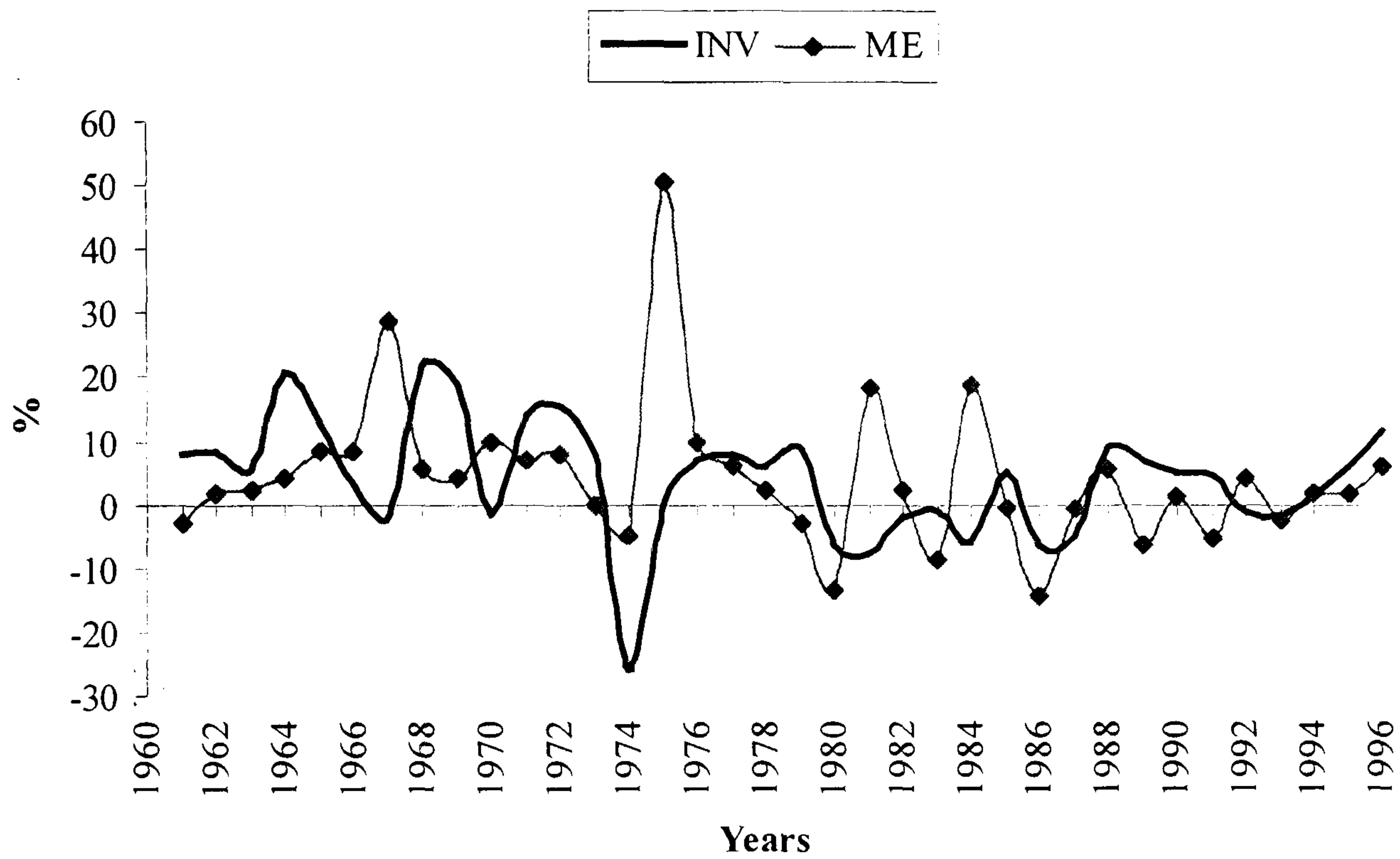
*calculated from figures in constant 1990 mn US \$

Source: SIPRI and EUROSTAT

The first energy crisis and the international monetary turmoil following the Arab-Israeli war in 1973 had an adverse effect on the Greek economy. The high cost of foreign oil could not be covered by exports and as a result the Greek balance of payments faced a large deficit (see Figure 4.3) and the economy suffered inflationary pressures (inflation went up to 13.7% for that decade), while unemployment was kept at very low levels (see Figure 4.4.). In the early 1970s government controlled defence industries were established because of weapon embargoes during the seven year military government but also because Greece wanted some independence in weapon procurement due to the increasing tensions with Turkey. The huge economic problems increased popular resistance to the dictatorship and contributed to its collapse in 1974. In this year, the Turkish invasion of Cyprus and the establishment of democracy in Greece marked a huge increase in defence spending and at that time the threat of an open confrontation with Turkey seemed highly likely.

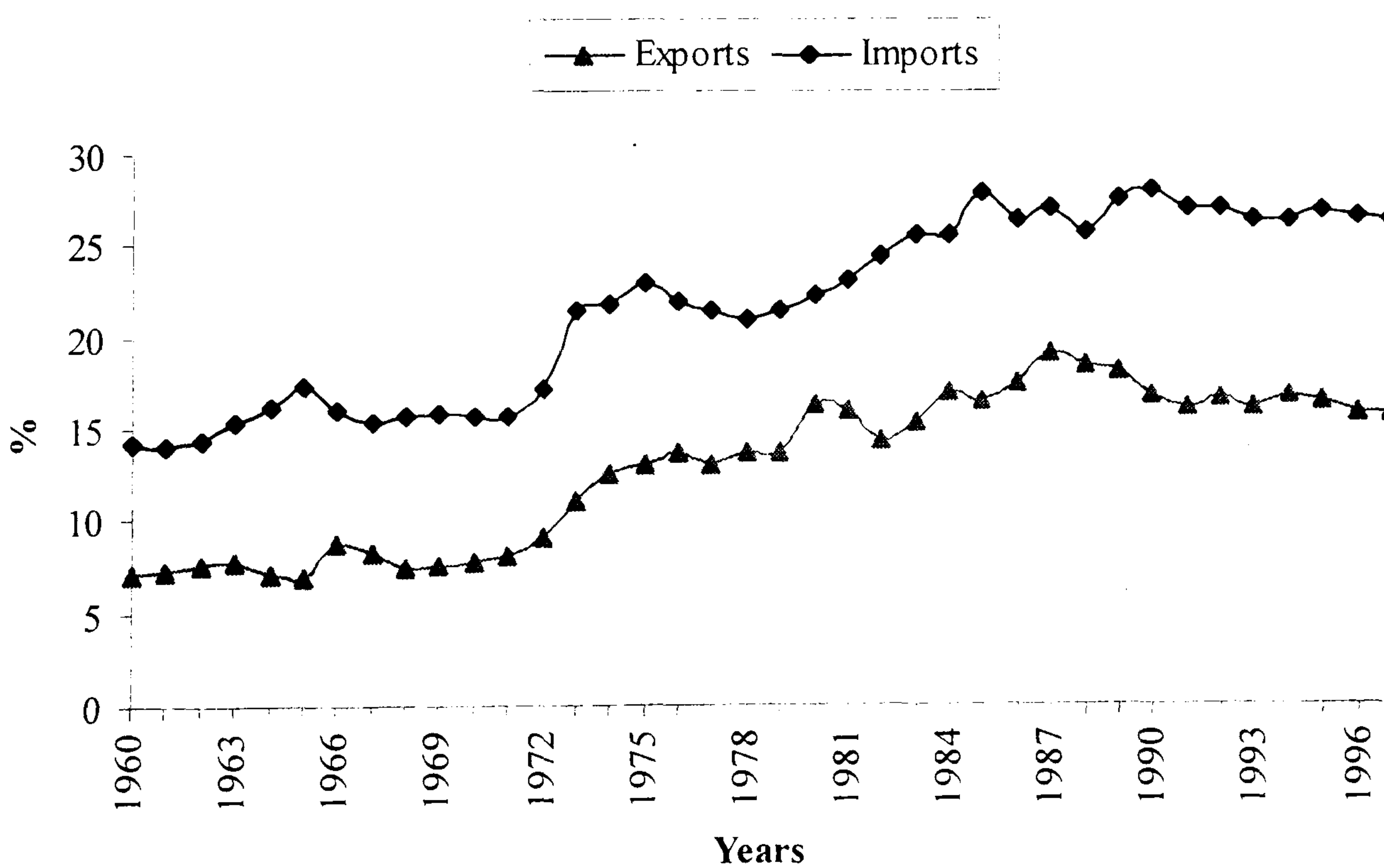
All these events contributed to dramatic decreases in investment which during the mid-1970s saw negative rates of growth (see Figure 4.2.).

Figure 4.2. Real Growth of Greek Investment and Military Expenditure*



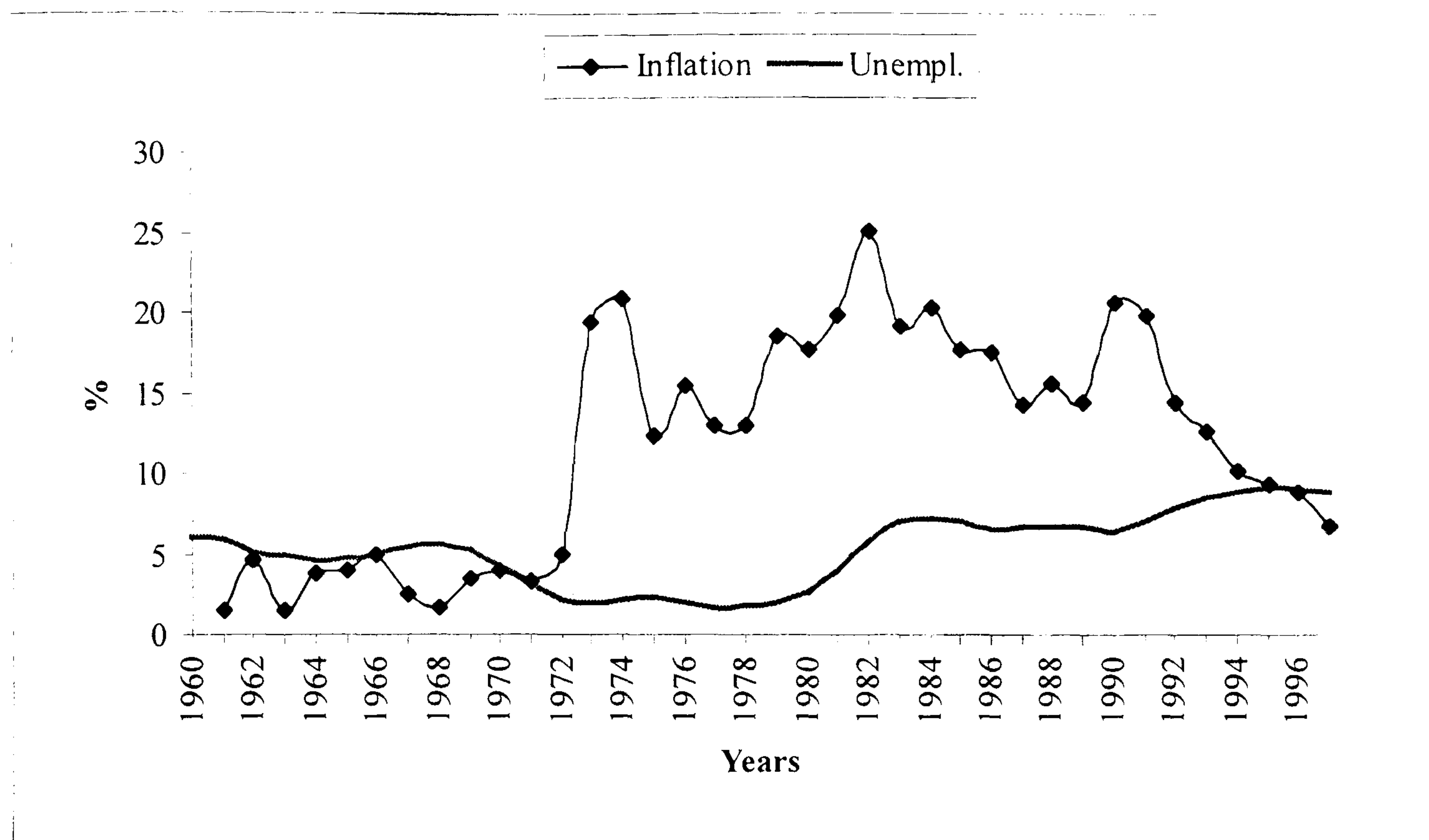
*calculated from figures in constant 1990 mn US \$
Source: SIPRI & EUROSTAT

Figure 4.3. Greek Exports and Imports as a share of GDP



Source: EUROSTAT

Figure 4.4. Greek Inflation and Unemployment Rates*

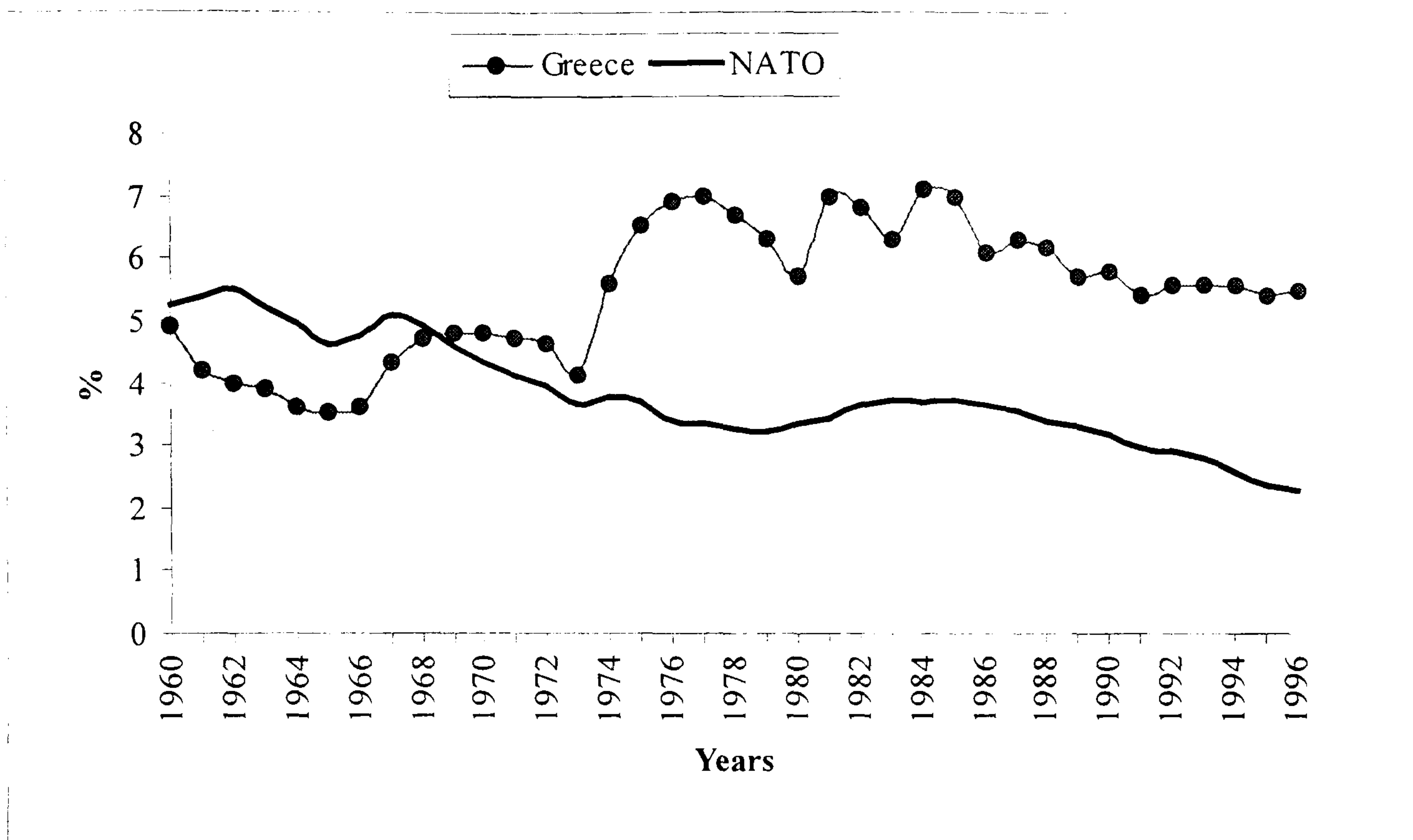


*Unemployment as a percentage of civilian labour force and inflation as the annual percentage change in GDP deflator in 1990

Source: OECD

In the 1980s the Greek economy deteriorated. The average annual growth rate was 1.6% compared to that of the rest of Europe which was 2.3%, while inflation increased even more, averaging 18.4% annually (see Figure 4.4.). Despite the persistent economic problems military expenditure was kept at a high level due to the perceived threat from Turkey. During the 1980s Greece allocated an average of 6.52% of GDP to defence annually, a percentage much higher than that of the NATO alliance as a whole (see Figure 4.5) and in 1985 Greece officially declared a defence doctrine according to which Turkey was identified as the principal threat to its security.

Figure 4.5. Greek and NATO Military Burden*



*military expenditure as a share of GDP

Source: SIPRI

During the last decade there was a deep concern over the events in the Balkans as Yugoslavia began to break up. Greeks were particularly upset by the creation of a state called Macedonia (as Macedonia is the name of the northern part of Greece) and there was some concern over the treatment of the Greek minority in Albania. Initially these events seemed to add to the security concerns for Greece, but since none of these countries possessed large military establishments Greek defence policy and military planning was not affected.

As can be seen in Table 4.1., economic indicators improved slightly during 1991-1997 mainly because of Greece's effort to achieve the required criteria for joining EMU. For this period GDP growth rate was 1.9% while military burden fell to 5.5% of GDP because of the tight macroeconomic policies. Inflation was brought down to an annual average of 11.7% for the same period. Despite the slight improvements in

the main economic indicators⁵, Greece's economy is still very weak and well below the EU average. On top of this, the conflict with Turkey⁶ remains unresolved. There are still disagreements⁷ over Cyprus, over the continental shelf of the Aegean Sea, and over the control of the airspace above it. These security considerations are used to justify Greece's high defence spending⁸. The end of the Cold War left Greece with major foreign policy concerns to its immediate North and East.

⁵ Table A1 in Appendix A gives the main economic indicators for Greece annually.

⁶ For a comprehensive view of the Greek-Turkish relations, see Conostas, D. (1991).

⁷ From the Greek perspective, Turkey is characterised by imperialism and aims to change the status quo which was established by the treaties of Lausanne (1923), Montreux (1936) and Paris (1947). The 1974 Turkish invasion of Cyprus and the up to date occupation of 40% of the island by Turkish troops is a clear proof of Turkey's ambitions and strategic aims.

⁸ Table A2 in Appendix A gives the Greek military figures annually.

Table 4.2. Greece: Main Economic Indicators (1961-1997)

	1961-70	1971-80	1981-90	1991-96	1992	1993	1994	1995	1996	1997
GDP growth (1990 prices)	7.6	4.7	1.6	1.9	0.5	0.2	2.2	2.0	2.6	3.1
Inflation rate (%)	3.1	13.7	18.4	11.7	14.5	12.7	10.1	9.3	8.9	6.7
Gross Invest. (% of GDP)	26.3	29.8	23.4	21.1	21.6	20.7	19.9	20.2	21.4	22.5
Gov. Debt (% of GDP)	16.1	20.2	53.1	106.2	99.2	111.8	110.4	111.8	111.8	108.3
Employment (% change)	-0.8	0.7	1.0	0.7	1.4	0.8	1.9	0.9	1.0	1.2
Cur. Balance (% of GDP)	-2.6	-1.6	-3.6	-2.6	-3.2	-1.7	-1.0	-2.7	-3.5	-3.7
Imports (% of GDP)	15.6	20.7	26.1	26.7	27.0	26.3	26.4	26.9	26.5	26.4
Exports (% of GDP)	7.7	12.4	16.9	16.4	16.7	16.2	16.8	16.5	15.8	15.8
Population (000s)	8662	9525	10016	10356	10322	10380	10426	10454	10506	10559

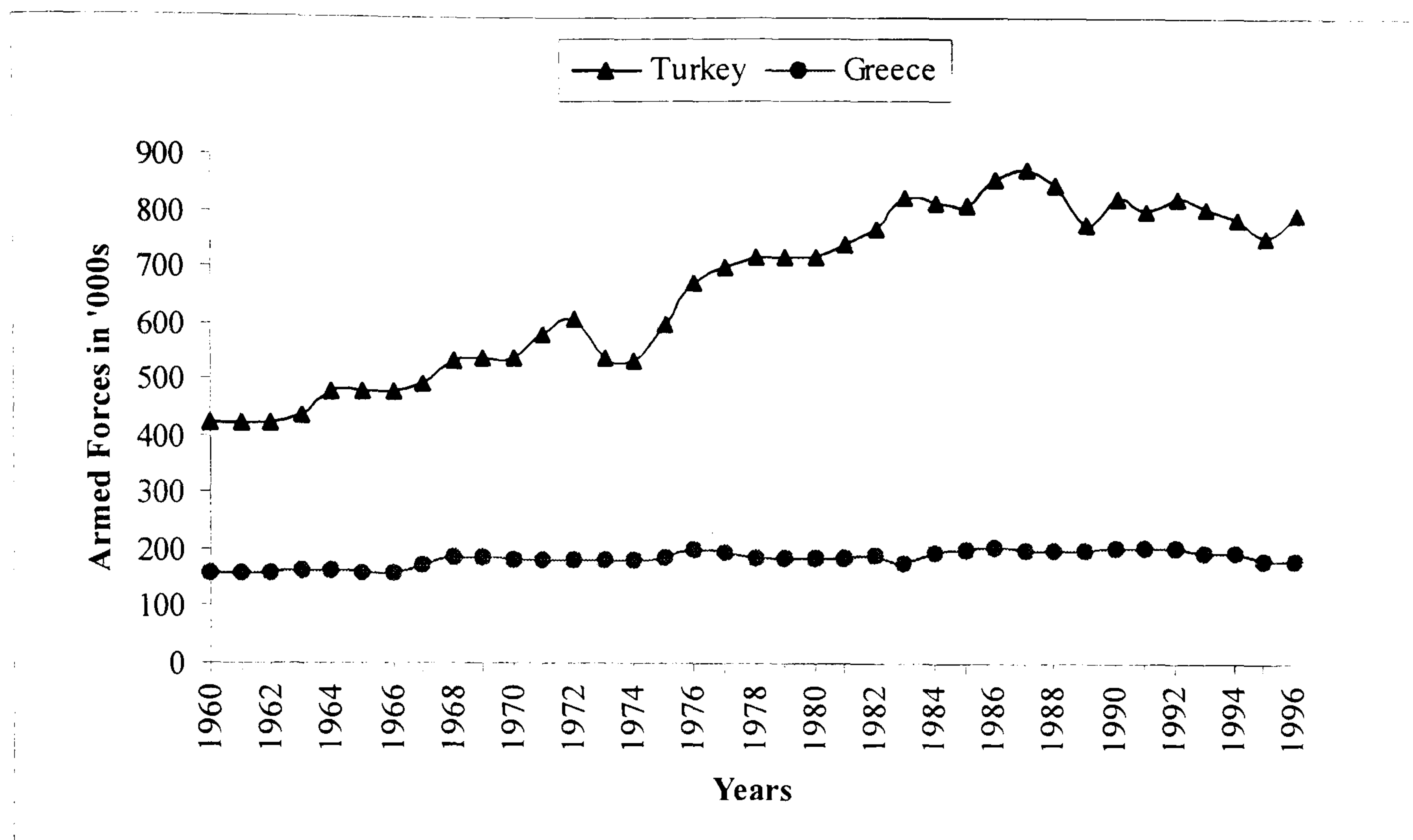
Source: EUROSTAT (Various years)

4.4. National Security Concerns

Although the end of bipolar geopolitics has eliminated the communist threat, Greece's eastern neighbour remains a major concern that necessitates large military expenditures affording the opportunity for continued political input by the military establishment. Also, the protracted Balkan crisis of the early mid-90's highlighted the military's politically sensitive role (Curtis, 1994).

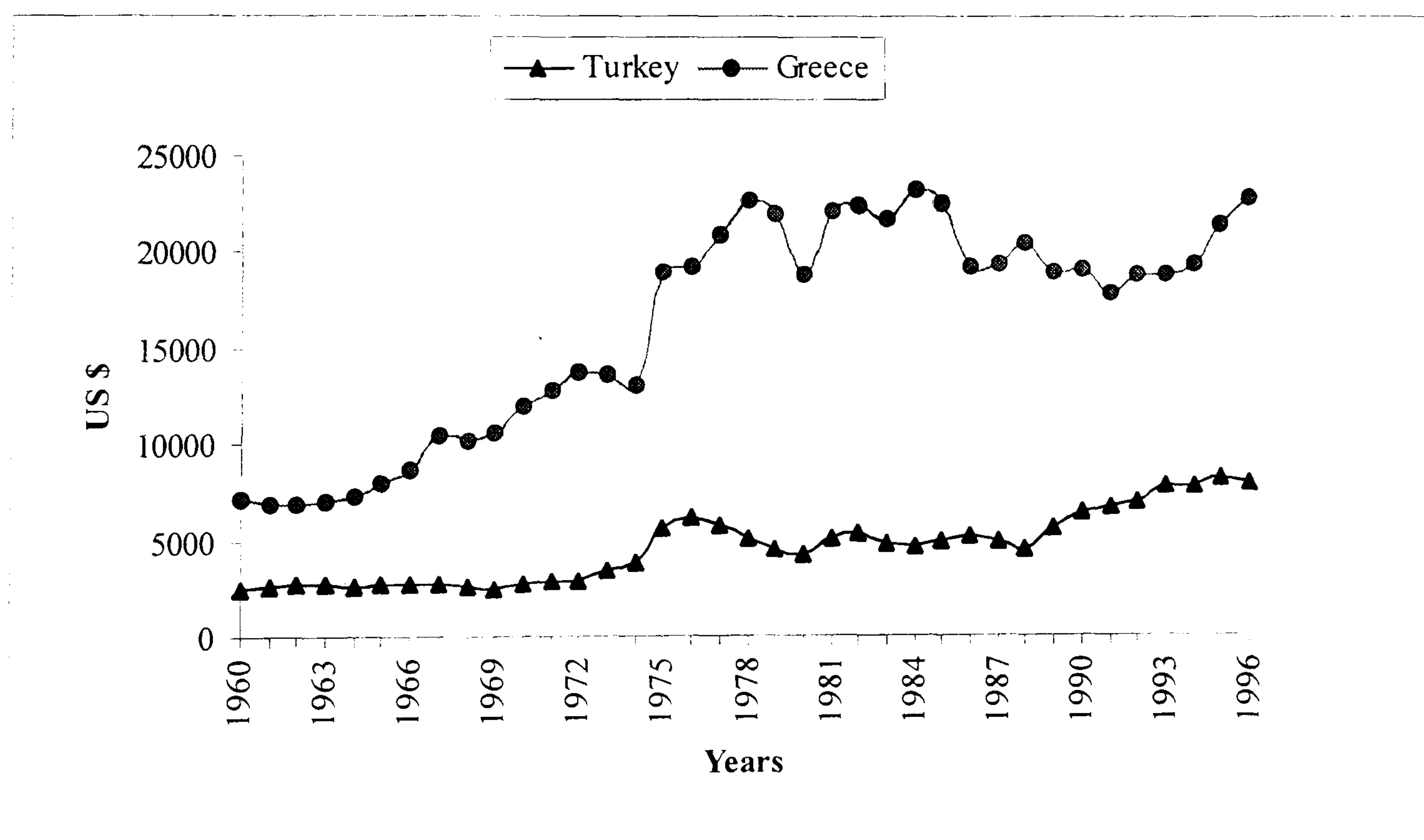
Greece's strategic position at the junction of three continents (Europe, Asia and Africa) and nearly totally surrounded by sea has made continuous involvement with close neighbours and constant attention from great powers with vested interests in the eastern Mediterranean inevitable. Its national security concerns can be divided into a pre-1974 and a post-1974 period. The pre-1974 period was characterised by instability and conflicts between royalists and republicans, communists and nationalists. The collapse of the last Greek military dictatorship signalled the beginning of a new era for Greece. Since 1974, the Hellenic forces' primary mission has been to maintain a balance of power with Turkey, specifically deterring the infringement of Greek national interests and sovereignty and preventing a Turkish attack on the Greek-Cypriot part of Cyprus. Given Turkey's quantitative advantage of a population six times larger than Greece's and larger armed forces (see figure 4.6.), Greece has always tried to "compete" in qualitative terms. Greek military expenditure per soldier has always been higher than Turkish (see figure 4.7.), furthermore, as can be seen in Figure 4.8., the Greek ratio of armed forces to population exceeded the Turkish one throughout the period examined. As a secondary mission, Greece's status as a member of NATO requires military contributions to the alliance's efforts to deter threats in Eastern Europe, the Balkans and the Mediterranean.

Figure 4.6. Greek and Turkish Armed Forces



Source: SIPRI and ACDA

Figure 4.7. Greek and Turkish Military Expenditure per Soldier*

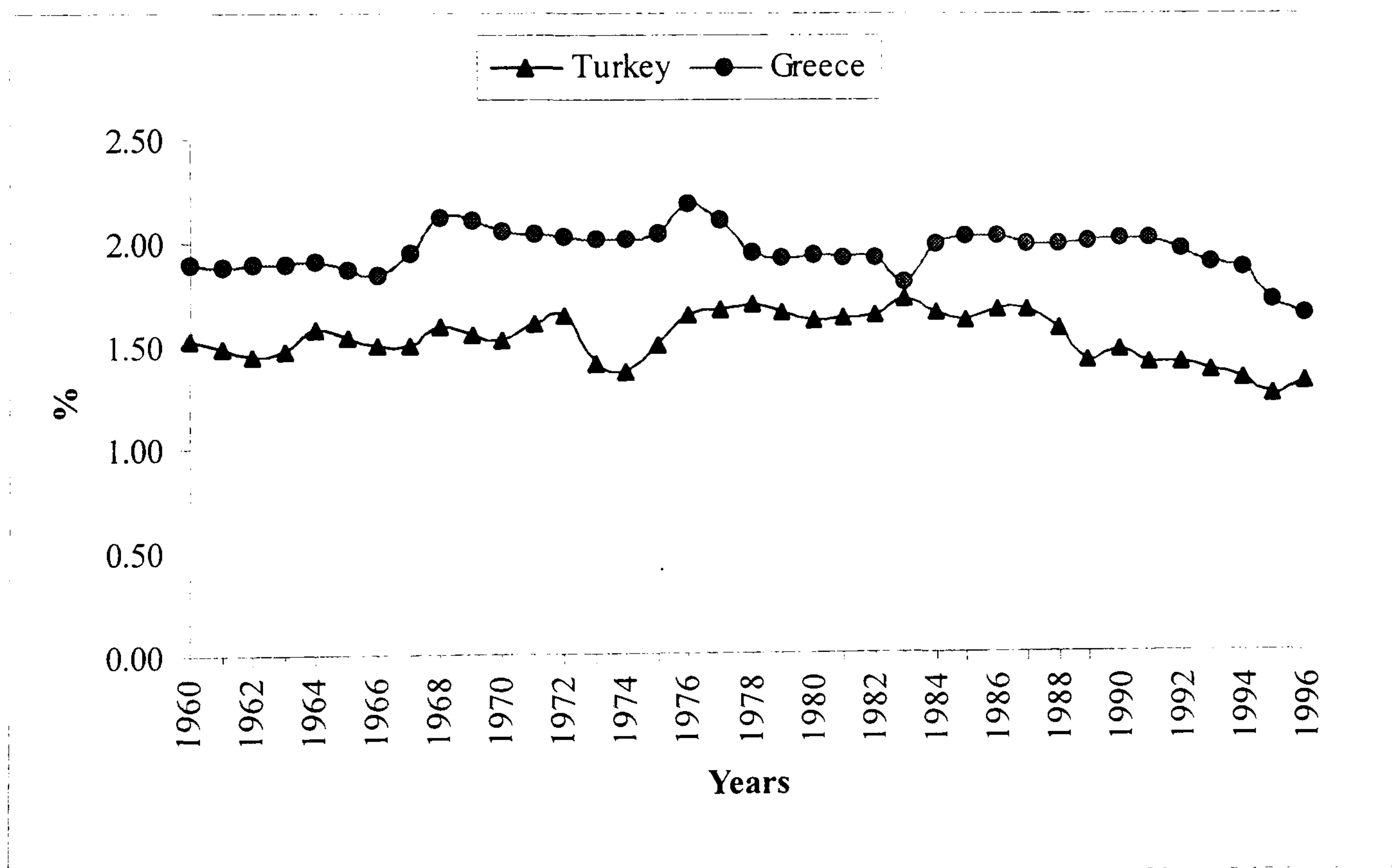


*in constant 1990 US \$

Source: SIPRI and ACDA

In 1994, Greece and Cyprus announced the creation of a *Joint Defence Area*. According to this doctrine, as long as Turkey maintained an occupation force of more than 30,000 troops in Cyprus, Greek and Cypriot forces would remain in the posture of joint defence. In late 1994, all Greek political parties regarded Turkey as the principal threat to Greece's security. This perception has been used to justify increased emphasis on military expenditures in the 1990s. Spending that has supported deployment of military forces to demonstrate Greek resolve at a time of reduced reliance on NATO - an organisation that Greece has blamed for its inability to prevent the invasion of Cyprus by another member of the alliance⁹.

Figure 4.8. Greek and Turkish Ratio of Armed Forces to Population



Source: ACDA & OECD

⁹ During the post-war period Greece's security considerations have been the threat from the Warsaw Pact countries and from Turkey. By joining NATO, Greece secured its northern borders but not the eastern ones, since the strategic interaction between Greece and Turkey has two contradictory facets: they are state to state adversaries and NATO allies (Sezer, 1991).

So, in the 1990s, Greece's most critical concerns were the chronic disagreements with and the perceived security threat from Turkey together with the instability in the Balkans (Albania, Bulgaria, Yugoslavia). Policy makers in Greece justify high levels of military expenditure because of these security concerns.

4.5. Defence Industries

In the 1950s Greek defence policy was primarily organised by the US. This continued until 1974 when the Turkish invasion of Cyprus proved that this strategy degraded Greece's independence in defence by exposing it to threats from within the NATO alliance. After 1974, Greece attempted to achieve partial independence from NATO. But it soon became apparent that this policy was not beneficial for Greece, as it was extremely difficult for a small country to organise its defence without being a member of one or more defence alliances. So Greece, after many efforts, managed to find the right balance between independence and attachment to the alliance's policies.

Greece is a net importer of military equipment, mainly from US, France and Germany. According to SIPRI it ranked fifth among the major recipients for conventional weapons during 1990-1995 while Turkey ranked first, Spain twentieth and Portugal twenty-third (see Table 4.2.). During the 1950s, under a military aid programme that aimed to integrate smaller NATO countries in the allied structure of armed forces and production capabilities, equipment from World War II and the Korean War was transferred to Greece. In other words, Greece was obtaining used military equipment through military grants and under these circumstances there was little hope for the development of

indigenous military production. Instead, Greece was involved in creating maintenance networks for the imported weapon platforms and developing capabilities in ammunition and aircraft maintenance.

Table 4.2. Imports of Major Conventional Weapons*

	1988-92	1991	1992	1993	1994	1995	1991-95
Turkey	6167	954	1640	2288	2089	1125	8096
Greece	6197	559	2632	891	1185	489	5756
Spain	3747	126	261	580	863	359	2189
Portugal	1374	1062	3	300	500	5	1870

* in constant 1990 mn US \$

Note: For the years 1991-95, Turkey was ranked first among the major recipients for conventional weapons, Greece fifth, Spain twentieth and Portugal twenty-third

Source: SIPRI

In the mid-1960s the transfer of used military equipment from US and other NATO countries was eliminated, as were military grants towards countries with developing defence industries (DDI countries). Greece was spending a large amount on defence and this amount was further increased after 1974 (after the Turkish invasion in Cyprus). It was during this time (mid-late 1970s) that state owned defence industries started to be established. The development of an indigenous military industry was seen as necessary because of weapons embargoes during the seven year military government, but also because of the need to reduce balance of payments deficit on current account via import substitution. Manufacturing plants were built-up whenever a big order could create a sufficient market for a new production line (Bartzokas, 1992).

The creation of the Defence Industries Directorate within the Ministry of National Defence in 1977, was the first step towards organising Greece's defence industry. In 1998, the Greek military industry consisted of four large state-owned companies --

Hellenic Arms Industry (EBO), Hellenic Aerospace Industry (EAB), Greek Powder and Cartridge Company (PYRKAL), and Hellenic Vehicle Industry (ELBO). There was a fifth one - the Hellenic Shipyards SA - which was privatised in the early 1990s. Besides the state-owned military suppliers, there were also some small and medium-size companies that allocate from 20% to 80% of their capacity to military production. These companies are now grouped under the auspices of the Association of Greek Producers of Defence Materials (SEKPY). SEKPY was founded in 1982 by 20 companies with experience in the area of defence, employing about 2,000 people. SEKPY's objective was to substitute some of the defence imports by domestically produced defence products. The other objective was to promote and develop co-operation between the armed forces and the defence industries, to develop indigenous arms production and exports. Currently, there are 105 members of SEKPY¹⁰, including almost all the defence industries - public and private ones - employing in total 20,000 - 25,000 full-time workforce (Balfoussias & Stavrinou, 1996).

In the 1980s, the possibility for countries like Greece to participate in an integrated European arms sector was seen as a great opportunity, since local firms could benefit from joint programmes and increase their exports to other West European countries. The basic difficulty for Greece seemed to be its dependence on military imports from the USA, who had used military aid funds, knowledge transfer, cheap prices and direct political pressure in order to secure sales. Greece became a significant market for advanced weapons systems and this led to a foreign trade deficit, shortages of foreign

¹⁰ SEKPY's member-companies produce the following types of defence material: explosives, guns and gun-systems, battleships, military vehicles, aircraft components, electronic components, satellite components, telecommunication components, electrical components, wires, bullet-proof vests, batteries, protective masks for chemicals and at around 40,000 parts.

currency and devaluation of the national currency against the US dollar. In these circumstances, the advanced countries' efforts to promote exports in the Greek market were connected with credit supplies from the US Foreign Military Sales (FMS) programme, with terms of loans a significant input in the decision making process for new orders.

Some investments were made in established sub-sectors such as ammunition and transportation and in the mid-1980s, a large scale modernisation of the Greek air force was accompanied by a shift towards advanced manufacturing in aircraft assembly and electronic components. According to Bartzokas (1992), "*After the first import-substitution phase, many arms producing companies were involved in "grey" military exports and benefited from the Iraq-Iran war (i.e. exports for 1982 were 120mn \$, for 1984 100mn \$, for 1986 40mn \$ and for 1987 40mn \$). This export-led growth forced these industries to further expansion in military manufacturing projects*" (Bartzokas, 1992, p.171).

However, significant economic problems arose, mainly because of management mistakes including delayed response to technological developments, the changing needs of the armed forces, and the inefficient use of offset agreements¹¹. The policy of industrial modernisation through the expansion of military industry has now been abandoned due to huge financial debts. In 1990 because of economic difficulties, the Greek government asked some of the main state-owned military companies to convert their activities to the production of civil goods. Meanwhile the privatisation programme

¹¹ Agreements by which Greek plants supply components to foreign military manufacturers in return for aircraft and equipment.

of public enterprises created some interest among European and US firms to buy parts of the Greek armaments sector. The move towards mergers with foreign interests, or even a long-term programme for the conversion to civilian production is likely to face political opposition and hostility from the armed forces (Bartzokas, 1992).

Countries like Greece with no developed military industrial sector but spending a large proportion of GDP on defence due to security considerations, obviously aim to develop indigenous defence industries in order to gain a certain degree of independence in defence procurement as well as political and national strength. But also, and maybe most importantly, because the substitution of imported military equipment by domestically produced can have very important economic and technological benefits, such as reduction in the loss of domestic currency for imports, reduction of unemployment, and increase in demand as well as the achievement of know-how and technical skills. These technological spin-offs may have beneficial effects for other sectors of the economy if there is an adequate infrastructure. But in Greece, the existing industrial infrastructure is inadequate, the scale of manufacturing plants too small, the indigenous technological capabilities very limited and the involvement in high technology sectors almost non-existent. The major activity, therefore, is assembly work.

4.6. Conclusions

It is clear from this brief background analysis of Greece that it is a country with many economic and security problems, with no developed defence industry, but with a large military burden. The absence of a developed indigenous arms industry and the existence of huge economic problems, make high defence spending seem irrational or unjustifiable by pure economic reasoning. But what could appear to force Greece to spend a lot on defence are security concerns, mainly the perceived threat from Turkey and the instability of the Balkans. Certainly policy makers use these threats to justify the substantial share of GDP that is allocated to defence each year. But what about the economic consequences of high defence spending? This is usually a secondary issue when a nation fears for its national security and policy makers tend to avoid asking this sort of questions. Defence spending, however, may bear considerable responsibility for the delayed progress of the Greek economy. Only recently, the economic effects of defence spending in Greece has attracted some interest from researchers. This study will provide a contribution to this area of research, thoroughly investigating the economic effects of military spending in Greece using three empirical approaches. Prior to this, though, it seems necessary to examine the determinants of Greek military expenditure, which given the important security considerations are likely to be strategic rather than economic. This issue is empirically investigated in the next chapter.

DETERMINANTS OF GREEK MILITARY EXPENDITURE

5.1. Introduction

Prior to investigating the economic effects of military expenditure in Greece it is appropriate to examine the determinants of such spending. There are a wide variety of models of the demand for military expenditure based on different theories about the decision-making process and the influence of various military, political and economic factors (see Smith, 1977,1989, 1995). Military factors (i.e. military spending of potential enemies, or of allies) are considered to be external influences on the demand for military expenditure, in which case it is represented by arms-race models or models of alliances. Internal influences include economic factors (income and prices, or even the need to stabilise demand and control public expenditure), political factors (lobbying by the Military Industrial Complex and other interest groups, or even the ideology of the government) and bureaucratic factors (bargaining over the budget starting from the status quo). As such, the demand for military expenditure is represented by public choice models, models of bureaucratic behaviour, or general models of aggregate defence spending in which all the above can be either incorporated or seen as special cases (Dunne, 1996). The majority of

empirical studies on the determinants of military expenditures focus on arms-race models and on general models of aggregate defence spending. The rest of this chapter reviews these two types of models and provides empirical estimations of: a) an arms race model for Greece and Turkey and b) a general model of aggregate defence spending.

5.2. Arms-Race Models

The starting point for arms-race models was Richardson's (1960) seminal work which explains the time-series pattern of military expenditure between potential enemies in an action-reaction framework. The Richardson model uses a coupled pair of differential equations to explain the change in levels of weapons in each of two nations as a function of the weapons held by both sides. He postulated three motives which lead a nation in time of peace to increase or decrease its preparation for war.

“First, there is the motive of revenge or hostility which is independent of existing armaments, and which tends to be enduring and constant. Second, there is the very strong motive of fear, which moves each group to increase its armaments because of the existence of those of the opposing group. Finally, there is always a tendency for each group to reduce its armaments in order to economise expenditure and effort”, (Richardson, 1960, p.13).

To mathematically represent these ideas, he described a process in which one side in a competitive relationship reacts to increases in the other side's arms by increasing its own arms. So, for two rival states with armament levels m_1 and m_2 , Richardson (1960) gave this process the following mathematical form:

$$dm_1/dt = a_1 + \beta_1 m_2 - \gamma_1 m_1 \quad (1)$$

$$dm_2/dt = a_2 + \beta_2 m_1 - \gamma_2 m_2 \quad (2)$$

According to these equations, the rate of change in one state's armaments, m_1 , rises with increases in the other state's armaments, m_2 , and vice versa. The coefficients β_1 and β_2 represent the sensitivity of each state's arms acquisition to the arms level of the other state and Richardson interpreted them as "reaction" terms. The coefficients γ_1 and γ_2 represent "fatigue" terms, as the rate of arms acquisition falls with increases in each state's own arms levels. Finally, Richardson called the constants a_1 and a_2 "grievance" terms, which are positive as the two states are in a competitive relationship to begin with.

Although the Richardson arms-race model constitutes one of the best known and one of the most influential formal models in international relations literature, it is a descriptive model without an explicit objective or an assumption of maximizing behaviour and its results have been quite disappointing when applied to data as Hartley and Sandler (1995) note (Hartley & Sandler, 1995, p.115). Also, finding that a country responds to current armaments of a potential enemy country (as the classical Richardson model postulates) is problematic in terms of interpretation since a country cannot know the current armaments of its potential enemy at the time it makes its own defence decisions. The common thing is that policymakers justify high military expenditure in the name of national security which is at stake due to perceived threats. Another problem that arises from arms-race models is their limited applicability since, according to Deger and Sen (1990), these models can only

be successful if applied to countries that are in conflict. Also, arms-race models do not perform well empirically (Deger, 1986; Mohammed, 1992; Smith, 1989). Finally, arms-race models are characterised by a further difficulty of choosing a measure of defence (Anderton, 1989, Hollist, 1977, Ward, 1984). Deger and Sen (1983) remarked that, since most of the studies investigate the nuclear arms-race between superpowers, such measures may not be applicable when studying smaller countries that lack nuclear capabilities. And as Smith (1980) claimed:

“Unlike other government expenditures it is impossible to quantify the objective of military expenditure. The government spends on armed forces, weapons and soldiers in order to provide security through military capability. While forces and spending can be measured, capability and security cannot. Military capability of a state is determined in quantitative terms (the size of the armed forces and weapons) and in qualitative terms (personnel training and weapon sophistication proxied by military expenditure per soldier). The consensus among arms race modellers tends to be that military expenditure is a good measure of military capability or at least the best available” (Smith, 1980, p.32).

After an extensive use of the classical Richardson model in the 1960s and early 1970s, researchers tried to modify and alter it by introducing, for example, more relevant variables (ie income), by using different theoretical formalisations of the arms race process such as game theory¹, by introducing strategic capabilities measures, by adding a variable for military stocks alongside that for military spending (Ward, 1984) or, more commonly, by introducing some more general variants of the classical model such as distributed lag or vector autoregression and error correction representations. So, any review of the studies on arms race models shows a diversity of model specification, data and testing procedures.

¹ Intriligator (1975), Intriligator and Brito (1990). Levy (1984) developed arms race models by using game theory and by introducing strategic capability measures in their models.

Empirical studies of arms races seem to end up with quite puzzling results. Most puzzling of all seems to be the inability of researchers to find evidence of an arms race between the US - USSR, indicating that defence spending in these countries may be influenced by internal factors only (Isard and Anderton, 1985; Intriligator and Brito, 1990; Gleditsch, 1990; McGinnis, 1991; Kinsella and Chung, 1998). Something that seemed strange given the Cold War confrontation between the superpowers. Certainly within the context of an action-reaction model, there was no apparent arms race between the US and the USSR, which suggests that it makes sense to move to other theories which try to explain the growth in military expenditure (see Chapter 2) in developed countries. For example, the Keynesian theory of defence spending would emphasize lack of effective demand or the Marxist theory would emphasize underconsumptionism and in both cases increases in defence spending arise from economic (internal) reasons. Furthermore, since most developed economies have a developed military industry, they also benefit from technological spin-offs that arise from research and development in this area.

In the case of developing countries these economic determinants may still be important but lack of aggregate demand is unlikely to be a problem. In contrast, constraints on the supply side are more likely to be a problem in LDCs. As such, the usual thing to claim for these economies is that the military competes for scarce resources leading to crowding-out of investment which in turn hinders economic growth. Since, there seems no logical economic reason to explain high military expenditures in LDCs, it is more likely to be strategic factors that influence these countries' high military burdens. Deger (1982) suggests that these strategic factors

are highly localised and lead to arms race and aggression between neighbours². The well-known Greek-Turkish conflict forced a number of researchers to test for the existence of an arms-race between the two countries. In the following section a brief review of empirical studies of arms race models for Greece and Turkey is presented.

5.3. Arms Race Models for Greece and Turkey

There is considerable debate over the Greece-Turkey arms race as previous studies have given mixed results. Majeski and Jones (1981) and Majeski (1985) using causality analysis, tested for interdependence in the military expenditures of Greece and Turkey for 1949-1975 and their results indicated the presence of instantaneous causality. Kollias (1991) applied the classical Richardson model for the two countries over the periods 1950-1986 as well as over 1974-1986 (the period after the Turkish invasion of Cyprus), but his results were very poor and did not indicate the existence of an arms-race. However, by employing specific indices of military capabilities, he found that Greek military expenditure depends on Turkish military expenditure and on the relative size of the arms forces. Also, a recent study, Kollias and Makrydakis (1997b), using cointegration and causality tests, found evidence of a systematic armaments competition between Greece and Turkey over the period 1950-1995. Refenes et al. (1995) using neural networks and indices of military capabilities (ratio of armed forces and military expenditures per soldier) examined the hypothesis of an arms-race between Greece and Turkey over 1962-90 and found

² Examples of neighbouring countries that are involved in arms race or they are characterised by conflicts include apart from Greece and Turkey, also, Iran-Iraq, India-Pakistan, Vietnam-Cambodia,

that Turkey's quantitative advantage is the most significant external security determinant of the Greek military expenditure.

On the other hand, there are studies that cannot provide strong evidence of an arms-race between the two countries. Georgiou (1990) tested the hypothesis of an arms-race over the period 1958-1987 but could not find any evidence of one. Also, Georgiou, Kapopoulos, Lazaretou (1996), based on the work of McGuire (1977), Desai and Blake (1981) and a vector autoregression specification ended up with similar conclusions for the period 1960-1990.

A review of these studies shows that results are mixed as to the existence of an arms race between Greece and Turkey. In the rest of this chapter, the same issue for the two countries is reexamined over the period 1960-96 by initially employing the classical Richardson model and later considering variants of it which draws on more advanced econometric techniques than have so far been used, namely VAR specifications using the notion of cointegration. Furthermore, the effect of adding other variables such as income to proxy the budget constraint is also considered.

5.4. Methodology and Specification of the Arms Race Model

The familiar Richardson model (see equations 1 and 2 of this chapter) can be written in discrete time with the addition of a stochastic error term as:

$$\Delta m_{1t} = \alpha_1 + \beta_1 m_{2t} + \gamma_1 m_{1t-1} + \varepsilon_{1t} \quad (3)$$

$$\Delta m_{2t} = \alpha_2 + \beta_2 m_{1t} + \gamma_2 m_{2t-1} + \varepsilon_{2t} \quad (4)$$

where m_{it} is some measure of military preparedness of country i in year t ($i=1,2$), and as mentioned previously, Richardson interpreted α_i ($i=1,2$) as exogenous “grievance” terms, $\beta_i > 0$ as “reaction” terms and $\gamma_i < 0$ as “fatigue” terms. The following assumptions are made:

$$E(\varepsilon_{it}) = 0, \quad E(\varepsilon_{it}^2) = \sigma_i^2, \quad E(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij}, \quad E(\varepsilon_{it}\varepsilon_{jt-s}) = 0, \quad \text{where } s \neq 0 \text{ and } i, j = 1, 2.$$

The structural shocks ε_{it} in these countries will be driven partly by idiosyncratic factors (events in former Yugoslavia and instability in the Balkans in general for Greece and the conflict with the Kurds for Turkey) and partly by common factors (events in the former Soviet Union or NATO modernisation). So, one would not expect the structural shocks to be independent.

The reduced form of the system can be written in VECM (Vector Error Correction Model) form of a first order VAR (Vector Autoregression) specification (see Smith et al, 1999) as:

$$\Delta m_{1t} = \delta_{11} + \delta_{12} m_{1t-1} + \delta_{13} m_{2t-1} + u_{1t} \quad (5)$$

$$\Delta m_{2t} = \delta_{21} + \delta_{22} m_{1t-1} + \delta_{23} m_{2t-1} + u_{2t} \quad (6)$$

where $E(u_{it}) = 0$, $E(u_{it}^2) = \omega_{ii}^2$, $E(u_{it}u_{jt}) = \omega_{ij}$, $E(u_{it}u_{jt-s}) = 0$, where $s \neq 0$ and $i, j = 1, 2$.

There will be Granger (1969) causality from m_1 to m_2 if $\delta_{22} \neq 0$ and from m_2 to m_1 if $\delta_{13} \neq 0$. In the theory the military expenditure variables are treated as stationary variables, integrated of order zero $I(0)$ ³. If the variables are $I(1)$, or equivalently contain a stochastic trend, then there is a danger of spurious regression. In a regression of one $I(1)$ variable on another, the R^2 tends to unity with the sample size and the t ratio to a non zero value, even if the two series are unrelated. The requirement for the regression not to be spurious is that the two variables cointegrate. If this is the case, then the process can be represented as a restricted form of the error correction model outlined above. If the long-run relationship is $m_{1t} = \beta m_{2t}$, then the disequilibrium is measured by $z_t = m_{1t} - \beta m_{2t}$ and the VECM takes the form:

$$\Delta m_{1t} = \delta_{11} + \alpha_1 z_{t-1} \quad (7)$$

$$\Delta m_{2t} = \delta_{21} + \alpha_2 z_{t-1} \quad (8)$$

where the feedbacks are stabilising if $\alpha_1 < 0$ and $\alpha_2 > 0$.

Estimation and testing of the cointegrating vectors can be done in a number of ways, including the maximum likelihood framework suggested by Johansen (1988).

Unit root tests and cointegration have been widely adopted, Kollias and Makrydakis (1997b) is an arms race example. However, there are a number of problems with the

³ A variable is said to be $I(d)$, integrated of order d , if it must be differenced d times to become covariance stationary. A variable is said to be covariance stationary if its expected value, variances and autocovariances are all constant, perhaps after the removal of a deterministic trend. An $I(0)$ variable is thus stationary.

techniques. Both the tests for unit roots (used to determine the order of integration) and the tests for cointegration tend to have low power, so determining the order of integration and cointegration is not straightforward. The tests are also sensitive to the choice of lag order, the treatment of serial correlation, the treatment of the deterministic elements, the presence of structural breaks and various other factors. There are also questions of interpretation, since the order of integration is not a structural property of the series but a description of the time-series properties of a sample. Series which appear $I(1)$ on short spans of data often appear $I(0)$ on long spans, where span refers to the length in time of the series not necessarily the number of observations. Over centuries of data, the UK share of military expenditure is clearly $I(0)$, over shorter spans it appears to be $I(1)$. While cointegration allows the estimation of the long-run equilibrium, it does not help in identifying the short-run structural interaction (Smith et al, 1999).

A major problem with the Richardson model is the lack of a budget constraint. This can be dealt with by, for example, including GDP to reflect income. Care needs to be taken in including variables within a VAR, however, as the number of parameters grows very rapidly with the number of variables and the number of lags, and the small sample properties of large VARs are rather poor. In addition, inference (e.g. Granger Causality tests), tends to be sensitive to specification and including or excluding variables can change the results. However, adding income may provide more plausible identifying restrictions. For instance, it is possible that countries adjust their military expenditure in response to their own GDPs, but not to the other countries GDP, or have an arms race in shares of military spending in GDP (military burdens).

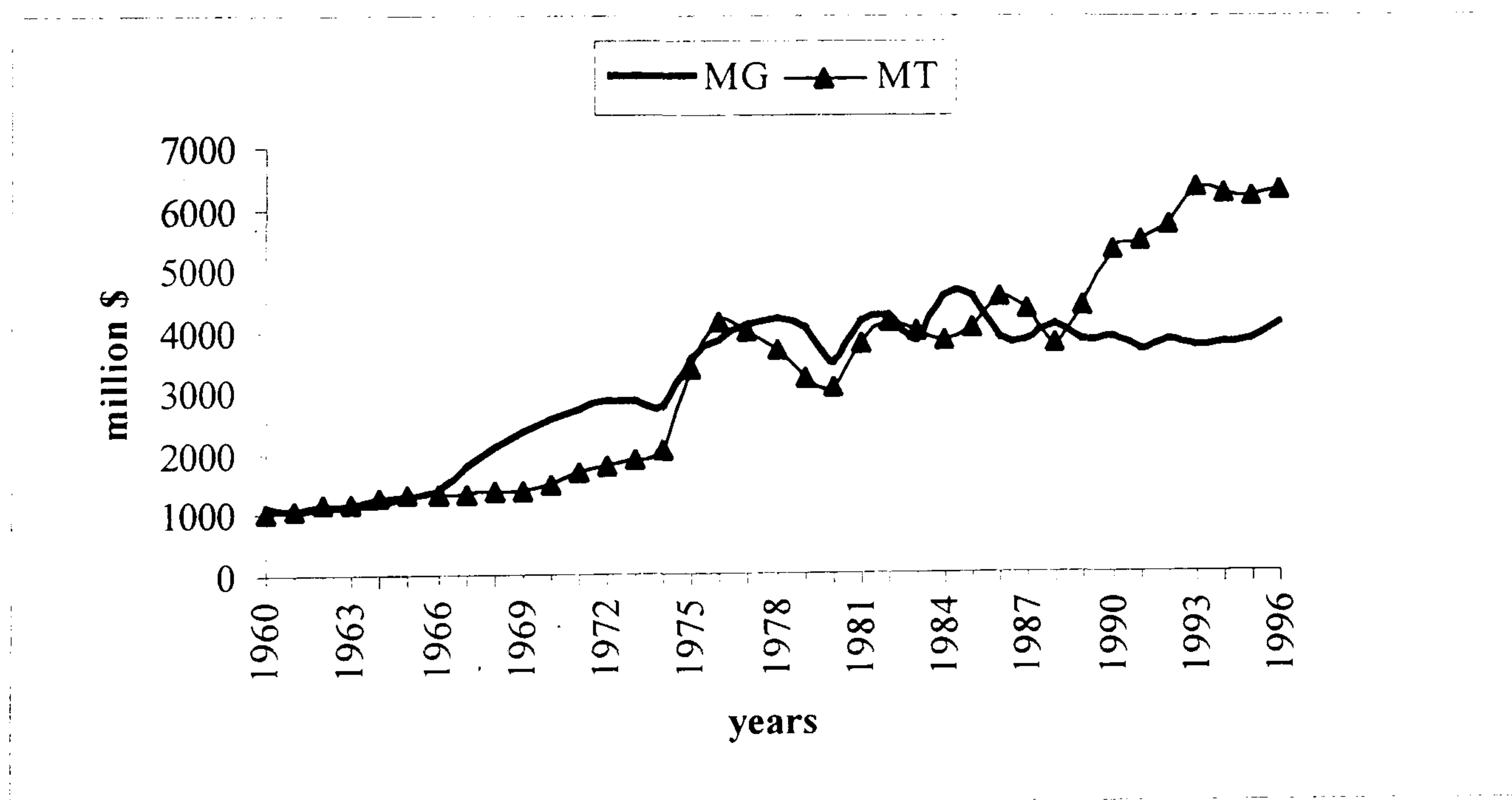
There are a variety of interesting testable system restrictions on the VAR (e.g. exogeneity of income, levels versus shares). In principle, starting from a general system and testing system wide restrictions is an appropriate way to develop a model of the arms race process. In practice, it can be difficult to find theoretically coherent and statistically acceptable specifications on a large system through such a procedure. Ad hoc deletion of individual insignificant coefficients is also unsatisfactory because what looks like acceptable single equation restrictions can produce unacceptable systems properties. A further consideration is the expectations process, which is left, unspecified in the theoretical model. Within the framework discussed above there are a number of possible interpretations, which are discussed in Smith et al (1999). The following section starts by providing estimates of the classical Richardson model and of its reduced form, allowing each time for structural breaks in the data. Finally the possibility of including income is assessed.

5.5. Data and Empirical Results

Using SIPRI data (see Figure 5.1.) on military expenditure for the two countries, the starting point is to test the integration properties of the two series both in logs and in levels. Initial tests for unit roots showed the series to be $I(1)$. The Dickey Fuller tests are given in the Appendix B, in Tables B1 and B2. Table B1 gives the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) results when only an intercept is included, for the levels and logarithms of the Greek and Turkish military expenditure series. These show that the levels of Greek and Turkish military spending for 1960-96 do not reject the null hypothesis of a unit root. For the logs of the variables, the

null hypothesis of no unit root is not rejected only for the Turkish series but it is rejected for the Greek ones. Before reaching a conclusion about the integration properties of the series, the DF and ADF tests with an intercept and a linear trend must also be considered. These are presented on Table B2 in Appendix B and indicate that both the levels and the logarithms of both countries military expenditure contain unit roots. When the series are first differenced (see Appendix B, Table B3 for the DF and ADF tests with only an intercept), the hypothesis of a unit root is rejected, indicating that the variables are integrated of order one $[I(1)]$. The implication of this is that the variables should be used in first differences and the Richardson model does not do so.

Figure 5.1. Military Expenditure for Greece and Turkey*



*in constant 1990 million US \$
 Source: SIPRI Yearbooks

5.5.1. Empirical Results for the Richardson Model

Although results from the Richardson model (equations 3 and 4) are presented in Table 5.1., given the fact that the two series contain stochastic trends or equivalently they are integrated of order one, $I(1)$, there is a danger of spurious regression. As such, one would not expect the Richardson model to work particularly well.

Table 5.1. Estimates of Richardson Model (eq. 3,4)

	Levels		Logs		Logs with Dummy	
	Greece	Turkey	Greece	Turkey	Greece	Turkey
Constant	304 (2.1)	-5.23 (0.0)	0.55 (2.2)	-0.08 (0.2)	0.53 (2.3)	0.08 (0.3)
Other	0.04 (0.8)	0.11 (1.1)	0.02 (0.3)	0.13 (1.6)	0.001 (0.0)	0.04 (0.7)
Own(-1)	-0.12(1.6)	-0.06(1.0)	-0.08 (1.2)	-0.11 (1.9)	-0.06 (1.0)	-0.05 (1.0)
D75					0.22 (2.6)	0.44 (4.8)
Diagnostic Tests						
R²	0.09	0.04	0.12	0.10	0.27	0.48
DW	2.07	1.40	1.79	1.38	1.79	1.69
Ser.Cor.	0.11[.744]	3.58[.059]	0.22[.639]	3.83[.122]	0.20[.657]	0.92[.338]
Function	7.70[.006]	1.95[.162]	11.82[.001]	2.39[.122]	10.28[.001]	0.25[.616]
Normality	2.45[.294]	3.71[.156]	1.24[.537]	23.12[.000]	0.39[.825]	0.22[.897]
Heterosc.	1.48[224]	6.09[.014]	0.10[.750]	3.57[.059]	.31[.575]	0.61[.433]

All $\chi^2(1)$ except normality $\chi^2(2)$

Note: D75 is a shock dummy taking the value of 1 for the year 1975 and 0 otherwise

The results in Table 5.1. show that the model performs poorly as expected. Investigating the residuals (see Figures B1 and B2 in Appendix B) suggests the need to consider the role of Cyprus invasion in producing some instability in the relationship and some possible outliers. The residuals were regressed against a number of dummies to account for this event, taking the value of one for the whole period after 1975, looking at the first few years (1975-8), or a shock dummy that takes the value of 1 in 1975 and 0 otherwise. Another attempt was made to have a step dummy which took the value of 0.5 in 1974, 1 in 1975-79 and 0 otherwise. In fact the most significant dummy was the shock dummy, which took the value of one for 1975 only and zero otherwise. Estimating in logs improved the performance of

the model, though it was still a relatively poor fit for a time series regression. This again illustrates the problems of attempting to estimate these models, how sensitive they are to specification and how important dummy variables are to pick up structural breaks in the relationships.

5.5.2. Empirical Results for the Reduced Form Model

Writing the reduced form of the models as a VAR, equations 5 and 6 are estimated giving the results that appear in Table 5.2. These are simply the change in one country's military spending as a function of the lagged levels of its own and the other country's military spending. These are estimated using OLS equation by equation in this instance. The results are every bit as poor as one would expect from the Richardson model. Again the 1975 dummy is significant.

Table 5.2. Estimates of the Reduced Form Model (eq. 5,6)

	ΔMG_t		ΔMT_t	
Constant	296.1 (2.1)	267.8 (2.0)	81.8 (0.4)	33.6 (0.2)
MG₋₁	-0.09 (1.2)	-0.10 (1.5)	0.06 (0.6)	0.04 (0.4)
MT₋₁	0.02 (0.4)	0.03 (0.7)	-0.04 (0.6)	-0.01 (0.2)
D75		720.9 (2.6)		1226.9 (3.6)
Diagnostic Tests				
R²	0.07	0.23	0.01	0.29
DW	2.12	2.19	1.44	1.69
Serial Correlation	0.24 [.628]	0.54 [.462]	3.12 [.077]	0.98 [.321]
Functional Form	8.65 [.003]	7.51 [.006]	0.15 [.700]	0.21 [.644]
Normality	2.54 [.280]	3.17 [.205]	7.45 [.024]	1.02 [.602]
Heteroscedasticity	1.70 [.192]	0.55 [.458]	1.26 [.262]	0.38 [.536]

All $\chi^2(1)$ except normality $\chi^2(2)$

As discussed in the previous section, the significance of the coefficient on the lagged other country's military spending term gives a test of Granger causality⁴. In this case there is no evidence for it for either country.

5.5.3. Empirical Results for the VECM

Given that the variables do seem to be I(1), especially in logs the possibility that they are cointegrated should be considered. Making an initial estimate of a VAR(5) for the logs⁵ and using a step dummy⁶ (CD) as an exogenous variable, the adjusted Likelihood Ratio (LR) tests and the Schwarz Bayesian Criterion (SBC) indicate a first order VAR, though the Akaike Information Criteria (AIC) and unadjusted LR tests suggest longer lags, as can be seen on Table 5.3.

Table 5.3. Determination of the Order of the VAR for MG, MT (in logs)

1965-96. Order of VAR=5, Variables included: MG, MT. Exogenous: CD					
Order	LL	AIC	SBC	LR	LR Adjusted
5	73.0910	51.0910	34.9679	-----	-----
4	71.1679	53.1679	39.9763	X ² (4)= 3.8 [.427]	2.5 [.640]
3	65.0967	51.0967	40.8365	X ² (8)=16[.043]	10.5 [.232]
2	58.6323	48.6323	41.3036	X ² (12)=28.9[.004]	19.0 [.089]
1	56.7142	50.7142	46.3170	X ² (16)= 32.7[.008]	21.5 [.160]
0	-117.8735	-119.8735	-121.3393	X ² (20)= 381.9[.000]	250.6 [.000]

⁴ Given the discussion of exogeneity and Granger causality (see Appendix H), the causality tests in Table 5.2. do not have standard t and F distributions as they have Dickey Fuller style distributions. This means that the t value at 95% interval is closer to 3 than to 2. But this would not alter the results here.

⁵ Non-nested tests indicated that the log equation was preferred to the levels one.

⁶ The step dummy takes the value of 0.5 in 1974, 1.0 during 1975-1979 and 0 elsewhere.

Given the length of the time series, a VAR(1) is chosen to investigate whether or not the variables are cointegrated. Testing for cointegration between the logs of the two countries military expenditure including the step dummy⁷ which takes the value of 0.5 in 1974, 1.0 from 1975-1979 and zero otherwise, gives the results presented on Table 5.4.

Table 5.4. Cointegration Tests with Unrestricted Intercepts and Restricted Trends for MG, MT (in logs) and Step Dummy

Cointegration with unrestricted intercepts and restricted trends in the VAR				
36 observations from 1961 to 1996. Order of VAR = 1				
List of variables included in the cointegrated vector: MG, MT, Trend				
List of I(0) variables included in the VAR: CD				
List of eigenvalues in descending order: .45235 .11432 0.00				
Cointegration LR test based on Maximal Eigenvalue of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r = 1	21.6764	19.2200	17.1800
r <= 1	r = 2	4.3703	12.3900	10.5500
Cointegration LR test based on Trace of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r >= 1	26.0467	25.7700	23.0800
r <= 1	r = 2	4.3703	12.3900	10.5500
Choice of r using Model Selection Criteria				
Rank	Max. LL	AIC	SBC	HQC
r=0	66.8060	62.8060	59.6390	61.7006
r=1	77.6442	69.6442	63.3101	67.4334
r=2	79.8294	69.8294	61.9118	67.0659

AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion

HQC = Hannan-Quinn Criterion

The null hypothesis of $r=0$ against the alternative of $r=1$ can be rejected, for both the eigenvalue form of the test and the trace version at 5%⁸. The SBC and HQC model

⁷ When the step dummy (CD) was not included or other dummies were included in its place (such as a dummy equal to 1.0 for the years 1975-1979 and zero elsewhere) there was no evidence of cointegration in the data.

⁸ Without the restricted trend the result were much less clearcut.

selection criteria indicate a single cointegrating vector, though the AIC does not. It is fairly common for these tests to differ. Estimating with a single cointegrating vector in the Johansen Estimation procedure with unrestricted intercepts and restricted trends gives long run solution of:

$$Z_t = 0.04 MG + 1.18 MT - 0.06 Trend \quad (9)$$

which normalised (imposing the exactly identified restriction that the coefficient of MG equals one ($A_1=1$), becomes:

$$MG_t = - 29.1 MT_t + 1.6 Trend \quad (10)$$

Which has the wrong sign on MT. The finding of a cointegrating vector was sensitive to changes in the specification. Indeed, when the CD dummy was not included or other dummies were included in its place (such as a dummy variable equal to 1 in 1975-79 and zero otherwise), there was no evidence of any cointegrating relations in the data. This illustrates the care needed in dealing with such models.

5.5.4. Empirical Results for the VECM with Income Variables

These are clearly problematic results and may reflect the failure to specify the arms race correctly (e.g. failing to take account of the budget constraint). To consider this a VAR model in military expenditure and GDP variables, which were calculated from SIPRI figures for military expenditure and shares, was estimated. The GDP variables for Greece (YG) and Turkey (YT) were tested for unit roots (see Appendix B, Tables B4, B5 and B6) and were found to be I(1) and non-nested tests suggested that the log equation was favoured over the levels one. The SBC indicated a second order VAR, while the AIC suggested a fifth order VAR (see Table 5.5.).

Table 5.5. Determination of the Order of the VAR for MG, MT, YG, YT, CD

1965-96. Order of VAR=5, Variables included: MG, MT, YG, YT. Exogenous: CD					
Order	LL	AIC	SBC	LR	LR Adjusted
5	252.3095	164.3095	99.8172	-----	-----
4	219.7961	147.7961	95.0296	X ² (16)=65.0 [.000]	20.3 [.206]
3	200.8595	144.8595	103.8189	X ² (32)=102.9 [.000]	32.2 [.459]
2	190.5405	150.5405	121.2258	X ² (48)=123.5 [.000]	38.6 [.832]
1	160.7833	136.7833	119.1945	X ² (64)=183.1 [.000]	57.2 [.714]
0	35.3838	27.3838	21.5209	X ² (80)=433.8 [.000]	135.6 [.000]

A joint Likelihood ratio test for the exclusion of the GDP variables gave $\chi^2(8) = 42.9$, which is well above the 5% critical value, suggesting that income is important.

Moving on to test whether the variables are cointegrated assuming unrestricted intercepts and restricted trends in a VAR(2) gave the results on Table 5.6. below:

Table 5.6. Cointegration Tests with Unrestricted Intercepts and Restricted Trends for MG, MT, YG, YT (in logs) and Step Dummy

Cointegration with unrestricted intercepts and restricted trends in the VAR				
35 observations from 1962 to 1996. Order of VAR = 2				
List of variables included in the cointegrated vector: MG, MT, YG, YT, Trend				
List of I(0) variables included in the VAR: CD				
List of eigenvalues in descending order: .73987 .39033 .23874 .20338 0.00				
Cointegration LR test based on Maximal Eigenvalue of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r = 1	47.1299	31.7900	29.1300
r <= 1	r = 2	17.3192	25.4200	23.1000
r <= 2	r = 3	9.5471	19.2200	17.1800
r <= 3	r = 4	7.9582	12.3900	10.5500
Cointegration LR test based on Trace of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r >= 1	81.9544	63.0000	59.1600
r <= 1	r >= 2	34.8244	42.3400	39.3400
r <= 2	r >= 3	17.5053	25.7700	23.0800
r <= 3	r = 4	7.9582	12.3900	10.5500
Choice of r using Model Selection Criteria				
Rank	Max. LL	AIC	SBC	HQC
r = 0	170.9986	146.9986	128.3345	140.5558
r = 1	194.5636	162.5636	137.6780	153.9731
r = 2	203.2232	165.2232	135.6716	155.0220
r = 3	207.9967	165.9967	133.3344	154.7217
r = 4	211.9758	167.9758	133.7582	156.1639

The LR tests based on both the eigenvalues and the trace suggest one cointegrating vector, though only the SBC test results are consistent with this. Estimating this as a cointegrating VAR gave the long run solution:

$$Z_t = -0.42 MG + 1.7 MT + 0.7 GY - 0.59 YT - 0.05 Trend \quad (11)$$

which normalised becomes:

$$MG_t = 4.01 MT_t + 1.64 YG_t - 1.38 YT_t - 0.13 Trend \quad (12)$$

This relationship is again difficult to interpret. Looking at the coefficients it is possible that this is a relation in shares and this was tested using overidentifying restrictions (that the coefficient on YG is -1 and the coefficients of MT and YT sum to 0) giving:

$$(MG - YG) = 4.98 (MT - YT) + 0.08 Trend \quad (13)$$

This does not give sensible coefficient values and when the dynamic properties of the system were investigated, the system converged quickly (see Figure B3 in Appendix B) but the impulse response was slow and had the wrong feedbacks. The restrictions were also rejected by the data with $\chi^2(2) = 12.8$. The VECM estimates for the just identified system were:

$$\Delta MG_t = 2.43 + 0.10 \Delta MG_{t-1} - 0.06 \Delta MT_{t-1} - 0.58 \Delta YG_{t-1} - 0.26 \Delta YT_{t-1} + 0.10 Z_{t-1} + 0.12 CD_t \quad (14)$$

(2.74) (0.55) (0.39) (2.17) (1.36) (2.68) (2.10)

$R^2 = 0.29$; $SER = 0.09$; $DW = 2.02$

$$\Delta MT_t = 5.10 - 0.27\Delta MG_{t-1} + 0.37\Delta MT_{t-1} - 0.59\Delta YG_{t-1} - 0.62\Delta YT_{t-1} + 0.21Z_{t-1} + 0.24CD_t \quad (15)$$

(6.83) (1.86) (2.64) (2.61) (3.80) (6.76) (4.91)

$R^2 = 0.69$; $SER = 0.07$; $DW = 2.08$

(t-ratios in brackets)

The diagnostic tests as well as the equations for GDP are reported in Appendix B, Tables B7 and B8, respectively.

For the Greek equation, four of the seven coefficients are significant at 5%, although the specification easily passes the tests for first order serial correlation, functional form, normality and heteroscedasticity (see Table B8 in Appendix B for Diagnostic tests). The equation for Turkey is a better specification in terms of the coefficient estimates, with six of the seven significant, but fails the tests for functional form $\chi^2(1) = 7.68$. Cusum and Cusum squared tests suggest structural stability (see Figures B4, B5, B6 and B7 in Appendix B), while the persistence profiles to system wide shocks are fairly similar (see Figures B8 and B9 in Appendix B). The persistence profile of system wide shocks to the CVs show a relatively fast convergence, around 3 years (see Figure B10 in Appendix B). The coefficients on Z1 and Z2 measure the speed at which any disequilibrium is removed and suggest that Turkey adjusts quicker than Greece. Again there seems to be some evidence of cointegration, but not in the form of a long run arms race model and the results are sensitive to the specification used.

If the cointegrating VAR is estimated with unrestricted intercepts and no trend the results in the Table 5.7. below are found:

Table 5.7. Cointegration Tests with Unrestricted Intercepts and No Trends for MG, MT, YG, YT (in logs) and Step Dummy

Cointegration with unrestricted intercepts and no trends in the VAR				
35 observations from 1962 to 1996. Order of VAR = 2				
List of variables included in the cointegrated vector: MG, MT, YG, YT				
List of I(0) variables included in the VAR: CD				
List of eigenvalues in descending order: .68683 .38973 .20598 .17482				
Cointegration LR test based on Maximal Eigenvalue of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r = 1	40.6348	27.4200	24.9900
r ≤ 1	r = 2	17.2848	21.2000	19.0200
r ≤ 2	r = 3	8.0725	14.8800	12.9800
r ≤ 3	r = 4	6.7253	8.0700	6.5000
Cointegration LR test based on Trace of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r ≥ 1	72.7173	48.8800	45.7000
r ≤ 1	r ≥ 2	32.0825	31.5400	28.7800
r ≤ 2	r ≥ 3	14.7978	17.8600	15.7500
r ≤ 3	r = 4	6.7253	8.0700	6.5000
Choice of r using Model Selection Criteria				
Rank	Max. LL	AIC	SBC	HQC
r = 0	170.9986	146.9986	128.3345	140.5558
r = 1	191.3160	160.3160	136.2081	151.9940
r = 2	199.9584	163.9584	135.9622	154.2941
r = 3	203.9947	164.9947	134.6654	154.5250
r = 4	207.3573	167.3573	136.2503	156.6192

AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion
HQC = Hannan-Quinn Criterion

Although the different tests give conflicting results, based on the Maximal Eigenvalue test one cointegrating vector can be identified and this gives the following long run relation:

$$Z_t = MG_t - 3.86 MT_t - 1.35 YG_t + 3.07 Yt_t \quad (16)$$

Looking at the coefficients and remembering that the variables are in logs suggests that the long run relation may be in a ratio form, between the military burdens. Imposing the overidentifying restriction that the coefficient on YG was equal to -1

gave $\chi^2 (1) = 0.675$, which is not significant at 5%. Adding the restriction that the coefficients on MT and YT sum to 0 gave a value $\chi^2 (2) = 20.57$ for the joint test which is significant. This rejects a long run solution between the military burdens and suggests :

$$Z_t = (MG_t - YG_t) - 4.39MT_t + 3.21 YT_t \quad (17)$$

$$\text{or } (MG_t - YG_t) = 4.39MT_t - 3.21 YT_t \quad (18)$$

Which again is not very meaningful. To progress, the possibility of a second cointegrating vector is considered as the results were not conclusive⁹. Estimating a VAR(2) with two cointegrating vectors gave the following:

$$\text{Vector 1: } Z_t = -0.45MG_t + 1.75MT_t + 0.61 YG_t - 1.39 YT_t \quad (18)$$

$$\text{Vector 2: } Z_t = 1.18MG_t - 1.29MT_t - 1.66 YG_t + 1.32 YT_t \quad (19)$$

This again suggests a relation between the shares in the second cointegrating regression. Imposing the exactly identifying restrictions on Vector 1 that $a_1=1$; $a_3=0$; and Vector2 $b_1=1$ $b_3=-1$ and adding the overidentifying restriction that $b_2+b_4=0$ gave $\chi^2 (1) = 1.06$ which is not significant at 5% (for testing the restrictions, see Johansen, 1995). This gives:

$$Z_t = (MG_t - YG_t) - 0.472(MT_t - YT_t) \quad (20)$$

⁹ In fact, a small sample adjustment such as that of Reimers is likely to tend to reject $r=2$, but it was thought worthwhile looking at the $r=2$ case.

which suggests that the long run solution is for the Greek military burden to be just under half of the Turkish one. However, it is not possible to find any meaningful interpretation or restrictive form for the first cointegrating relation¹⁰.

Other identifying restrictions, (e.g. two reaction functions with the restriction that each country's demand depended only on its own income, or each share is $I(0)$) also did not give sensible results. Overall, there is some evidence of cointegration in Greece and Turkey, but not in the form of a long run arms race. The results obtained are difficult to interpret and very sensitive to minor features of the specification¹¹.

Greece and Turkey are in a complex strategic environment, both members of NATO, concerned about a Soviet threat for much of the period. Furthermore, Turkey faces internal conflict with the Kurds and Greece is quite concerned about the instability in the neighbouring Balkan countries. The strength of their antagonism waxed and waned with internal and external political developments and they adopted rather different military force structures. Thus, it is not surprising that the evolution of their military expenditures over a period of 35 years cannot be described by a simple mechanical rule. The next section considers a more general approach to the determinants of military expenditure.

¹⁰ When two cointegrating vectors are selected ($r=2$), the model makes sense. When r is wrongly selected the size of the test has a large right shift.

¹¹ Alternative specifications of the model using stocks of weapons/military spending, as discussed in Smith et al (1999) were tried but failed to provide sensible results.

5.6. General Models of Aggregate Defence Spending

The second group of studies (the general models of aggregate defence spending) either focuses on the pure economic or political determinants of military expenditure or considers all possible influences of military expenditure (economic, political, strategic) and tries to operationalise them in empirical analysis. By combining all possible influences, these studies provide a more complete picture of the determinants of military expenditure.

These studies usually start by defining a welfare function which is maximised subject to resource and security constraints. There is a wide variety of forms used for the welfare function as well as for the security and budget constraints. Smith (1980b) assumed a constant elasticity of substitution utility function for the UK while McGuire (1987) used a Stone-Geary utility function for Israel, Dunne et al (1984) employed a Deaton-Muellbauer functional form to estimate the determinants of UK's defence and other government spending and Hewitt (1991) used a Cobb-Douglas welfare function for a cross section of countries.

5.6.1. General Models of Aggregate Defence Spending for Greece

Kapopoulos and Lazaretou (1993) investigated the strategic determinants of Greek military expenditure by a long-run equilibrium demand function and an error correction model. They concluded that Greek defence spending was strongly influenced by Turkish military expenditure for the period 1962-1988. Kollias (1994, 1996) ended up to similar conclusions. Avramides (1997) using both a Stone-Geary utility function and a restricted Deaton Muellbauer system, found that Greece

responds to Turkish military expenditure and as for the alliance effect (NATO) that Greece is a follower in the short-run and a free-rider in the long-run. Antonakis and Karavidas (1990) and Antonakis (1995, 1997a) investigating the determinants for military expenditure in Greece over the post-war period found that the demand for military expenditure is not motivated by economic factors.

5.7. Methodology and Specification of the Aggregate Defence Spending Model

A simple demand model is developed here to reflect the features of the Greek economy (see Smith, 1980; Dunne and Mohammed, 1995). Within the Neoclassical framework, the state as a ‘rational actor’ tries to maximise social welfare subject to a budget constraint. The social welfare function is determined by the state (based on individual preferences or on the median voter) and military expenditure is determined by balancing the opportunity cost and the security benefits they provide. So, social welfare is a function of utility derived from private consumption C (non-military), security S (produced by military expenditure), other government expenditure G and some other political and strategic factors Z (exogenous). So, the social welfare function (W) will be:

$$W = W (C, S, G, Z) \quad (21)$$

The level of security (S) will depend on military expenditure conditioned on the political and strategic factors (Z). So, the following security constraint will apply:

$$S = S (M, Z) \quad (22)$$

Assuming that Greek national output (Y) is devoted to military (M) and civilian uses (C), the usual budget constraint will be:

$$Y = P_m M + P_c C \quad (23)$$

where P_m and P_c are the prices of M and C relative to an income deflator.

Maximising the social welfare function subject to the security and budget constraints, the demand for Greek military expenditure can be modelled as:

$$M = D (Y, Z, P_m, P_c) \quad (24)$$

Prices can be dropped from the equation without biasing the results since there is not a separate price deflator for military goods in Greece. Based on the above considerations, the equation that best describes the determinants of Greek military expenditures should incorporate economic, political and strategic effects all of which need to be specified and quantified. This leads to the following specification:

$$M = M (GDPC, POP, NG, TB, NATO, TM, M(-1), CYP, POL) \quad (25)$$

where:

M: share of military expenditure in GDP

GDPC: GDP per capita in constant 1990 mn US \$

POP: population (in '000s)

NG: share of government expenditure (excluding military) in GDP

TB: share of trade balance (exports - imports of goods and services) in GDP

NATO: NATO's share of military expenditure in GDP

TM: Turkish share of military expenditure in GDP

CYP: dummy variable to account for the perceived Turkish threat after the Turkish invasion of Cyprus (takes the value of 1 for the years 1974-1996 and 0 elsewhere).

POL: dummy variable to account for the military government (takes the value of 1 for the years 1967-74 and 0 elsewhere)

Defence is considered a public good and conventional public finance theory suggests that the levels of military spending should be positively related to income. This should be captured by the positive coefficient of real GDP per capita (GDPC). However, once a country attains a certain degree of security, further increases in income leave defence budgets relatively unchanged, thus, leading to reductions in military spending shares (Antonakis, 1997a). If this were the case for Greece, then the coefficient of GDPC would be negatively related to the share of military spending (M). Following Deger's (1986) study, population (POP) is also introduced as a proxy variable to capture the public good effect of military spending with an expected positive sign.

The inclusion of the share of non-military government expenditure (NG) in the model represents the economic burden of defence and is expected to enter the equation with a negative sign to account for the opportunity cost of defence. The share of the trade balance in GDP (TB) reflects the openness of the economy and its sign is ambiguous. To account for the strategic and political factors that played an important role in military spending during 1960-1996, two dummy variables are introduced. POL to capture the effect of the military government that was in power for seven years (1967-74) and CYP, an impulse dummy for the year 1974 to capture

the effect that the Turkish invasion of Cyprus. Although military governments¹² tend to spend more on defence this is not a general fact and as Dunne and Mohammed (1995) claimed that “...*there is unlikely to be a simple dichotomy between military and non-military governments*” (Dunne & Mohammed, 1995, p.335). As such, the sign of POL cannot be predetermined. The second dummy variable captures the threat of war, the expected sign is positive. Since Greece is a member of the NATO alliance, the inclusion of the alliance’s military burden, excluding Greece and Turkey, seemed reasonable in order to account for the spill-in effect. If the sign on NATO is positive Greece is a ‘follower’, otherwise a ‘free-rider’. Turkey’s military burden (TM) is introduced to see whether Greece’s military burden depends on the “enemy’s” military burden. Finally, the lagged value of the dependent (M) is introduced to account for inertia, such as hangover from previous expenditures or commitments to programmes (Dunne and Mohammed, 1995).

5.8. Data and Empirical Results

Data for the Greek, Turkish and NATO military burden (the share of military expenditure in GDP) come from various SIPRI Yearbooks. Data on government expenditure, trade balance, population and GDP per capita (in 1990 mn US \$) come from the EUROSTAT database. Specifically, the share of non-military government expenditure was constructed by deducting military expenditure (taken from SIPRI) from general government expenditure and was then divided by GDP (taken from EUROSTAT). All variables were tested for unit roots by Dickey-Fuller tests and

¹² Military governments are thought to spend more on defence. But as Zuk and Thompson (1982) claimed, *ceteris paribus*, military governments do not spend more on defence than the civilian ones.

were found to be non-stationary, while their first differences had no unit roots and so the differenced series are used for the estimation (the DF and ADF tests are reported in Appendix B, Table B9). The proposed equation of the demand for military expenditure for Greece over the period 1960-96 is the following:

$$DM=DM (DGDPC, DPOP, DNG, DTB, DNATO, DTM, DM(-1),CYP,POL) \quad (26)$$

where D in front of a variable indicates first-difference.

In estimating this model over the period 1960-96, the data were allowed to determine the particular short-run dynamic form using a general to specific methodology for testing exclusion restrictions. Surprisingly, the coefficient of the dummy for the military government in Greece (POL) although positive was insignificant and the same applied for the population variable (DPOP). Joint tests of zero restrictions on the coefficients of these variables could not be rejected (LR $X^2(2)=2.26$) suggesting that they were both individually and jointly insignificant and as such they were excluded from the model. Further specification searches led to¹³:

$$DM=0.12 -0.56DGPC_{-1} -0.44DNG-0.15DTB_{-1}+0.27DTM_{-1}+0.50NATO+2.42CYP-0.14DM_{-1}$$

(1.83) (2.11) (4.31) (3.98) (2.50) (1.42) (6.58) (1.22)

(27)

$$R^2 = 0.73, DW = 2.00$$

¹³ Note that this is a VAR model of the Sims (1980) type. Finding cointegration earlier might suggest that this equation has a small moving average error and a unit root when the error structure is modelled in a system, due to partial differencing.

The results support the initial expectations for the effect of the change in non-military government expenditure (DNG), which is significant and negative indicating the opportunity cost of defence, and for the Cyprus dummy, which is significant and positive. The change in previous year's income (DGDPC.₁) is negative and significant, which implies that increases in income will not lead to increases in defence budgets; this further implies that defence is an inferior good. The effect of the lagged value of the change in Turkish military burden (DTM.₁) is positive and significant. This suggests that Greek defence spending is influenced by the "potential enemy's" spending, but it is not influenced by NATO's spending, as NATO although positive is not significant. The lagged value of the change in the share of trade balance in GDP (DTB.₁) is negative and significant while Greek military burden does not seem to depend on previous year's burden¹⁴.

These "rational actor" models of military expenditure have attracted a lot of criticism. Governments are not always unified rational actors but coalitions operating in a political and bureaucratic environment (Smith, 1995). Defence policy can be affected by lobbying, class interests, bureaucratic and interest group models (see Smith, 1977, 1980b; Griffin, Wallace and Devine, 1982; Sandler and Hartley, 1995).

Given these limitations, empirical findings for the case of Greece suggest that the determinants of military expenditure are unlikely to be found in economic factors but

¹⁴ Tests for serial correlation are relevant. If they are not significant, this confirms the result that the levels appear in the Turkish but not in the Greek equation for military expenditure and in this case the Greek behaviour would be weakly exogenous to the Turkish behaviour.

rather in strategic factors - namely the perceived threat from the neighbouring country, Turkey.

5.9. Conclusions

This chapter investigated the causes of high military expenditure in Greece. Given the poor economic performance of the country and its security considerations, it was expected that economic factors would not play an important role in determining Greek military burden. This was indeed supported by empirical evidence. Specifically two different models were considered: an arms race model and a general model of aggregate defence spending.

The long-term animosity between Greece and Turkey has led historians and political commentators to argue that there exists an arms race between the two countries, which explains the high levels of their military expenditures. Although a widely held view, it is not fully supported by the empirical evidence provided by previous studies and by that provided in this chapter. The deficiencies of the classical Richardson arms race model are to be blamed for the poor empirical performance and the inconclusive results.

Recent econometric techniques (unit root tests and cointegration) were applied to deal with most of the deficiencies that arise from the Richardson model. The analysis provided evidence of a long-run relationship between Greek and Turkish military burdens (suggesting that income variables are important) but not in the form of a long-run Richardson type arms race. So, although it can be said that there is

something going on between the two countries this is definitely not an arms race in the classical Richardson form. This might be due to the fact that both countries are in a more complex environment especially Turkey with a number of conflicts and potential conflicts. Also, another important factor that might affect the spending patterns of the two countries is that they are both members of the NATO alliance. One implication of this could be that both countries before the collapse of the Warsaw Pact had a common threat (the containment of communism) and that this was affecting their procurement decisions.

As far as the general model of aggregate defence spending is concerned, the empirical findings suggested that strategic factors and not economic ones play an important role in determining Greek military burden. Specifically, the Greek military burden is determined by the Turkish military burden and the threat of war after 1974 as captured by a dummy variable.

A GRANGER CAUSALITY APPROACH FOR THE DEFENCE - GROWTH RELATIONSHIP IN GREECE

6.1. Introduction

This chapter, instead of assuming exogeneity or endogeneity of the defence variable in the growth equation or instead of relying on the implicit assumption that defence is causally prior to economic growth - as most of the previous studies have done, it systematically analyses the presence and direction of the causal relationship between the two variables in Greece over the period 1960-96. In other words it investigates whether the rate of output growth affects defence outlays or defence outlays affect the rate of output growth.

The contribution of the analysis that follows, lies on the fact that in addition to standard 'pre-cointegration' Granger causality techniques, a vector autoregression methodology (hereafter VAR) that utilises cointegration via Granger's representation theorem is employed. The VAR specification has become increasingly popular in the applied econometrics literature in recent years, its main advantage being that such models are dynamic specifications, free of economic assumptions imposed a priori.

“Thus, they allow for the testing of causal linkages without the need to first construct arguments and develop hypotheses justifying those linkages”, (Georgiou et al, 1996, p.233).

The rest of this chapter discusses the methodology to be employed, the empirical results obtained and the conclusions.

6.2. Methodology Employed

The approach adopted in this chapter is to analyse the statistical causality¹ of military burden and economic growth within a VAR framework, starting off by investigating the integration properties of the two series. If the two series are integrated of the same order (i.e. they both are $I(1)$), Granger causality must exist in at least one direction, at least in the $I(0)$ variables (Engle and Granger, 1987). The Granger representation theorem demonstrates how to model cointegrated $I(1)$ series in the form of a VAR model. The VAR can be constructed in terms of the levels of the data or in terms of their first differences with the addition of an error correction term (hereafter ECT) to capture the short run dynamics. These features are used as pre-test strategy to establish whether causality exists prior to identifying the direction via standard Granger-type tests. Specifically, the empirical analysis will rely on the following steps:

¹ For a discussion on exogeneity and Granger causality, see Appendix H.

6.2.1. Testing for unit roots

The first step prior to applying the Granger causality tests is to establish the integration properties of the Greek time series by employing the Dickey-Fuller (1979) unit root tests. According to these, for a time series, X_t , DF test is based on an autoregression that includes either only an intercept or both an intercept and a linear trend. For the first case, where only an intercept is included, the following autoregression takes place:

$$\Delta x_t = \beta_0 + \alpha_1 x_{t-1} + \sum_{i=1}^k \alpha_i \Delta x_{t-i} + \varepsilon_t \quad (1)$$

and for the second case (where both an intercept and a linear trend is included), the autoregression is:

$$\Delta x_t = \beta_0 + \beta_1 t + \alpha_1 x_{t-1} + \sum_{i=1}^k \alpha_i \Delta x_{t-i} + \varepsilon_t \quad (2)$$

In both cases the null hypothesis of a unit root is the same ($H_0: \alpha_1 = 0$) but the critical values differ. The maximum lag order², k , is selected according to some information criteria which usually give quite contradictory results.

² Lagged differences of the series are added to “whiten” the error of the autoregressions

6.2.2. Testing for Cointegration

It is important to establish the integration properties of the involved time series to justify further cointegration analysis. If both series are integrated of the same order (i.e. they are found to be $I(1)$), then there might exist a long-run relationship between them - that is the two series might be cointegrated. Hence, the second step involves testing for cointegration via Johansen's (1988) maximum likelihood approach³. If cointegration exists then either unidirectional or bi-directional Granger causality must exist in at least the $I(0)$ variables. Furthermore, the existence of a long-run relationship between them will have important consequences when examining the short-run Granger causality.

6.2.3. Granger Causality Tests

The third step involves the construction of the standard Granger causality tests augmented with an appropriate error correction term derived from the long-run cointegrating relationship in case such a relationship exists. Granger tests presume the use of stationary data so, they must be applied on $I(0)$ series in order to derive valid inferences. The standard Granger causality test (when cointegration is not taken into account) assumes that the information for the prediction of the variables X_t and Z_t is contained only in the time-series data of these variables. The test involves estimating the following regressions:

³ The common approach followed in the literature is the two step Engle-Granger procedure, according to which the series are initially tested for unit roots and if they are integrated of the same order then the residuals of the static model are tested for unit roots. If the residuals contain no unit roots, then the series cointegrate and the lagged value of the residuals can be included in the short-run model as the ECT. But testing for cointegration under this procedure has lower power against the Johansen procedure (see Harris, 1995)

$$X_t = \sum_{i=1}^k \alpha_i Z_{t-i} + \sum_{j=1}^k \beta_j X_{t-j} + u_{1t} \quad (3)$$

$$Z_t = \sum_{i=1}^m \lambda_i Z_{t-i} + \sum_{j=1}^m \delta_j X_{t-j} + u_{2t} \quad (4)$$

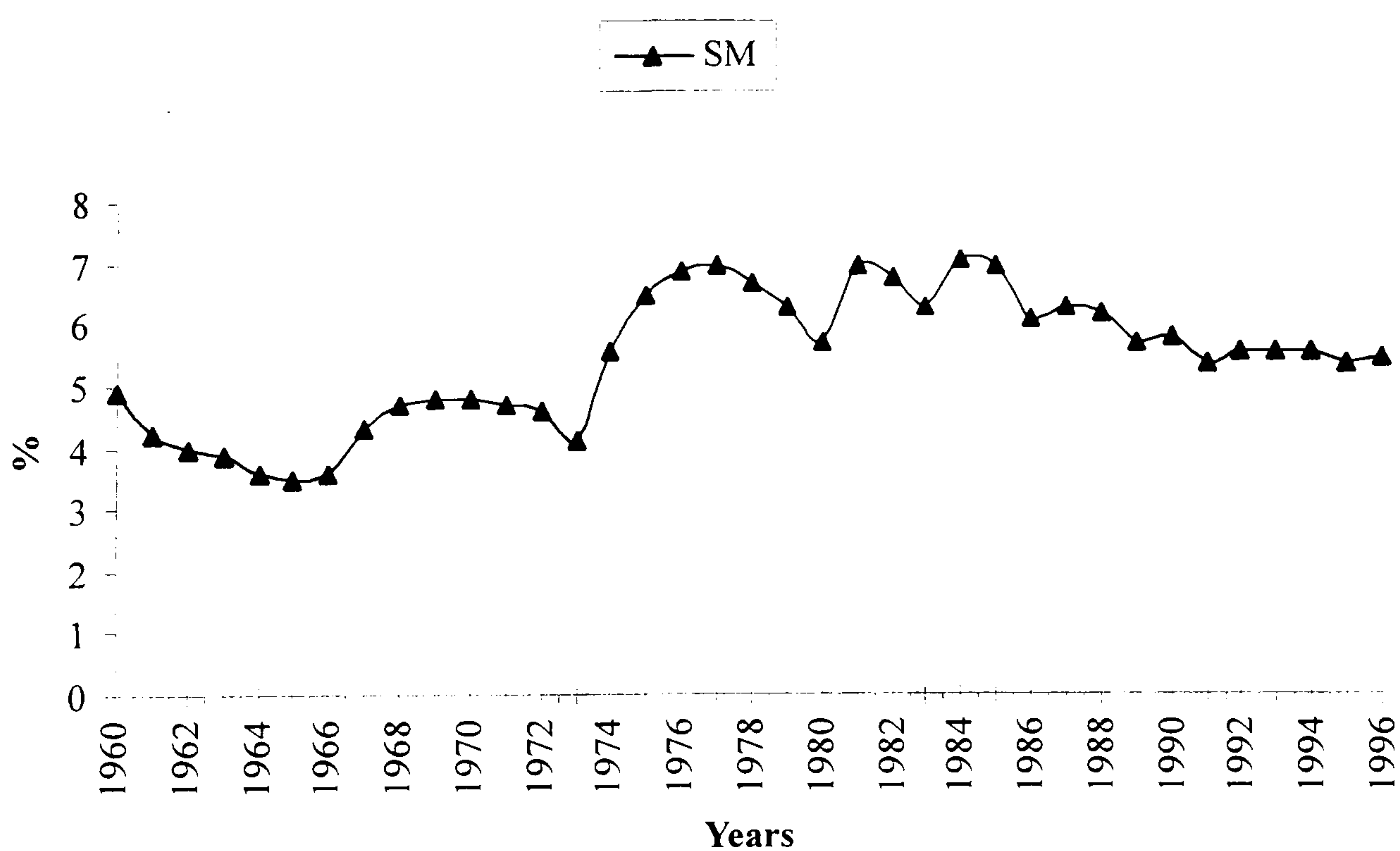
Equation 3 postulates that current X is related to past values of X itself as well as of Z and equation 4 postulates a similar behaviour for Z. Generally, if Z Granger causes X, then changes in Z should precede changes in X. Therefore, in a regression of X on other variables (including its own past values) if past or lagged values of Z are included and they significantly improve the prediction of X, then it can be said that Z Granger causes X. A similar definition if X Granger causes Z.

A final consideration in estimating the equations is the possibility of structural change. That is, the parameter values may change through time which is very likely to have happened in the time period examined here. A Chow test will be performed in order to determine whether the parameters of the model remained constant during the whole period covered by the data. In case a structural break is present, it will be accounted for by introducing a dummy variable. In the section that follows, empirical results are presented under three specifications: the standard Granger causality test, the one augmented by the ECT, and the one augmented by both the ECT and dummy variables that account for structural breaks in the data.

6.3. Data and Empirical Results

Following the methodology outlined above, this section starts by testing the integration properties of the two series, namely the logarithm of Greek GDP (Y_t) and Greek military burden (SM_t). Data for the GDP series in 1990 mn US dollars were taken from EUROSTAT and for the military burden series from SIPRI. Table C1 in Appendix C gives the Dickey Fuller tests for unit roots of various lag orders when only an intercept is included. According to these tests the null hypothesis of no unit roots is rejected for both series. But before concluding about the integration properties of the series, DF tests with an intercept and a linear trend must also be examined. These results are presented in Table C2 in the Appendix and also indicate that the logarithm of GDP and the military burden (the share of military expenditure in GDP) contain a unit root, and appear to be $I(1)$, (integrated of order one).

Figure 6.1. Greek Military Burden*

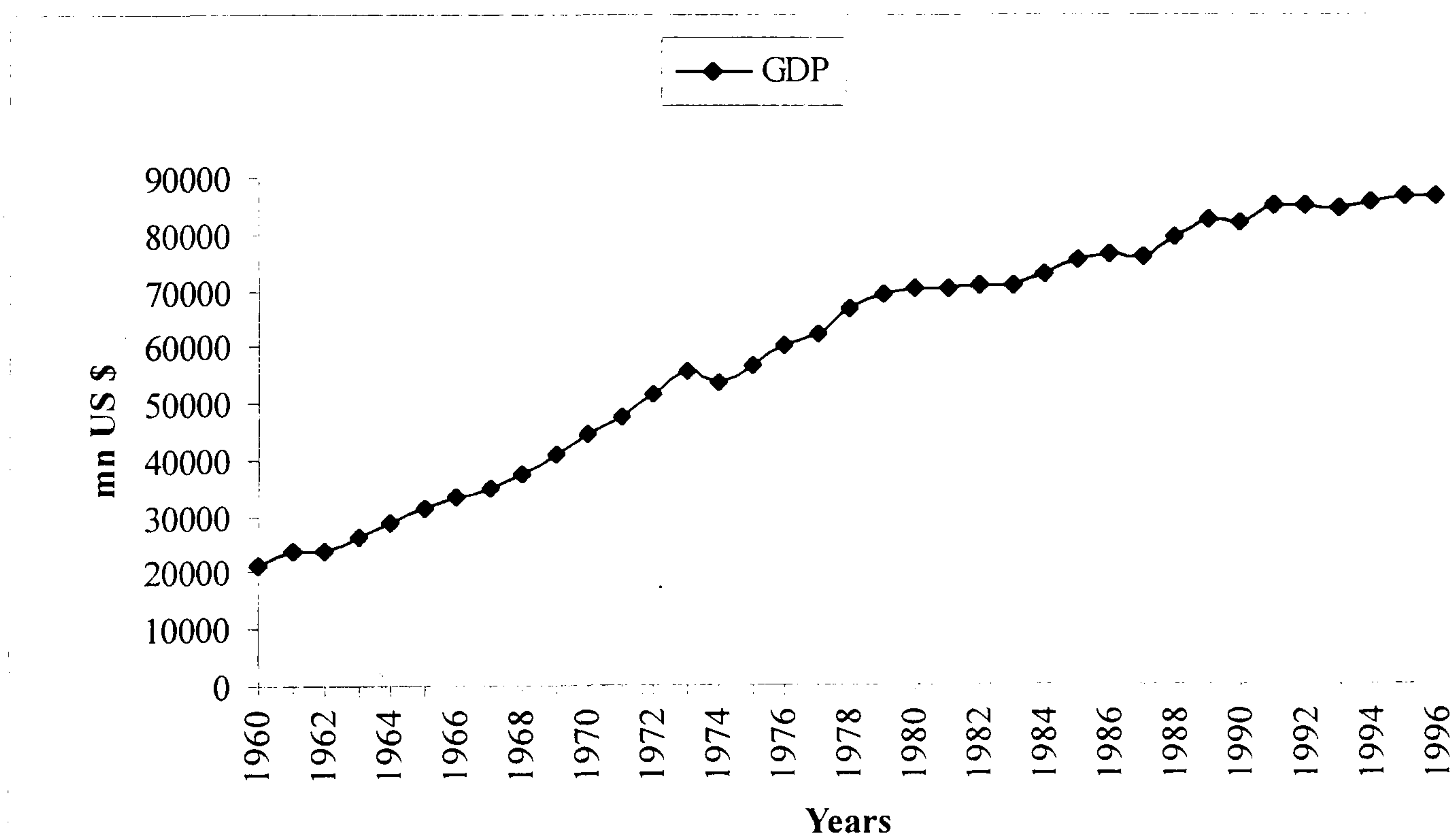


*Military burden is the share of military expenditure in GDP

Source: SIPRI

There is persistence of military burden to either low spending levels, when the burden is low, or to persistently higher spending levels, when burden is high. Indeed, one observes that a considerably higher proportion of Greece's GDP is devoted to defence spending after 1974 (after the Turkish invasion of Cyprus) than before. (See Figure 6.1. As for the Greek GDP series, one can easily note a drop in real GDP in the year of the invasion (see figure 6.2). See, also, Figure 6.3 where the annual percentage change in the two series is presented and according to which for the year 1974 Greek GDP grew at a negative rate of around 0.4% while for the same year military burden had an impressive growth rate of around 40%.

Figure 6.2. Greek GDP in 1990 mn US \$

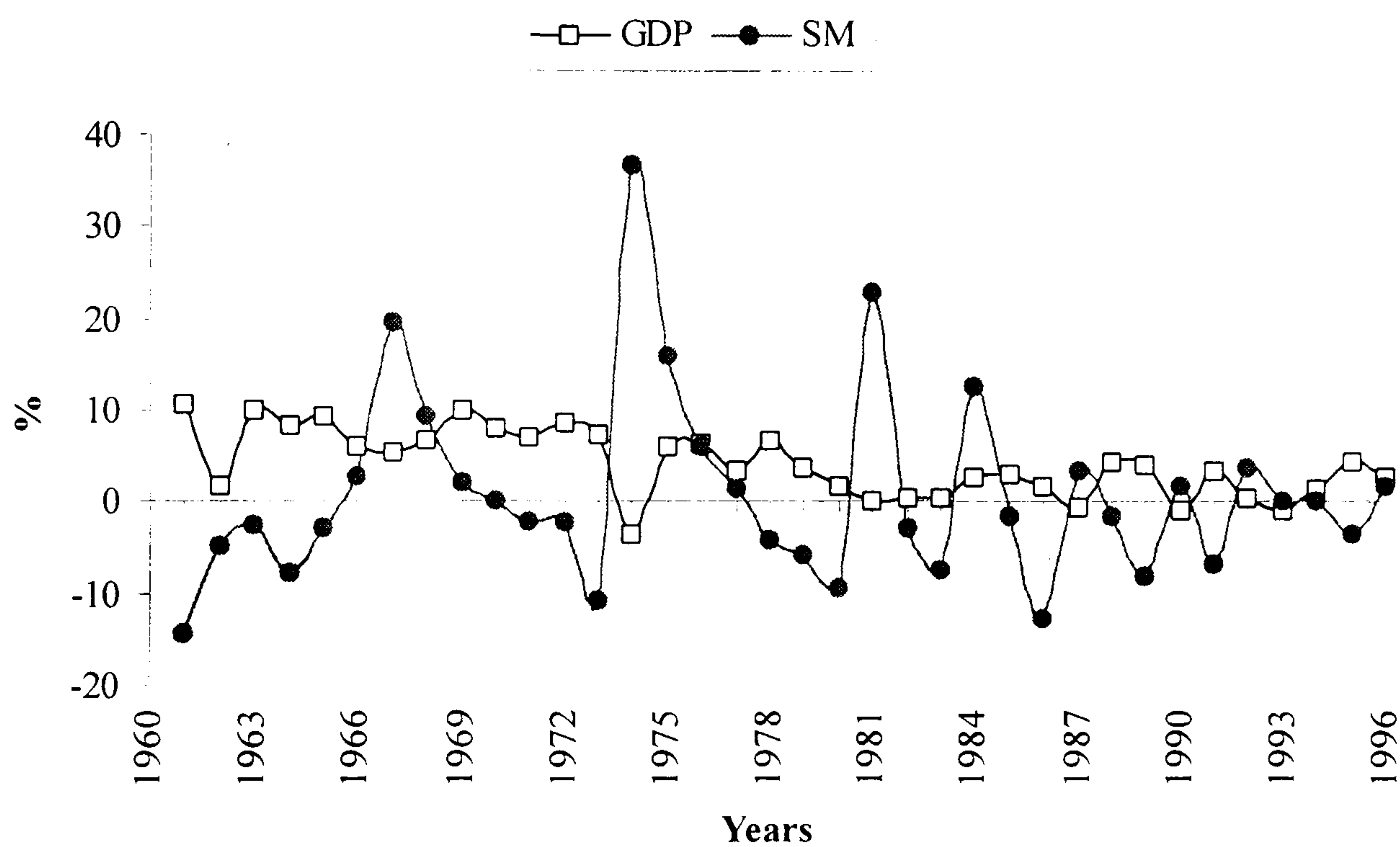


Source: EUROSTAT

To justify the conclusion that the series (Greek GDP and Greek defence burden) are I(1), the DF tests for the differenced series are also presented in Table C3 in the Appendix. If the differenced series are proved to be stationary, then by induction, the level series are I(1). If on the other hand, the differenced series are still non-

stationary, but the second differenced series are stationary that means that the levels series are I(2) and so on. For the first differenced series the hypothesis of a unit root is rejected at 95% level of significance. So, there is no doubt that the level series are I(1). Also, the plot of the two differenced series in Figure 6.3, shows a stationary behaviour with a possible outlier for 1974 (the year of the Turkish invasion of Cyprus).

Figure 6.3. Annual Percentage Change in Greek GDP and Military Burden*



*GDP growth calculated from figures in constant 1990 mn US \$
 Source: SIPRI and EUROSTAT

Having established the integration properties of the series, which are integrated of the same order [I(1)] as was shown in the previous section, it can be examined whether there is a long-run relationship between them. In other words it can be tested whether cointegration exists between the logarithm of real Greek GDP (Y) and the Greek military burden. If they are cointegrated, this will have important consequences when examining short-run Granger causality between them.

Table 6.1. Cointegration Tests for Military Burden and the log of GDP

Cointegration with restricted intercepts and no trends in the VAR for Greece				
36 observations from 1961 to 1996. Order of VAR = 1				
List of variables included in the cointegrated vector: Y, SM, Intercept				
List of eigenvalues in descending order: .79953 .15350 0.00				
Cointegration LR test based on Maximal Eigenvalue of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r = 1	57.8560	15.8700	13.8100
r ≤ 1	r = 2	5.9991	9.1600	7.5300
Cointegration LR test based on Trace of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r ≥ 1	63.8551	20.1800	17.8800
r ≤ 1	r = 2	5.9991	9.1600	7.5300
Choice of r using Model Selection Criteria				
Rank	Max. LL	AIC	SBC	HQC
r = 0	194.2370	194.2370	194.2370	194.2370
r = 1	223.1650	219.1650	215.9980	218.0597
r = 2	226.1646	220.1646	215.4140	218.5065

AIC = Akaike Information Criterion, SBC = Schwarz Bayesian Criterion.

HQC = Hannan-Quinn Criterion

Testing for cointegration using Johansen's (1988) ML cointegration method, a VAR(1) model with restricted intercept, as the two series are quite different in nature is estimated (See Figures 6.1 and 6.2). Table 6.1. gives the results of two tests for cointegration - the Likelihood Ratio test based on the maximum Eigenvalues of the stochastic matrix and one based on the Trace of the stochastic matrix. It also presents the various selection criteria for the choice of the number of cointegrating vectors. The null hypothesis of no cointegration ($H_0: r=0$) is rejected by both tests in favour of the alternative ($r=1$), indicating that there is one cointegrating vector in the Greek series. Results from a VAR(2) model point to the same conclusions. As for the selection criteria, it is very common to give contradictory results as far as the choice of the number of cointegrating vectors is concerned, and as such one should

not rely on them (Pesaran & Pesaran, 1997). Nevertheless, the Schwarz Bayesian Criterion suggests the choice of one cointegrating vector.

The existence of one cointegrating vector between the series should be taken into consideration when the short-run causality between the variables is examined. On the basis of such results it can be established that Y_t and SM_t are causally related, since they are cointegrated, but to find the direction of the causality, the standard Granger tests must be augmented by the error correction term⁴ (ECT), which is derived from the long-run cointegrating relationship. The cointegrating regression for Greece is:

$$Y_t = 9.34 + 28.82 SM_t + \varepsilon_t \quad (5)$$

(36.64) (6.28)

Bearing these results in mind, the cointegrating series can be modelled as a VAR. The choice of the VAR's order (the lag-length) was made on the basis of Akaike's final prediction error and a second order VAR model is accepted (see Table C4 in the Appendix). Three specifications of the VAR models are presented. First, the standard Granger causality test (that is the existence of cointegration is ignored), second, the Granger causality test augmented by the error correction term derived from the cointegrating regression and finally, the above specifications are further augmented by dummy variables to capture possible structural breaks in the data.

⁴ The ECT is nothing more than the lagged value of the estimated residuals from equation 5.

An important feature of the Granger causality tests (as mentioned earlier) is that they presume the use of stationary data. Since both the Greek level variables are I(1), their first differences which are stationary [I(0)] must be used. So, the VAR(2) for Greece when cointegration is ignored is:

$$\Delta Y = a_0 + a_1 \Delta Y(-1) + a_2 \Delta Y(-2) + a_3 \Delta SM(-1) + a_4 \Delta SM(-2) + u \quad (6)$$

$$\Delta SM = \beta_0 + \beta_1 \Delta SM(-1) + \beta_2 \Delta SM(-2) + \beta_3 \Delta Y(-1) + \beta_4 \Delta Y(-2) + \varepsilon \quad (7)$$

The null hypothesis in equation 6 is that $\Delta SM(-1)$ and $\Delta SM(-2)$ do not Granger cause ΔY ($H_0: a_3 = a_4 = 0$) and in equation 7 that $\Delta Y(-1)$ and $\Delta Y(-2)$ do not Granger cause ΔSM ($H_0: \beta_3 = \beta_4 = 0$). Results on Table 6.2 for the standard Granger causality test (column 1) indicate that defence is causally prior to economic growth while there is no causality running from growth to defence. Given the positive and highly significant sign of the defence term in the growth equation, it appears that defence promotes growth. The Lagrange Multiplier test, the Likelihood Ratio test and the F statistic, all suggest that military burden Granger causes economic growth at 5% level of significance with the effect being positive.

When the long-run relationship that exists between Greek growth and military burden is taken into account by introducing the ECT from equation 5 in the Granger causality tests, the VAR(2) model for Greece is:

$$\Delta Y = a_0 + a_1 \Delta Y(-1) + a_2 \Delta Y(-2) + a_3 \Delta SM(-1) + a_4 \Delta SM(-2) + \gamma_1 ECT(-1) + u \quad (8)$$

$$\Delta SM = \beta_0 + \beta_1 \Delta SM(-1) + \beta_2 \Delta SM(-2) + \beta_3 \Delta Y(-1) + \beta_4 \Delta Y(-2) + \gamma_2 ECT(-1) + \varepsilon \quad (9)$$

Table 6.2. Granger Causality Results of a VAR(2) for Greece (1963-96)

	Dependent ΔY			Dependent ΔSM		
	Eq. 8	Eq. 10	Eq. 12	Eq. 9	Eq. 11	Eq. 13
$\Delta Y(-1)$	0.44 (2.49)**	0.35 (2.21)**	-0.02 (0.10)	-0.02 (0.54)	-0.009 (0.28)	-0.04 (0.76)
$\Delta Y(-2)$	0.28 (1.68)	0.18 (1.16)	-0.08 (0.47)	0.03 (0.79)	0.04 (1.13)	0.02 (0.47)
$\Delta SM(-1)$	2.67 (2.75)***	1.43 (1.45)	0.88 (0.96)	0.008 (0.04)	0.14 (0.70)	0.11 (0.50)
$\Delta SM(-2)$	0.02 (0.02)	-0.68 (0.68)	-0.25 (0.27)	-0.07 (0.35)	0.005 (0.02)	0.03 (0.16)
Constant	0.008 (1.04)	0.02 (2.19)**	0.07 (3.40)***	0.001 (0.09)	0.001 (0.51)	0.003 (0.58)
ECT(-1)	—	-0.06 (2.77)***	-0.06 (3.33)***	—	0.006 (1.46)	0.006 (1.36)
D74	—	—	-0.04 (2.71)**	—	—	-0.003 (0.81)
R²	0.43	0.55	0.65	0.04	0.11	0.14
SE	0.03	0.03	0.02	0.005	0.005	0.005
DW	1.87	1.92	1.99	2.05	2.10	2.08

Causality Tests

LM	X ² (2)=7.0 9 [.029]	X ² (2)=2.89 [.236]	X ² (2)=1.20 [.549]	X ² (2)=0 .75 [.687]	X ² (2)=1. 56 [.458]	X ² (2)=1.09 [.579]
LR	X ² (2)=7.9 5 [.019]	X ² (2)=3.02 [.221]	X ² (2)=1.22 [.543]	X ² (2)=0 .76 [.684]	X ² (2)=1. 60 [.450]	X ² (2)=1.11 [.574]
F	F(2,29)=3. 8 [.034]	F(2,28)=1.3 [.289]	F(2,27)=0. 5 [.615]	F(2,29) =0.3 [.723]	F(2,28)= 0.7 [.518]	F(2,27)=0.4 [.643]

t-ratios for regression results in parenthesis and probabilities for causality tests in brackets

Again in equation 8, the null hypothesis is that $\Delta SM(-1)$ and $\Delta SM(-2)$ do not Granger cause ΔY , ($H_0: a_3 = a_4 = 0$) and in equation 9 that $\Delta Y(-1)$ and $\Delta Y(-2)$ do not

Granger cause ΔSM ($H_0: \beta_3 = \beta_4 = 0$). Results in Table 6.2 (column 2) show that the existence of the unidirectional Granger causality from defence to growth is not sustained once the ECT is added. The null hypothesis that military burden does not Granger cause economic growth can not be rejected according to the LM, LR and F tests. So, now there is absence of any causal relationship between the two series. Finally, the hypothesis of structural stability in the data during the whole period examined was rejected by a Chow test⁵ [$X^2(6)=22.28$ at 1% level of significance] suggesting the use of a dummy variable. A dummy variable D74 taking the value of zero before 1974 and one thereafter is included in the above VAR models to capture the structural break in the data that occurred after the Turkish invasion of Cyprus. From the results in Table 6.2, it is clear that the invasion had a significant negative effect on Greek growth. But again there is absence of any causal relationship between economic growth and military burden.

The analysis provided in this chapter showed that if the usual approach to Granger causality testing was taken, (column 1 of Table 6.2.), the conclusion would be that military burden has a significant positive effect upon growth, with no significant effect from military burden to growth. Military spending would appear to Granger cause growth. This is, however, the result of a misspecification as the standard Granger causality testing fails to allow for the long run properties of the data and the possible structural break caused by the shock of the Cyprus invasion. When either or both of these are considered the significant positive effect disappears and there is no causality from military burden to growth nor vice versa.

⁵ For the Chow test the data were split in two groups: 1960-1973 and 1974-1996

These results are in contrast to those of Joerding (1986)⁶ who found that causality runs from growth to defence with little evidence of causality from defence to growth for 57 LDCs over the period 1962-77. But Joerding did not account for the long-run relationship that might have existed in his data nor for structural breaks and information unique for each country in his sample. On the other hand, Chowdhury (1991) and Kusi (1994) did not find any causality between defence spending and growth for most of the 55 and 77 LDCs respectively. And although this supports the findings reported here, it comes from generalising the findings from many countries, failing to capture specific information unique for each country. Among the studies that have focused on cases of individual countries an interesting example that provides evidence of the importance that the Vector Autoregression and ECM can have on testing short-run causality is that of Chen (1993) and Hasan (1994). Chen (1993) employing the standard Granger causality test found no causal link for China but Hasan (1994) when reworking Chen's data with Vector autoregression (VAR) model found a positive effect of military spending on growth. Dunne and Vougas (1999) found that military burden has a negative impact on growth in South Africa, but only when analysed within a VAR framework. Two recent studies that employed the VAR methodology for Turkey (Kollias & Makrydakis, 1997a) and Greece (Kollias & Makrydakis, 1998) support the results here.

⁶ But see Chapter 3, section 3.4 for a brief critic of this study.

6.4. Conclusions

This chapter has empirically investigated the existence of a causal relation between defence spending and economic growth in Greece over the period 1960-1996. It has systematically analysed the presence and direction of the causal relationship between defence and growth, paying attention to the integration properties of the series and using vector autoregression methodology (VAR). In this way it has extended the methodology commonly employed and has shown that the standard approach can lead to spurious findings of Granger causality. This is the case for Greece, where a positive effect of military burden on growth is found for the standard Granger causality test, but does not survive the introduction of long run information, nor a dummy to allow for the impact of the Cyprus invasion in 1974.

Granger causality tests have been widely criticised (see Jacobs et al, 1979) for being sensitive to a wide variety of factors, including structural changes over the period examined, stationarity of and cointegration across the variables.

Ram (1995) warned that: *“inferences based on these tests can be problematic and several notes of caution seem warranted even if one overlooks the inferential uncertainties inherent in such tests”* (Ram, 1995, p.263). But the methodology employed here has overcome many of the shortcomings that the standard Granger causality may have - especially when applied to a group of countries, in which case many of the unique characteristics of each country are ignored. Testing for Granger causality between the growth and military burden is still useful prior to developing the structural models which follow in the next chapters.

A SUPPLY-SIDE ANALYSIS FOR THE DEFENCE- GROWTH RELATIONSHIP IN GREECE

7.1. Introduction

This chapter estimates the defence-growth relationship in Greece over the period 1960-96 by employing an augmented Feder-type model consisting of the civilian, military, government and export sector. The model allows the identification of the size (total) effects of each sector on growth, externality effects and factor productivity differentials. The sensitivity of the model to the inclusion of each additional sector is also taken into consideration by reporting estimates for a two and a three-sector model over the same period.

The contribution of this empirical investigation lies on the following features: It attempts to account for as many economic linkages as possible by decomposing the economy in four sectors (civilian, military, government and export) and it examines the sensitivity of the Feder-type model to the inclusion of the extra sectors. Also, in addition to the total (size) effects of each of the sectors on economic growth, it estimates the externalities and productivity differentials of each sector with respect to the 'base' sector (civilian). In this way it overcomes many of the problems that arose

in Alexander's (1990) four-sector model¹ with a very complicated set of externalities between sectors. As Ram (1995) suggested:

"...extensions of Feder-type two-sector models to cover three or more sectors should be done cautiously.....such models might be more informative than two-sector formats and could attenuate the problem of omitted variables. However, it seems hazardous to use such multisector models to obtain separate information about the external effects and productivity differences relative to any sector", (Ram, 1995, p.261).

The rest of the chapter is organised as follows: Section 2 provides the methodology employed as well as the specification of the Feder-type model. Section 3 provides the data used and the description of the variables while Section 4 gives the empirical results. Finally, Section 4 discusses the results and gives the main conclusions.

7.2. Methodology and Model Specification

The method followed in this chapter is to estimate the defence-growth relationship in Greece based on a widely used supply-side model, the Feder-type model. In the Neoclassical framework, Feder-type models for the defence-growth relationship have developed from Biswas and Ram (1986)² who adopted Feder's (1982) model of the role of exports in economic growth, as a two-sector framework (military and civilian) to assess the externality effect of the military sector and the factor productivity variation between the two sectors. After them, many versions of the Feder model have been developed (i.e. assuming different sets of externalities or

¹See Section 3 of this chapter for a brief critique of Alexander (1990) study.

² Their estimates suggested that there is not any significant externality effect of military sector on civilian output and also that there is no statistically significant factor productivity difference across the two sectors. They concluded that military expenditure neither promotes nor retards growth in LDCs.

more sectors) with most of the studies employing cross-sectional methodologies.³ This type of model considers externalities between sectors and may explain both the size effect of defence expenditures as well as their externality effects and factor productivity differentials⁴.

The form of the model used here assumes the economy consists of four sectors mutually exclusive and exhaustive: the civilian sector (C), the non-military government sector (G), the export sector (X) and the military sector (M) so that total output of the economy is the sum of the civilian output, the non-military government output, the export output and the military output. That is:

$$Y = C + G + X + M \quad (1)$$

Capital and labour are allocated among the four sectors at each point in time. So, that:

$$K = K_C + K_G + K_X + K_M \quad \text{and}$$

$$L = L_C + L_G + L_X + L_M \quad (2 \text{ a, b})$$

where uppercase subscripts denote the civilian sector (C), the non-military government sector (G), the export sector (X), and the defence sector (M).

Each of the M, G and X sectors has an externality effect on the civilian (C) sector. For this approach the production functions for the four sectors are:

³ Also see, Ward et al (1991), Ward & Davis (1992), Huang & Mintz (1991), Mintz & Huang (1990),

$$G = G (K_G , L_G)$$

$$M = M (K_M , L_M) \tag{3 a, b, c, d}$$

$$X = X (K_X, L_X)$$

$$C = C (K_C , L_C , G, X, M)$$

where subscripts C, M, G, X denote sectoral inputs.

Allowing for relative productivity differences between the “base” sector (civilian) and the other three sectors, i.e. by $(1+\delta)$, the ratios of the marginal productivities for the sectors are:

$$M_L / C_L = M_K / C_K = (1 + \delta_m)$$

$$G_L / C_L = G_K / C_K = (1 + \delta_g) \tag{4 a, b, c}$$

$$X_L / C_L = X_K / C_K = (1 + \delta_x)$$

where the uppercase subscripts on M, G, X, C denote partial derivatives (or marginal products) of labour and capital (i.e. $M_L = \theta M / \theta L_m$ and $M_K = \theta M / \theta K_m$). Also, the size of M, G, X may act as “externality” factors for the civilian sector (C). In other words, the model also identifies marginal externality effects of each of the three sectors (M, G, X) on the civilian sector (C), so that:

$$G_K = (1 + \delta_g) C_K \quad \text{and} \quad G_L = (1 + \delta_g) C_L$$

$$X_K = (1 + \delta_x) C_K \quad \text{and} \quad X_L = (1 + \delta_x) C_L \tag{5 a, b, c}$$

$$M_K = (1 + \delta_m) C_K \quad \text{and} \quad M_L = (1 + \delta_m) C_L$$

Atesoglou & Mueller (1990), Mueller & Atesoglou (1993), Ward, Davis and Chan (1993).

where δ_i is the relative factor productivity between the “base” sector and the other three sectors. If, for example, the productivity index for defence δ_m is positive then the defence sector is more productive than the civilian sector. A zero value for δ_m would indicate the absence of a productivity difference while a negative value for δ_m would indicate that the civilian sector is more productive.

Due to the unavailability of sectoral input data the model is reformulated in terms of aggregate inputs. The general equation for this approach that gives the total effect can be derived by manipulating the production functions (see Feder, 1982, Ram, 1986, 1989, 1995) :

$$\dot{Y} = \alpha \frac{I}{Y} + \beta \dot{L} + \sum_{i=2}^J \left[\left(\frac{\delta_i}{1+\delta_i} + C_i \right) \dot{Y}_i \frac{Y_i}{Y} \right] \quad (6)$$

where α is the marginal product of capital in sector C (civilian), β is the elasticity type measure equal to $C_L(L/Y)$, and $[\delta_i/1+\delta_i + C_i]$ is the sum of the externality and factor productivity differences (the overall effect of sector i on economic performance). $(\delta_i/1+\delta_i)$ alone is the relative productivity effect of the i sector on economic growth while C_i alone represents the marginal externality effect of the i sector on the civilian sector (Huang and Mintz, 1991). Note that the full derivation of the Feder-type model is given in Appendix D.

Based on (6), the four-sector model in which the total effect of each of the sectors can be measured is the following:

⁴ See, Chapter 3 of this thesis for a review of the studies that employ the Feder-type model.

$$\dot{Y} = \alpha \frac{I}{Y} + \beta \dot{L} + \left[\left(\frac{\delta_g}{1 + \delta_g} \right) + C_G \right] \dot{G} \left(\frac{G}{Y} \right) + \left[\left(\frac{\delta_x}{1 + \delta_x} \right) + C_X \right] \dot{X} \left(\frac{X}{Y} \right) + \left[\left(\frac{\delta_m}{1 + \delta_m} \right) + C_M \right] \dot{M} \left(\frac{M}{Y} \right) \quad (7)$$

Adding an intercept and a disturbance term gives the equation to be estimated for Greece over the period 1960-96 to get the size (total) effect of each of the sectors on economic growth.

A further assumption that G, M and X affect the production of C with constant elasticities of θ_g , θ_m and θ_x respectively (see Feder, 1982, Ram, 1986, 1989), suggests that:

$$C = C(L_C, K_C, G, X, M) = G^{\theta_g} X^{\theta_x} M^{\theta_m} \varphi(L_C, K_C), \quad \text{and it can be shown that:}$$

$$\partial C / \partial G = C_G = \theta_g (C/G)$$

$$\partial C / \partial X = C_X = \theta_x (C/X) \quad (8 \text{ a, b, c})$$

$$\partial C / \partial M = C_M = \theta_m (C/M)$$

Then, plugging (8a,b,c) into equation 7 (see Huang and Mintz, 1991), equation 7 can be reformulated to give the separate externality effects of each sector as well as the productivity differentials between the “base” and the other sectors⁵.

⁵ As Ram (1995) mentioned, if one wants to include externality effects across the non-base sectors or to obtain separate estimates for the externality effect and the factor productivity differences many problems arise and the advantage of multisectorial modelling seems uncertain. This issue arises in Alexander's (1990) study.

$$\dot{Y} = \alpha_0 + \alpha \frac{I}{Y} + \beta \dot{L} + \left[\left(\frac{\delta_g}{1 + \delta_g} \right) + \theta_g \left(\frac{C}{G} \right) \right] \dot{G} \left(\frac{G}{Y} \right) + \left[\left(\frac{\delta_m}{1 + \delta_m} \right) + \theta_m \left(\frac{C}{M} \right) \right] \dot{M} \left(\frac{M}{Y} \right) + \left[\left(\frac{\delta_x}{1 + \delta_x} \right) + \theta_x \left(\frac{C}{X} \right) \right] \dot{X} \left(\frac{X}{Y} \right)$$

and rearranging terms:

$$\dot{Y} = \alpha_0 + \alpha \frac{I}{Y} + \beta \dot{L} + \left(\frac{\delta_g}{1 + \delta_g} \right) \dot{G} \left(\frac{G}{Y} \right) + \theta_g \left[\dot{G} \left(\frac{C}{Y} \right) \right] + \left(\frac{\delta_x}{1 + \delta_x} \right) \dot{X} \left(\frac{X}{Y} \right) + \theta_x \left[\dot{X} \left(\frac{C}{Y} \right) \right] + \left(\frac{\delta_m}{1 + \delta_m} \right) \dot{M} \left(\frac{M}{Y} \right) + \theta_m \left[\dot{M} \left(\frac{C}{Y} \right) \right] \quad (9)$$

Equation (9) is the second equation to be estimated and captures the externality effects (θ) and the productivity differentials (δ) between the “base” and the other three sectors. In other words, it allows for the isolation of both the productivity and externality effects of government, defence and export sectors. The elasticity measure of the intersectoral externalities θ_i ($i=g, x, m$) may be interpreted as the effect on economic growth of the interaction between the growth rate of sector i and the share of the civilian sector (C) in total output (Y), while $(\delta_i/1+\delta_i)$ can capture the direct effect of sector i on growth. Note that in order to estimate equations 7 and 9, the instantaneous change rate of the variables is replaced with their discrete equivalents (i.e. $\dot{Y} = \Delta Y/Y_{-1}$).

Several shortcomings arise from these models concentrating on the supply-side, as they ignore the demand-side, assuming that it stays in equilibrium with the supply constraints of the economy. Also, high collinearity between the two terms of each sector (growth rate and share in GDP) is inevitable, and thus, *“the estimates may not provide a good feel for the magnitude of the externality effect and/or the productivity differences andas is common with most single equation models, there are some measurement and data problems and there may be ‘feedback’ from the dependent variable to some of the regressors”* (Ram, 1995, pp261-262.). Another weakness of the Feder-type model is that it assumes that the production function consists only of physical capital and labour and in this way it excludes human capital, which can comprise native ability and talent as well as education and acquired skills⁶. Furthermore, as will be shown in the analysis that follows, the two-sector model can appear too restrictive, suggesting that government and export sectors should also be included.

Despite such shortcomings, one should not ignore the advantages of such models, which tend to outweigh their weaknesses. First of all, these models are well based in economic theory and can describe the supply constraints that are important for countries like Greece. They require relatively less data than full demand and supply models, which is an important advantage when analysing less developed countries. Finally, they allow the identification of size effects, externality effects and the relative marginal productivities of each sector (Ward et al., 1991).

⁶ Sezgin (1997) proxied human capital by educational expenditure but “the results were not improved suggesting that educational expenditure was not a good proxy”.

7.3. Data and Variable Description

Data required for the estimation of the above models come from SIPRI, EUROSTAT and OECD. Specifically, data for GDP, investment, government expenditure, and exports were taken from the EUROSTAT database, labour force data were taken from OECD while military expenditure data were taken from SIPRI Yearbooks. All figures were first deflated in constant 1990 million drachmas and then converted to 1990 million US dollars by means of exchange rates. A problem that is often observed and usually ignored - especially when dealing with developing countries - concerns labour force data. As Scheetz (1991) mentioned, LDC data series are very imprecise "*..even figures published by international organisations*" (Scheetz, 1991, p.66). Usually labour force data is not available and its growth is proxied by the population growth rate - as Ram (1986), Ward et al (1992), Alexander (1990) did. For Greece, labour force data was in fact available from 1970 onwards, with labour force growth proxied by population growth prior to 1970. To measure non-military government spending military expenditure was subtracted from government expenditure. This overcomes the problem exemplified by Alexander (1990) where government consumption was used as a proxy for non-military government consumption leading to an overvaluing of government consumption by the amount of military expenditure, leading to the invalidity of the assumption of the mutually exclusive and exhaustive sectors.

To consider the existence of cointegration all the variables in equations 7 and 9 were tested for unit roots by Dickey Fuller tests. Apart from the investment variable which contained a unit root, all the other variables appeared to be stationary - which was expected given their specification in growth rates. No evidence of cointegration

was found, so the models are estimated without the addition of an Error Correction Term (ECT). As for the investment variable, which appeared to exhibit a unit root, it was not first differenced on the grounds of losing the interpretation of the coefficient. The existence of non-stationary variables on the right hand side when the dependent is stationary may have two effects: First, the coefficient on the non-stationary variable (here on I/Y_{-1}) should theoretically be zero in infinite samples. Given that results reported here come from finite sample, this theoretical expectation does not apply. Second it may lead to inefficiencies that affect all the variables in the equation. This was examined by comparing results from equations that included the investment variable in first difference form. No significant changes in the estimates were observed.

7.3.1. Description of Variables

$$\dot{Y} = \Delta Y / Y_{-1} = \text{GDP growth}$$

$$I/Y_{-1} = \text{Share of investment in GDP}$$

$$\dot{L} = \Delta L / L_{-1} = \text{Labour force growth}$$

$$\dot{M}\left(\frac{M}{Y}\right) = \Delta M / M_{-1} (M/Y_{-1}) = \text{Total effect of defence sector}$$

$$\dot{G}\left(\frac{G}{Y}\right) = \Delta G / G_{-1} (G/Y_{-1}) = \text{Total effect of non-military government sector}$$

$$\dot{X}\left(\frac{X}{Y}\right) = \Delta X / X_{-1} (X/Y_{-1}) = \text{Total effect of export sector}$$

$$\dot{M}\left(\frac{C}{Y}\right) = \Delta M / M_{-1} (C/Y_{-1}) = \text{Externality effect of military sector}$$

$$\dot{G}\left(\frac{C}{Y}\right) = \Delta G / G_{-1} (C/Y_{-1}) = \text{Externality effect of non-military government sector}$$

$$\dot{X}\left(\frac{C}{Y}\right) = \Delta X / X_{-1} (C/Y_{-1}) = \text{Externality effect of export sector}$$

where $C=Y-M$ in the two-sector model

$C=Y-M-G$ in the three-sector model

$C=Y-M-G-X$ in the four-sector model

δ_m = productivity difference of the military sector with respect to the civilian sector

δ_g = productivity difference of the government sector with respect to the civilian sector

δ_x = productivity difference of the export sector with respect to the civilian sector

and Y = GDP in constant 1990 mn US \$

M = Military Expenditure in constant 1990 mn US \$

G = Government Expenditure (excluding military) in constant 1990 mn US \$

X = Exports in constant 1990 mn US \$

I = Private Investment in 1990 mn US \$

L = Labour Force in '000s

7.4. Empirical Results

Equations (7) and (9) were estimated by OLS using Microfit 4.0. Table 7.1. gives results for the total (size) effects of each sector (equation 7) and Table 3 also gives the externality effects and the productivity differentials (equation 9). In each case the first column gives results from the two-sector model (military and civilian), the second column from the three-sector model (civilian, military and government) and the third column gives results from the four-sector model (civilian, military, government and export).

7.4.1. Empirical Results for the 'Total Effect'

Starting from equation 7, that describes the total (size) effects of each sector on economic growth, it is obvious that the overall performance of the model in terms of explanatory power is not very satisfactory with the R^2 being 0.41, 0.47, 0.48 for the two, three and four sector models, respectively. But another consideration when evaluating the overall performance of this model (as Mintz & Stevenson, 1995 stress), concerns the coefficients on the investment and labour variables. "*In general, one would be more confident in the specification of the model if the coefficients on these variables conform to the standard predictions of the economic theory*" (Mintz & Stevenson, 1995, p.293). If, for example, investment is found significantly negatively related to economic growth, the validity of the model should be questioned. But this is not the case for any of the three specifications of the model for Greece in all of which investment is positive and highly significant. Labour force growth on the other hand has an unexpected significantly negative effect, which is a bit problematic as it does not conform to the standard predictions of the economic theory although the theories underlying the impact of labour on the economy is less conclusive than that of investment. Its significance might suggest that, in Greece, increases in the workforce do not necessarily imply a more productive workforce. In fact, this is not an unusual finding and Ward et al. (1991) justify it by arguing that: "*Economies of scale in the production process are not always linear and also they don't necessarily apply to the wage bill*" (Ward et al., 1991, p.53). Furthermore, Antonakis (1997) in his two-sector model for Greece found a negative but insignificant effect for the labour force⁷ variable justifying it by

⁷ Antonakis (1997) as most other studies have done, proxied labour force growth by population growth. But this can cause the impact of labour growth to be underestimated, especially in cases

saying “*..in labour surplus economies like Greece, the natural rate of growth is not a binding constraint*” (Antonakis, 1997, p.653). As far as the total effect of the military sector is concerned (in the 2-sector model) it is positive and significant at 10% supporting the modernisation and spin off arguments for defence spending.

On the second column of Table 7.1., the government sector (excluding the military) enters the equation with a positive sign, significant at 10%. As for the effect of the military sector, it is still positive but now insignificant. The intercept, investment and labour force growth continue to have the same signs as before with their significance slightly altered. Finally, by adding the export sector (see column 3 of Table 7.1.), all of the variables’ signs remain the same, the significance of the government sector increases (from 10% to 5%) and the significance of investment and labour force growth drops slightly to 5%. The effect of the export sector is positive but not significant, which is not surprising for a country like Greece which mainly exports agricultural products. As for the constant term, which measures an average trend rate of technological progress, it is insignificant in all three specifications.

where the size of the labour force changes significantly while population remains stable (almost stable population is a fact for Greece).

Table 7.1. OLS Results of the Feder-type model for Greece (1961-1996)

Dependent GDP Growth (equation 7)			
Indep. Variables	2 Sectors	3 Sectors	4 Sectors
<i>Intercept</i>	-0.03 (1.23)	-0.03 (1.15)	-0.03 (1.29)
I / Y_{-1}	0.33 (3.06)***	0.27 (2.51)**	0.26 (2.39)**
$\Delta L / L_{-1}$	-0.92 (2.50)**	-0.95 (2.71)***	-0.83 (2.21)**
$\Delta M / M_{-1}(M / Y_{-1})$	1.59 (1.84)*	0.43 (0.42)	0.37 (0.36)
$\Delta G / G_{-1}(G / Y_{-1})$	—	1.04 (1.92)*	1.14 (2.05)**
$\Delta X / X_{-1}(X / Y_{-1})$	—	—	0.49 (0.90)
R²	0.41	0.47	0.48
SE	0.03	0.02	0.03
DW	1.66	1.74	1.54
F-statistic	F(3,32)=7.3***	F(4,31)=6.85***	F(5,30)=5.61***
Diagnostic Tests			
Serial Correlation	X ² (1)=0.06 [.801]	X ² (1)=0.03 [.861]	X ² (1)=0.63 [.427]
Functional Form	X ² (1)=0.01 [.918]	X ² (1)=0.05 [.830]	X ² (1)=0.05 [.825]
Normality	X ² (2)=9.74 [.008]	X ² (2)=10.94 [.004]	X ² (2)=8.80 [.012]
Heteroscedasticity	X ² (1)=1.08 [.299]	X ² (1)=0.18 [.675]	X ² (1)=0.45 [.501]

The top columns give the coefficients estimates followed by the t-ratios (in parentheses) while the bottom columns give the X² tests for Serial Correlation, Functional Form, Normality and Heteroskedasticity followed by the probabilities (in brackets). ***: significant at 1% level of significance, **: significant at 5% level of significance, *: significant at 10% level of significance.

For all estimations Microfit 3.0 was used.

Non-nested tests indicated that the three and four-sector models are preferred to the two-sector one, while no clearcut preference could be made among the three and four-sector models (as the Akaike's information criterion was in favour of the four-sector model while the Schwarz Bayesian criterion was in favour of the three-sector one). Given this, plus the fact that results are very similar for the three and four-sector models, reliance on either model is acceptable. It would appear that the military sector in Greece does not have a significant impact on economic growth, and that the same applies to the export sector. Only the non-military government sector seems to be growth promoting in Greece. This is in contrast to Antonakis (1997)

who found a significant negative effect of the defence sector. But this result can be questioned as he assumed only two sectors in the economy (the civilian and the military), did not use recent data (his data covered the period 1958-91) and, most importantly, claimed a negative and significant effect of the military sector in the original form of the model at 5% level of significance when the t-ratio that he reported for the specific coefficient was just 1.7. Only when he introduced lags in his model was the effect significantly negative, though still he did not report the long run coefficients. In addition, one would expect differences to this study's results as he used different data to this study, using the Greek National Accounts data and he proxied labour force growth by population growth.

On the other hand, the three-sector model for India that Ward et al (1991) estimated, gave a positive overall effect of the military sector and a negative one for the government sector. But for a country like India that spends a lot on R&D for advanced defence technologies, the growth promoting effect of the military need not be surprising, given the spin-off effects that the military sector might have on other sectors. The three sector model by Murdoch et al (1997), for a well-defined cohort of nations (8 Asian and 16 Latin American countries) with similar economic, political or regional characteristics over the period 1955-1988 indicated that private investment, defence spending and other forms of public sector spending are growth promoting in the context of a purely supply-side Feder analysis. This is in line with the results for Greece as far the non-military government sector and investment is concerned, but not for the military sector. It is worth noting that studies for the US which has the most developed defence industry (i.e. Huang & Mintz, 1990, 1991; Ward & Davis, 1992; Ward et al, 1995) found a negative overall effect of the

defence sector on economic growth rejecting the modernisation and spin off effects of defence, probably because defence diverts scarce resources (top scientists) from other sectors that might have been growth promoting.

7.4.2. Empirical Results for ‘Externality and Relative Productivity Effects’

Moving on to equation 9, which decomposes the overall effect in the original two, three, and four sector models into externality and relative productivity effects, the results are slightly altered. The specification seems to be a reasonable one, according to the different tests, with some minor problems as far as the normality assumption is concerned. The R^2 suggests that the equation only explains 44% of the variation of the dependent variable in the two-sector case, 56% in the three-sector case and 61% in the four-sector case but the statistical insignificance of most of the variables is also apparent. This low individual significance combined with the high F statistics (reported in Table 7.2.) point to the existence of multicollinearity, which is the most commonly observed problem with this type of model, given the high collinearity between the two terms of each sector (i.e. between the size effect of the defence sector $\Delta M / M_{-1}(M / Y_{-1})$ and its externality effect $\Delta M / M_{-1}(C / Y_{-1})$). The implication of this is that although the OLS estimates are unbiased they are imprecise and unstable. Given that multicollinearity is typically caused by lack of sufficient information in the sample, common remedial measures involve getting more data to break the pattern of multicollinearity or dropping some independent variables. The first can be impossible if more data are not available while the second can lead to specification error if the variables dropped are theoretically relevant (i.e. Atesoglou

& Mueller, 1990; Alexander, 1995, dropped the externality effects from their analysis). There are some other studies that in order to deal with multicollinearity (i.e. Huang and Mintz, 1990, 1991) employ a k-class ridge⁸ estimator. Reporting results for both ridge and OLS estimators they find no significant differences in the results, although collinearity is reduced. Most studies simply report the results accepting the existence of multicollinearity and do not attempt ridge regressions as the value of such regressions is widely contested (Kennedy, 1986).

The approach taken here is to report the OLS results with this caveat. Starting from the two-sector model (civilian and military) in column 1 of Table 7.2, investment and labour force growth are the only variables that continue to be significant and to have the same signs as before. The size effect of the defence sector is negative while its externality is positive, with both effects being insignificant. This means that although the productivity differential can be calculated (it is -0.87)⁹ it would not be reliable as it comes from insignificant estimates. Despite that, the joint test of zero restrictions on the military coefficients is rejected at the 5% level of significance suggesting that the two military terms are important in the growth equation (Likelihood Ratio test $X^2(2)= 5.80$).

The inclusion of the government sector gives similar results as far as the individual effects of the two military terms are concerned and they remain insignificant. But now (unlike in the two-sector model) the military terms are not even jointly

⁸ The ridge technique introduces small biases in the coefficient estimates to achieve substantial gains in variance reduction

significant (Likelihood Ratio $X^2 = 0.28$). The total effect of the non-military government sector is negative and insignificant while its externality is positive and significant at 10%.

Table 7.2. OLS Results of the Augmented Feder model for Greece (1961-1996)

Dependent GDP Growth			
Indep.Var.	2 Sectors	3 Sectors	4 Sectors
<i>Intercept</i>	-0.03 (1.22)	-0.01 (0.56)	-0.01 (0.23)
I / Y_{-1}	0.32 (3.09)***	0.17 (1.55)	0.10 (0.89)
$\Delta L / L_{-1}$	-0.91 (2.53)**	-0.73 (2.13)**	-0.58 (1.60)
$\Delta M / M_{-1}(M / Y_{-1})$	-7.42 (1.13)	-1.89 (0.31)	-0.64 (0.13)
$\Delta G / G_{-1}(G / Y_{-1})$	—	-2.02(1.21)	-0.70 (0.53)
$\Delta X / X_{-1}(X / Y_{-1})$	—	—	-0.21 (0.23)
$\Delta M / M_{-1}(C / Y_{-1})$	0.54 (1.39)	0.12 (0.25)	0.03 (0.07)
$\Delta G / G_{-1}(C / Y_{-1})$	—	1.29 (1.91)*	0.89 (1.36)
$\Delta X / X_{-1}(C / Y_{-1})$	—	—	0.18 (1.23)
δ_m	-0.87	-0.64	-0.38
δ_g	—	-0.42	0.23
δ_x	—	—	-0.02
R^2	0.44	0.56	0.61
SE	0.03	0.03	0.02
DW	1.91	2.32	2.10
F-statistic	F(4,31)=6.12***	F(6,29)=6.19***	F(8,27)=5.30***
Diagnostic Tests			
Serial Correlation	$X^2(1)=0.53$ [.469]	$X^2(1)=2.32$ [.127]	$X^2(1)=0.53$ [.467]
Functional Form	$X^2(1)=0.10$ [.754]	$X^2(1)=0.01$ [.969]	$X^2(1)=0.93$ [.336]
Normality	$X^2(2)=15.27$ [.000]	$X^2(2)=36.86$ [.000]	$X^2(2)=18.76$ [.000]
Heteroscedasticity	$X^2(1)=1.06$ [.304]	$X^2(1)=0.04$ [.851]	$X^2(1)=0.12$ [.732]

The top columns give the coefficients estimates followed by the t-ratios (in parentheses) while the bottom columns give the Diagnostic tests and their probabilities (in brackets).

⁹ Note that the productivity differential is calculated from the estimated coefficients of the total effect $\frac{\delta_m}{1 + \delta_m}$ and the externality effect \mathcal{G}_m , as: $\frac{\delta_m}{1 + \delta_m} - \mathcal{G}_m$

Furthermore, the two non-military government terms are jointly significant at 5% (Likelihood Ratio $X^2 = 8.45$). The further addition of the export sector improves the model in terms of R^2 but at the same time all of the variables become insignificant. The signs of the size and externality effects of the military and government sectors remain the same as in the previous specification. As for the export sector, it gives negative size effects and positive externalities, though again the insignificance of the variables makes calculating the productivity differentials unrevealing. The joint test of zero restrictions on the military terms cannot be rejected (Likelihood Ratio $X^2(2) = 0.11$), suggesting that there is no significant impact of military spending on growth. This is also the case for the export sector terms (Likelihood Ratio $X^2(2) = 4.34$) while the non-military government sector terms are jointly significant at 5% level (Likelihood Ratio $X^2(2) = 6.43$)

These results support those of Mintz and Stevenson (1995) based on a three-sector Feder-type model for 103 developed and less developed countries. According to their findings, there was no short-run relation between military expenditure and growth and the externality effect was much smaller than the total effect¹⁰. Contrary to the results for Greece reported earlier, Sezgin (1997) in a two-sector Feder-type model for Turkey found a positive and significant relationship between military spending and economic growth while externalities from the defence sector to the rest of the economy were negative. The growth promoting effect of the defence sector must be attributed to the fact that Turkey has managed to develop an indigenous arms industry that interacts with other sectors and has spin-off effects.

¹⁰ They found that defence sector has a significant positive effect in only 10% of the cases (10% of 103 countries).

Alexander's (1990) conclusion for 9 industrial countries under an augmented four-sector Feder-type model that the gross effect of military expenditure on growth is neither significantly positive nor negative, although the defence sector is less productive than the 'rest' of the economy seems to fit perfectly the conclusion drawn for Greece. But what is of particular importance is that the model for Greece has overcome many of the shortcomings that arose in Alexander's study. Specifically, unlike his study that specified a very complex set of externalities among sectors (i.e. the non-military sector could influence both the defence, the export and the civilian sector while the defence and export sector could influence only the civilian sector) making some coefficients, (i.e. the coefficient of the non-military government sector), so complicated that could not be interpreted, the study for Greece defined simple externalities from each of the defence, export and non-military government sector only to the base sector (civilian sector). Furthermore, in the present study values for non-military government spending were derived by deducting military spending from total government spending while Alexander proxied non-military government expenditure by government consumption overvaluing in this way government consumption by the amount of military consumption, (as also Mintz and Stevenson (1995) stressed). Finally, in the present study the sensitivity of the Feder-type model to the inclusion of extra sectors was examined, leading to the conclusion that the three and four-sector models perform better and are much more informative than the two-sector ones, which appear to be very restrictive and can be misleading.

7.5. Conclusions

This chapter has provided evidence of the economic effects of military spending in Greece, using a supply-side model. The approach taken was to estimate a popular multi-sectoral Neoclassical model - the Feder-type model with special attention given to the sensitivity of the model to the number of sectors included and to the specification of the externalities and the productivity differentials.

Starting with the two-sector model, a positive effect of the defence sector on economic growth (significant at the 10% level) was found. However, this positive effect changed into a negative and insignificant one when either the government sector alone or both the government and the export sectors were introduced. The overall effect of the non-military government sector was positive and significant in both the three and four-sector model, while the export sector had a positive but insignificant effect on growth. The signs and significance of the intercept, the investment and the labour force variables remained unchanged. Furthermore, the general performance and the explanatory power of the three and four-sector models was higher than that of the two-sector model and this was also supported by non-nested tests, suggesting that one should rely on estimates from these models rather than the more restrictive two sector ones which can lead to misspecification.

The same story is repeated when the augmented models that give separate estimates for the total and the externality effects of each sector are considered. Again, the two-sector augmented model is poorly defined compared to the three and four-sector ones, but now it also gives insignificant total and externality effects of the military

sector and most of the variables are insignificant. The four-sector model in particular shows the absence of any statistical significance of the coefficients.

So, first of all the analysis provided in this chapter has pointed to the observation that the Feder-type model is very sensitive to the inclusion of additional sectors of the economy, especially when the size effects of the sectors are separated from their externalities in which case one gets insignificant estimates. The results for Greece fully support Biswas and Ram (1986) finding for a cross-section of countries, that:

“...the augmented models appear to suggest absence of any statistically significant impact of military expenditure on growth of total output. These models also indicate that neither the M (military) sector generates any significant positive or negative externality for the C (civilian) sector nor is the relative factor productivity differential across sectors statistically significant. So, although we can compute values of C_i and δ_i from the relevant parameter estimates, these computations would not be useful since most of these estimates are statistically insignificant” (Biswas and Ram, 1986, p.369-370).

Under the limitations of the Feder-type model, empirical evidence for Greece over the period 1961-96 indicates that the overall effect of the defence sector on growth is neither significantly positive nor negative, although the defence sector seems to be less productive than the civilian sector. This suggests that shifts of resources (spending or investment) out of the military sector into the private sector are likely to bring about higher economic productivity in the country.

A DEMAND AND SUPPLY-SIDE ANALYSIS FOR THE DEFENCE-GROWTH RELATIONSHIP IN GREECE

8.1. Introduction

This chapter investigates the defence-growth relationship in Greece over the period 1960-1996 by employing a demand and supply model. Specifically it estimates a simultaneous four-equation system consisting of a growth equation, a savings equation, a trade balance equation and a military expenditure equation. The military expenditure equation is the one already specified and estimated in Chapter 5 (aggregate model of defence spending). This type of model hypothesises possible direct effects of defence on growth through Keynesian demand stimulation and other spin-off effects and negative indirect effects through possible reductions in savings and trade balance (as discussed in chapter 2) allowing the calculation of the overall, the “net” effect.

In the rest of the Chapter a growth, savings and trade balance equations are specified and initially estimated by OLS. At a later stage these equations are combined with the demand for military expenditure equation (estimated in Chapter 5) to form a simultaneous equation system which is estimated by system estimation procedures - three stage least squares (3SLS) to deal with simultaneity and high covariance

problems and to give an estimate of the net effect of defence spending on economic growth.

8.2. Methodology Employed and Specification of the Model

Smith and Smith (1980) were the first to use simultaneous equation models (SEM) to capture both the demand-side influences in a Keynesian aggregate demand framework and the supply-side ones in a growth equation derived from an aggregate production function. This framework was further developed by Deger and Smith (1983), Deger (1986), Scheetz (1991), Dunne and Mohammed (1995), Roux (1996), Antonakis (1997a), Sezgin (1998a,b), Dunne & Nikolaidou (1999) among others. These models hypothesise possible direct effects of defence on growth through Keynesian demand stimulation and other spin-off effects and negative indirect effect through reductions in savings or investment, balance of payments, education and health.

The analysis followed here is based on Hendry's "general to specific" methodology. According to this, the starting point is to develop each equation by including as many variables as seem relevant according to economic theory (build a general model) and then restrict it to a more "specific" one by testing for exclusion restrictions. The specification of the growth, savings and trade balance equations with the preliminary single equation OLS estimates are as follows:

8.2.1. Growth equation

The growth equation is derived from a traditional production function: $Y = f(K, L, T)$ where Y is output, K and L are capital and labour inputs and T is a measure of technology (see Deger and Smith, 1983, p.341). Using a Cobb-Douglas production function this relation can be transformed to one that is linear in the growth rates. Thus, output growth rate is a function of capital growth, labour growth and variables which affect the growth in total factor productivity (technology). Capital growth is financed either through domestic savings (S) and/or foreign capital flows¹. Lack of data normally means that population growth is used as a proxy for labour force growth, but this is not necessary for Greece as the relevant data are available (L). The share of military spending in GDP (M) is intended to pick up the hypothesised modernisation and resource mobilisation impacts of military spending. Similarly, GDP per capita (GDPC) should capture any “catch-up” effects from importing technology, since countries with higher income per head are probably reaching the upper limits of their growth potential (Deger and Smith, 1983). So, the growth equation should be a function of the following variables:

$$Y = Y(S, M, GDPC, L, TB)$$

where Y is real growth of GDP, S is the share of national savings in GDP, M is the share of military expenditure in GDP (military burden), GDPC is GDP per capita, L is labour force growth and TB is the share of trade balance in GDP.

¹ Scheetz (1991) uses a broader term than foreign capital flows, the current account share in GDP.

8.2.2. Savings equation

The savings equation is derived from the output/expenditure relation:

$$Y = C + I + M - TB$$

where Y is total output, C is civilian consumption (public and private), I is total civilian investment, M is military expenditure and TB the trade balance. Adding some monetary factors and manipulating the above relation, it appears that the following variables should be included in the savings equation:

$$S = S (M, Y, TB, INF, NG)$$

where INF is the inflation rate and NG the share of non-military government expenditure in GDP.

Inflation (INF) is included to take account of the inflationary effects on resource creation. Deger (1986) assumed that inflation leads to forced savings, and thus affects savings positively, but inflation could also retard savings, so the expected sign is ambiguous. Growth of output should affect savings positively while the expectation for non-military government spending is ambiguous. The coefficient of the share of military spending in this equation, should be negative if crowding out is taking place and the trade balance (TB) is expected to affect savings positively through income multipliers and trade taxes (Scheetz, 1991).

8.2.3. Trade Balance equation

A country's trade balance can be affected by military burden if aggregate demand is increased and domestic supply is inelastic, leading to increased imports and/or reduced exports. This would suggest a negative sign on M, but Greece has received substantial military aid from NATO, so this effect may not be very strong. Deger (1986) argues that the growth of GDP will affect the trade balance positively, if the country in question promotes exports, or negatively, if it follows an import substitution policy. For Greece a positive effect is expected. The effect of inflation and previous year's trade balance is ambiguous and the real exchange rate is included to capture the effects of a change in the international purchasing power of the domestic currency with an expected positive sign. This gives a trade balance equation of the form:

$$TB = TB (M, Y, INF, GDPC, EXC)$$

where EXC is the exchange rate (US \$ to Greek Drachma)

The above functions represent the "general" form of the equations to be estimated. But prior to estimation, the integration properties of the series must be examined by employing the Dickey-Fuller tests for unit roots. This is done in the next section which also presents the data sources and the description of the variables used (after the unit root tests).

8.3. Data and Variables Description

Data for GDP, GDP per capita, national savings, government expenditure, trade balance, population and inflation were taken from the EUROSTAT database while data for the exchange rate and labour force from the OECD database. All figures were deflated to constant 1990 million drachmas and then converted to 1990 million US \$ by means of exchange rates. Data for Greek military expenditure as well as for Turkish and NATO military expenditure were taken from SIPRI. The fact that SIPRI (and thus, NATO) definition of military spending does not include the value of military assistance² received from abroad is recognised. The approach to measuring non-military government spending was to subtract military expenditure from government expenditure.

All the series were tested for unit roots by using ADF tests of stationarity and were first differenced when non-stationary (See Table E1 in Appendix E). Specifically, the only variable that was stationary was GDP growth, but this is expected since it is already in a growth form. But on the other hand, labour force growth did not appear as stationary (although in a growth form) and it had to be differenced.

² The main assistance programmes through which the US provided weapons, training and other defence-related services to Greece (as well as to Turkey) were: the Foreign Military Sales Program (FMS), the Economic Support Fund (ESF), the International Military Assistance Program (MAP) and the International Military Education and Training Program (IMET). (Balfoussias and Stavrinou, 1996)

8.3.1. Description of Variables

Y: real growth rate of GDP

DS: share of national savings in GDP (first difference)

DTB: current account balance (exports of goods and services less imports of goods and services) as a share of GDP (first difference)

DM: share of military expenditure in GDP (first difference)

DEXC: real exchange rate (first difference)

DNG: share of government spending (excluding military expenditure) in GDP (first difference)

DTM: share of Turkish military expenditure in GDP (first difference)

DNATO: share of NATO's defence spending (excluding Greece and Turkey) in GDP (first difference)

DINF: inflation rate (first difference)

DL: labour force growth (first difference)

DGDPC: GDP per capita in constant 1990 mn US \$ (first difference)

DPOP: Greek population (first difference)

D74: dummy to capture the threat of war after 1974 (takes the value of 1 for the years 1974-96)

CYP: impulse dummy to capture the effect of 1974 invasion of Cyprus (1974=1, 0 elsewhere)

D74: dummy to capture the deterioration in trade balance after 1974 (1974-96=1, 0 elsewhere)

T: linear trend

8.4. Empirical Results

This section starts by presenting empirical results using OLS method for each individual equation, and later all four equations (including the military burden equation estimated in Chapter 5) are combined to form a system of equations that will be estimated by system method (3SLS).

8.4.1. Growth Equation

All variables should be positively related to growth. Estimating this equation by OLS for Greece over 1960-96, the following results were obtained with the addition of a time-trend:

$$DY = 0.09 + 0.003DS(-1) - 0.02DM + 0.09 DGDPC + 0.003 DL - 0.001DTB - 0.002 T$$

(16.32) (3.27) (3.85) (7.45) (1.85) (0.42) (9.60)

$$R^2 = 0.88, \quad DW = 1.42$$

The overall performance of the estimated equation is satisfactory, apart from some evidence of serial correlation. The coefficient on the military burden is negative and significant; this implies that the argument that military spending has a positive impact through modernisation and resource mobilisation is not valid for the case of Greece. All the other variables are positively related to growth - except for the trend and the trade balance, which is also the only insignificant variable.

8.4.2. Savings Equation

Estimating the savings equation by OLS over the period 1960-1996, gave the following results:

$$DS = -1.30 - 2.07 DM + 0.30 DTB(-1) - 0.23 DINF + 31.61 DY - 0.87 DNG$$

(1.72) (2.23) (0.81) (1.91) (2.27) (1.04)

$$R^2 = 0.52, \quad DW = 2.00$$

Military burden has a negative effect on savings, in accord with the resource reallocation argument, real growth of output has a positive impact on savings, as expected, while non-military government spending and previous year's trade balance are insignificant.

8.4.3. Trade Balance Equation

Estimating this equation, after introducing some lags and a dummy to capture the deterioration of trade balance after 1974, gave the following results:

$$DTB = 3.85 - 0.90 DM - 43.6 DY_{-1} - 0.13 DINF_{-2} - 0.32 DTB_{-1} - 0.04 DEXC - 3.07 DGDPC - 1.9 D74$$

(2.66) (1.53) (2.47) (1.78) (1.77) (1.44) (1.57) (1.75)

$$R^2 = 0.35, \quad DW = 1.94$$

The trade balance equation is poorly defined in terms of R^2 either when it is estimated by OLS or by the instrumental variables method (IV). The effect of military burden on trade balance is negative but not significant.

8.4.4. Military Expenditure Equation

Recall from the military expenditure equation and its OLS estimates from Chapter 5:

$$DM = 0.12 - 0.56DGPC_{-1} - 0.44DNG - 0.15DTB_{-1} + 0.27DTM_{-1} + 0.50NATO + 2.42CYP - 0.14DM_{-1}$$

(1.83) (2.11) (4.31) (3.98) (2.50) (1.42) (6.58) (1.22)

$$R^2 = 0.73, DW = 2.00$$

Combining all the four equations together, the system of equations will be defined next.

8.4.5. System of Equations Results

The single equation estimates reported above generally give satisfactory results - except for the trade balance equation - and almost all coefficients have the expected signs. But there are problems with these single equation OLS estimates as they do not take into account the likely interrelationships between the variables. Simultaneity and high covariances between variables can lead to biased estimates. To overcome this problem it is necessary to use either some form of instrumental variables technique or simultaneous equations methods. In this case the system of equations is estimated using the 3SLS (three Stage Least Squares) method. Single equation 2SLS (Two Stage Least Squares) estimates are also presented.

The simultaneous equation model consists of the following four equations and the results are reported in Table 8.1., together with the OLS estimates³.

$$DY = a_0 + a_1 DS_{-1} + a_2 DM + a_3 DGDPC + a_4 DL + a_5 DTB_{-2} + T$$

$$DS = \beta_0 + \beta_1 DM + \beta_2 DTB_{-1} + \beta_3 DINF + \beta_4 DY + \beta_5 DNG$$

$$DTB = \gamma_0 + \gamma_1 DM + \gamma_2 DY_{-1} + \gamma_3 DINF_{-2} + \gamma_4 DTB_{-1} + \gamma_5 DEXC + \gamma_6 DGDPC + \gamma_7 D74$$

$$DM = \delta_0 + \delta_1 DTB_{-1} + \delta_2 DGDPC_{-1} + \delta_3 DNG + \delta_4 DTM_{-1} + \delta_5 DNATO + \delta_6 DM_{-1} + \delta_7 CYP$$

The 2SLS and 3SLS results are in general consistent with the OLS results. There are no differences in sign and the growth equation results are almost identical. There are some differences in using the systems estimation method for the trade balance model, where the significance of a number of variables improves, and for the savings and military expenditure equations, but none are particularly significant.

³ The models may seem at variance to the previous results. But in this case a general to specific methodology was used to determine dynamic structure in this case.

Table 8.1. Estimation Results of the Demand and Supply Model for Greece

	Exogenous variables	Estimation Method					
		OLS		2SLS		3SLS	
Growth Equation	intercept	0.09	(16.32)***	0.10	(14.29)***	0.10	(17.05)***
	DS ₋₁	0.003	(3.27)***	0.002	(2.51)***	0.002	(3.45)***
	DM	-0.02	(3.85)***	-0.02	(3.90)***	-0.02	(4.85)***
	DGDPC	0.09	(7.45)***	0.08	(6.30)***	0.08	(7.27)***
	DL	0.003	(1.85)*	0.003	(1.60)	0.001	(1.22)
	DTB ₋₂	-0.001	(0.42)	0.001	(0.11)	-0.001	(0.24)
	T	-0.002	(9.60)***	-0.003	(9.04)***	-0.003	(10.88)***
	R-squared	0.88		0.85		0.85	
DW	1.42		1.15		1.30		
Savings Equation	intercept	-1.30	(1.72)*	-1.30	(1.72)*	-1.46	(2.15)**
	DM	-2.07	(2.23)**	-2.07	(2.23)**	-2.04	(2.43)***
	DTB ₋₁	0.30	(0.81)	0.30	(0.81)	0.33	(1.02)
	DY	31.61	(2.27)**	31.61	(2.27)**	34.42	(2.75)***
	DINFL	-0.23	(1.91)*	-0.23	(1.91)*	-0.17	(1.63)*
	DNG	-0.87	(1.04)	-0.87	(1.04)	-0.44	(0.61)
	R-squared	0.52		0.52		0.51	
	DW	2.00		2.00		1.91	
Trade Balance Equation	intercept	3.85	(2.66)***	3.85	(2.66)***	4.51	(4.34)***
	DM	-0.90	(1.53)	-0.90	(1.53)	-1.26	(2.60)***
	DY ₋₁	-43.6	(2.47)***	-43.6	(2.47)***	-51.5	(3.95)***
	DTB ₋₁	-0.32	(1.77)*	-0.32	(1.77)*	-0.30	(2.27)**
	DINFL ₋₂	-0.13	(1.78)*	-0.13	(1.78)*	-0.10	(1.98)**
	DEXCH	-0.04	(1.44)	-0.04	(1.44)	-0.04	(1.96)*
	DGDPC	-3.07	(1.57)	-3.07	(1.57)	-4.37	(2.83)***
	D74	-1.90	(1.75)*	-1.90	(1.75)*	-2.45	(3.20)***
	R ²	0.35		0.35		0.33	
	DW	1.94		1.94		2.04	
Military Expenditure Equation	intercept	0.12	(1.83)*	0.14	(1.44)	0.13	(2.00)**
	DTB ₋₁	-0.15	(3.98)***	-0.24	(3.37)***	-0.21	(4.49)***
	DGDPC ₋₁	-0.56	(2.11)**	-1.30	(1.35)	-1.02	(1.62)
	DNG	-0.44	(4.31)***	-0.36	(2.61)***	-0.36	(3.87)***
	DTM ₋₁	0.27	(2.50)***	0.74	(1.27)	0.43	(1.14)
	DNATO	0.50	(1.42)	0.42	(0.88)	0.49	(1.58)
	DM ₋₁	-0.14	(1.22)	-0.30	(1.28)	-0.25	(1.61)
	CYP	2.42	(6.58)***	2.46	(5.22)***	2.49	(7.82)***
	R-squared	0.73		0.60		0.74	
	DW	2.00		1.75		1.78	

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

The simultaneous equation results serve to underline the findings and suggest that both the direct effect of defence spending on economic growth and the indirect effects through savings and trade balance are negative and significant (at 1% significance level). When we take into account both the direct and indirect effects of military burden we get $dG/dM = -0.026$, $dS/dM = -3.21$, $dTB/dM = -0.136$. So military burden has a negative impact on growth, savings and the trade balance.

Demand and supply models for Greece have been employed by Antonakis (1997a), whose simultaneous equation model consisted of three equations (a growth equation, a savings and a military burden one). He found a negative direct effect of defence on growth and a positive indirect effect through savings over the period 1960-1990, with the net effect being negative. In contrast, Sezgin (1998a,b) using more or less the same system of equations found a positive direct effect and a negative indirect effect through savings, with the net effect, however, being positive for the period 1958-1994.

Although these models provide a more complete picture of the defence-growth relationship by accounting for the interrelationships between the variables and the endogeneity of military expenditure, they have been criticised (Ram, 1995) for not being strongly based on theory and thus, relying on more ad-hoc justifications. But this is more than compensated for by the advantages that these models have to offer as they overcome problems of exogeneity, simultaneity and causality that may influence the defence-growth relationship if analysed in a single equation

8.5. Conclusions

This chapter has analysed the effects of defence spending on economic growth by a demand and supply SEM over the period 1960-96. A four-equation system was estimated using both single-equation methods (OLS, 2SLS) and system-equation methods (3SLS) to account for the interrelations between the variables. Findings suggest that both the direct effect of defence spending on economic growth and the indirect effects through savings and trade balance are significantly negative.

The negative direct effect of defence on growth implies that there are no positive spin-offs or externalities from the defence sector to the economy. The negative indirect effect of defence through savings supports the crowding out argument, that resources are misallocated through the growth of military burden. The negative indirect effect of military burden through the trade balance seems reasonable for a country like Greece which is a big importer of military equipment and only has a very small and underdeveloped defence industry.

Overall, the results suggest that the high military burden in Greece has been harmful to economic performance and has made a significant contribution to the backwardness of the economy and the huge problems it faces. The implications are that cuts in defence budgets in Greece would lead to improved economic performance and that if these resources were reallocated to other more productive sectors of the economy there is likely to be a “peace dividend”. The problem is that military burden also appears to be determined by security concerns and if there is no improvement in relations with Turkey it seems unlikely that significant cuts will be on the agenda. The recognition that there are clear economic, as well as security,

benefits to be gained by settling the disputes could hopefully provide a much needed incentive to move forward.

SPAIN AND PORTUGAL: BACKGROUND ANALYSIS OF THEIR ECONOMIES AND DEFENCE SPENDING

9.1. Introduction

Having analysed the economic effects of military expenditure in Greece, it would be interesting to know whether defence spending has similar effects on economic growth in the other peripheral economies of the EU that share common characteristics with Greece. The most suitable candidate countries for this analysis seem to be Spain and Portugal. All three countries (Greece, Spain and Portugal) have emerged from dictatorial rule, which in the case of the two Iberian countries, lasted for several decades and as Tsoukalis (1981) has observed “*had turned the three countries into observers of the international system*” (Tsoukalis, 1981, p.96). After more than a decade of uninterrupted growth in Western Europe, the recession of the mid-seventies also saw the collapse of the dictatorships in the three Mediterranean countries (mid-1970s). The transition towards parliamentary democracy led to internal political and economic changes and the desire for international recognition. Starting with Greece, the countries came to see membership of the European Community as a means of strengthening their economic

and political situation. When they did join their relative economic backwardness made them the poorest countries in the EU.

One important aspect of the economic development of these countries that has not attracted much interest from researchers is defence spending. This may bear some responsibility for the delayed progress of these economies, as was shown for the case of Greece. Before undertaking an empirical investigation of the defence-growth relationship in the two countries it is necessary to have some knowledge of their economic performance, their defence spending and their security concerns. A brief analysis of the Spanish and Portuguese economies as well as a descriptive comparison with Greece is presented in the rest of the chapter.

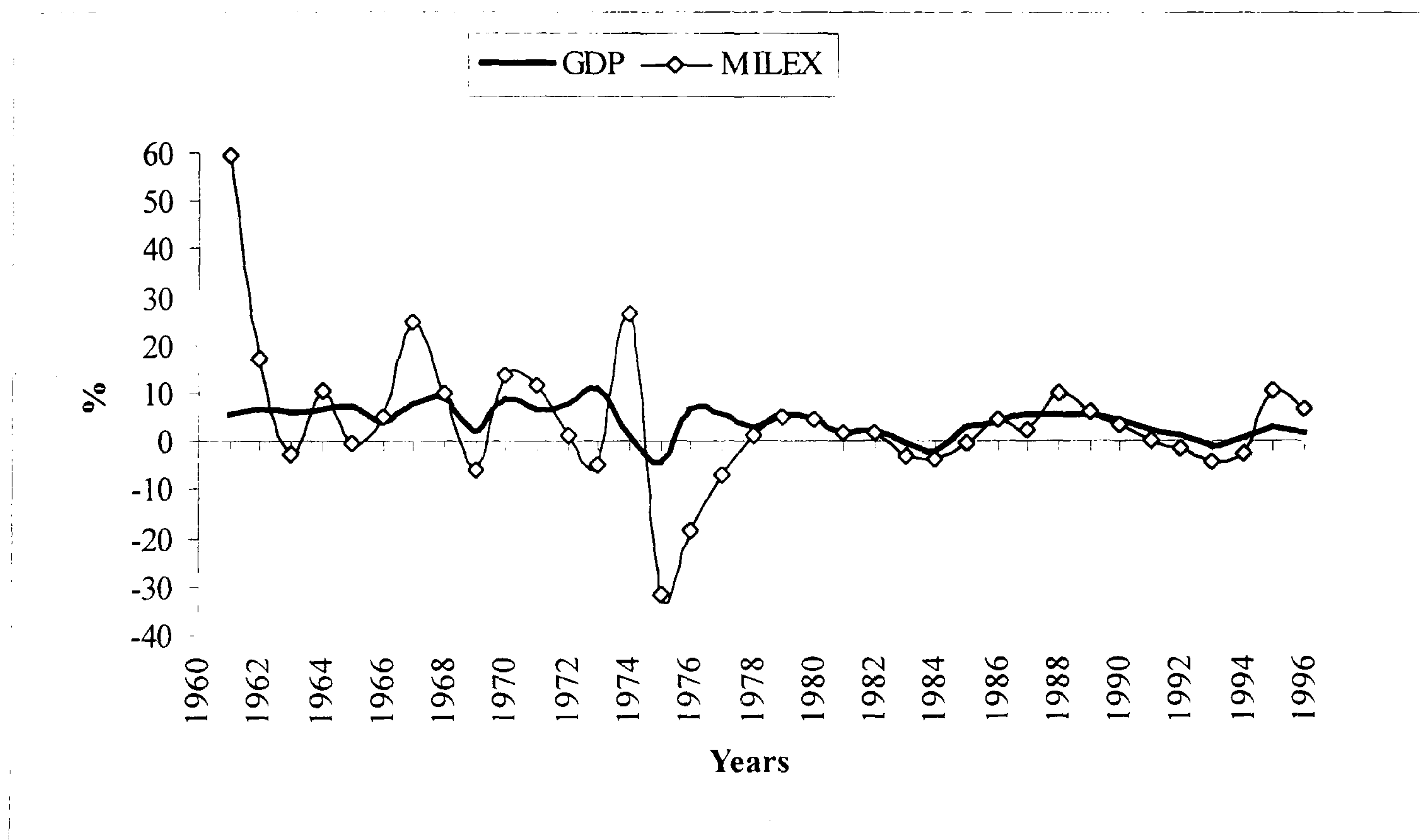
9.2. Portugal

9.2.1. Economic and Political background

Portugal was not among the group of Western countries that faced rapid industrialisation and economic growth in the 1950s. It started to open up its economy in the mid-1960s but progress was disrupted by the collapse of the Salazar and Caetano dictatorship in 1974. *“A period of austerity was broken in 1985 and the economy began to expand”*, (Cox and Furlong, 1992, p.99). The dictatorships of Salazar and his successor’s (1926-1974) were supported by the Armed Forces, the Catholic Church and the traditional bureaucracy. In contrast to Franco’s dictatorship in Spain, that completely isolated the country from the international events, Salazar-

Caetano's regime was more opened to the outside world. In 1949 Portugal became a member of the NATO alliance and its priority, during the 1950s and the 1960s, was to protect its colonies against independence movements. Economic growth during the 1950s was based on import substitution and heavy protection, but this changed gradually during the 1960s as a result of the integration movement in Western Europe, international economic changes and developments in Africa (Tsoukalis, 1981).

Figure 9.1. Real Growth of Portuguese Military Expenditure and GDP*



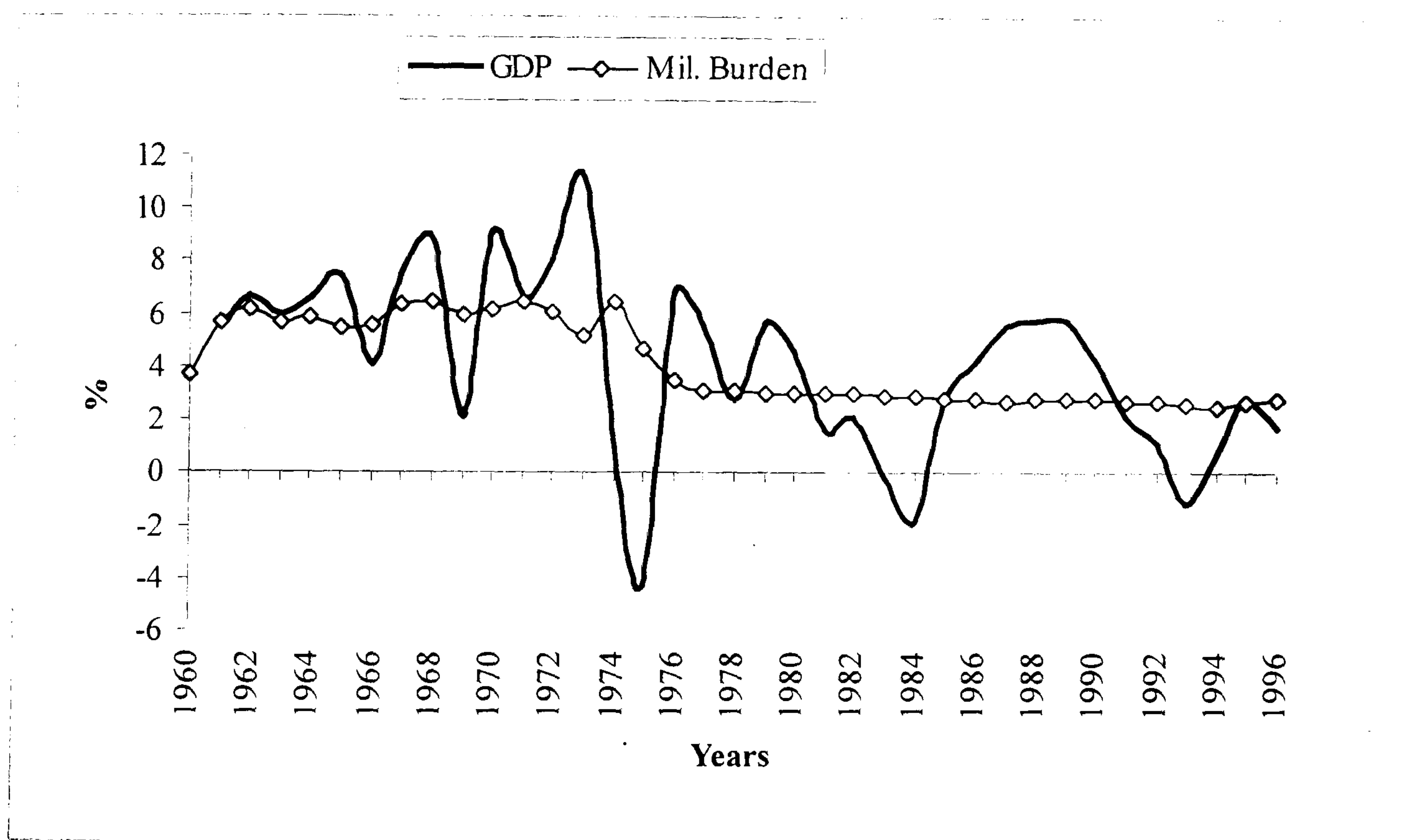
*calculated from figures in constant 1990 mn US \$

Source: SIPRI & EUROSTAT

During the 1960s, Portugal achieved a high rate of economic growth (as most of the industrialised countries of the West did) averaging 6.4% per annum with a very low

inflation rate (2.9%). During the same period, concern over losing its colonies¹ forced Portugal to keep military expenditure high at 6% of GDP with annual growth of 13.2% (see Figures 9.1. and 9.2.). When Salazar was succeeded by Caetano in 1968, further attempts to liberalise the economy and to integrate into Europe were made, but the process was very slow and the opening to Europe was not seen as a substitute for the African colonies. During this decade (the 1960s) an estimated 785,000 people left the country in search of work abroad, (Solsten, 1993).

Figure 9.2. Portuguese Military Burden and GDP Growth



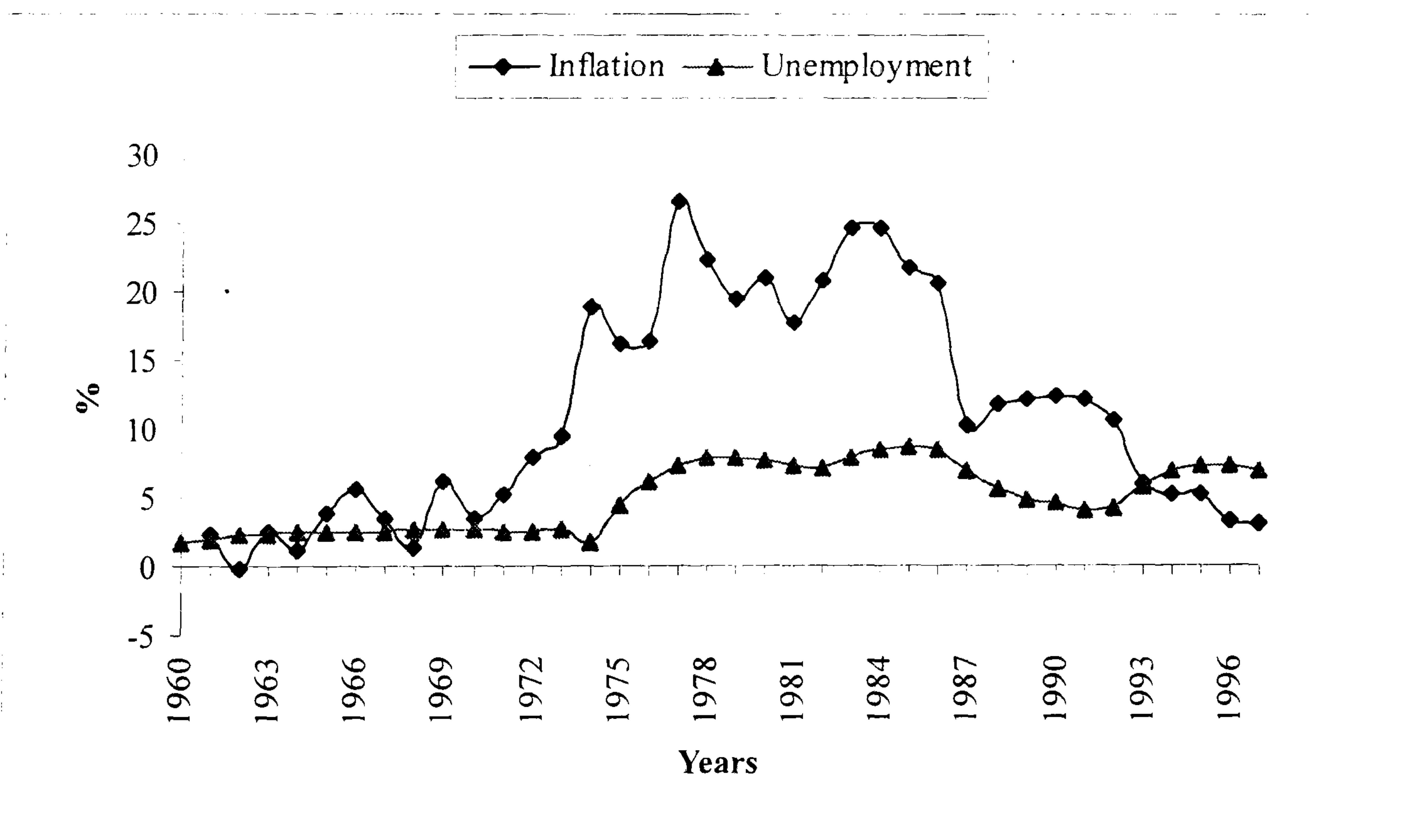
Source: SIPRI & EUROSTAT

The dictatorship collapsed in 1974 after the revolt of junior and middle ranking officers who formed a movement in favour of peaceful decolonisation². The coup ended a dictatorial regime established by Antonio De Oliveira Salazar in the late

¹ In the 1960s, guerrilla movements emerged in the Portuguese African colonies of Angola (1961-75), Mozambique (1964-1975) and Guinea-Bissau (1963-74) that aimed at liberating those territories from the last "colonial empire".

1920s and early 1930s and carried on by his successor Marcello Jodi Das Neves Caetano after 1968. A long period of social and political instability followed, with many reforms that culminated in the establishment of a Parliamentary Democracy in February 1976. An economic crisis followed, as reforms of the economy and the international crises of 1973 and 1979 impacted on the economy. Growth of GDP dropped to an average of 4.7% for the decade (which was still high) while inflation went up to 16.1% from 2.9% during the previous decade, (see Figures 9.2. and 9.3.). At the same time military burden started to decline, averaging at 4.7% of GDP for the whole decade with an average decline in military expenditure of 1.23 (see Figures 9.1. and 9.2.).

Figure 9.3. Portuguese Inflation and Unemployment Rates*



*unemployment as a percentage of civilian labour force
 Source: EUROSTAT & OECD

² Portugal had been fighting in its African colonies since the early 1960s. The wars ended and the colonies were granted independence in 1975 after the revolution.

Table 9.1. that follows gives the main economic indicators for Portugal over the period 1961-1997. Figures are presented as averages for the decades and annually for the years 1992 to 1997.

Table 9.1. Portugal: Main Economic Indicators (1961-1997)

	1961-70	1971-80	1981-90	1991-96	1992	1993	1994	1995	1996	1997
GDP growth (1990 prices)	6.4	4.7	2.9	1.4	1.8	0.3	0.8	2.3	3.0	3.2
Inflation rate (%)	2.9	16.1	17.5	7.1	10.6	6.0	5.2	5.1	3.3	3.1
Gross Invest. (% of GDP)	25.7	29.1	28.3	23.6	24.5	22.6	23.2	22.5	23.3	24.1
Gov. Debt (% of GDP)	15.4	26.2	58.3	65.4	60.7	64.3	66.7	66.4	65.6	64.1
Employment (% change)	0.2	0.1	0.2	-2.3	-1.7	-2.0	-0.9	-1.0	0.6	0.7
Cur. Balance (% of GDP)	-0.5	-2.7	-3.7	-2.4	-3.6	-2.3	-1.9	-0.3	-2.5	-2.1
Imports (% of GDP)	25.8	31.5	39.3	38.1	37.0	35.4	37.8	39	39.6	40.8
Exports (% of GDP)	21.5	21.7	30.9	30.6	28.1	27.9	30.8	33.2	33.0	34.0
Population (000s)	8731	9156	9916	9848	9833	9840	9840	9847	9866	9876

Source: EUROSTAT (Various years)

In the 1980s, the Portuguese economy (similarly to the Greek and Spanish economies) started to deteriorate. Accession to the EC, in 1986, provided structural funds and foreign investment and helped the country deal with some of the problems. Average annual growth for this decade was 2.9% but inflation increased to 17.5%. Economic pressures saw the military burden drop to 2.9% of GDP.

At the beginning of the 1990s Portuguese economy was characterised by the World Bank as an upper-middle-income economy. The 1990s saw Portugal attempting to achieve the required criteria for joining the EMU (as did Greece and Spain). In April 1992, Portugal's currency - escudo - was strong enough to be placed in the ERM of EMS. Growth rate during the period 1991-96 was only 1.45% but inflation was dramatically brought down from 17.5% during the last decade to 7.1%. This reduction in inflation was accompanied by a slight increase in unemployment (see Figure 9.3. on page 176). At the same time military burden seems to have stabilised at around 2.7% of GDP.

9.2.2. National Security Concerns and Defence Industries

Historically, Portugal has had two essential security objectives, the protection of its colonial empire and the maintenance of its status as a distinctive national entity on the Iberian Peninsula. Although a founding member of NATO in 1949, its material contribution to the alliance was only marginal for more than two decades. The main reason for this was that the armed forces were preoccupied with the fighting in Africa and the efforts to maintain the colonial empire alienated the country from the other members of the alliance. After 1974, Portugal showed more activity in NATO and the

defence of the West in response to the perceived threat represented by the Soviet Union and the Warsaw Pact.

Portugal's defence industry is small, similar in size to that of Greece. Its expansion started during the 1960s to meet the specialised requirements of the anti-guerrilla operations in Africa. However, since the end of the fighting in 1974 and the scaling back of the armed forces that followed, production capabilities have exceeded the country's needs, (Solsten, 1993). A modest level of sales abroad have helped the Ministry of Defence to keep production lines open for artillery, mortar, and small arms ammunition. But, as in Greece, private companies in Portugal are not permitted to engage in research, planning, testing, manufacturing or overhaul of equipment exclusively intended for military purposes. Only state-owned enterprises are involved in the production of bombs, missiles, torpedoes, mines, hand grenades, propellant powders and other explosives. The construction of combat aircraft, helicopters and warships was also limited to nationally owned companies, although component manufacture could be sub-contracted to private firms.

The main state defence companies include OGFE (production of uniforms and equipment), OGME (overhaul of military vehicles) and OGMA (for maintenance and repair of all aircraft, avionics, engines, communications and radar equipment of the Portuguese air force. OGMA also had some maintenance contracts for the US air force and navy equipment and to supply components to several European aircraft manufacturers. The main ordnance factory is INDEP producing mortars, artillery and mortar munitions, small arms ammunition, machine guns. Portugal's naval base,

Arsenal do Alfeite, near Lisbon has the facilities to build patrol craft, auxiliary ships and corvettes but not large modern vessels which are constructed abroad.

9.3. Spain

9.3.1. Economic and Political background

Spain's transition from a long period of dictatorship (the Franco regime) to parliamentary democracy (monarchy) took place in 1975, after Franco's death. The international isolation, autarky and stagnation that characterised Spain during the dictatorship dramatically changed after Spain acceded to the EC in 1986 (Story, 1995).

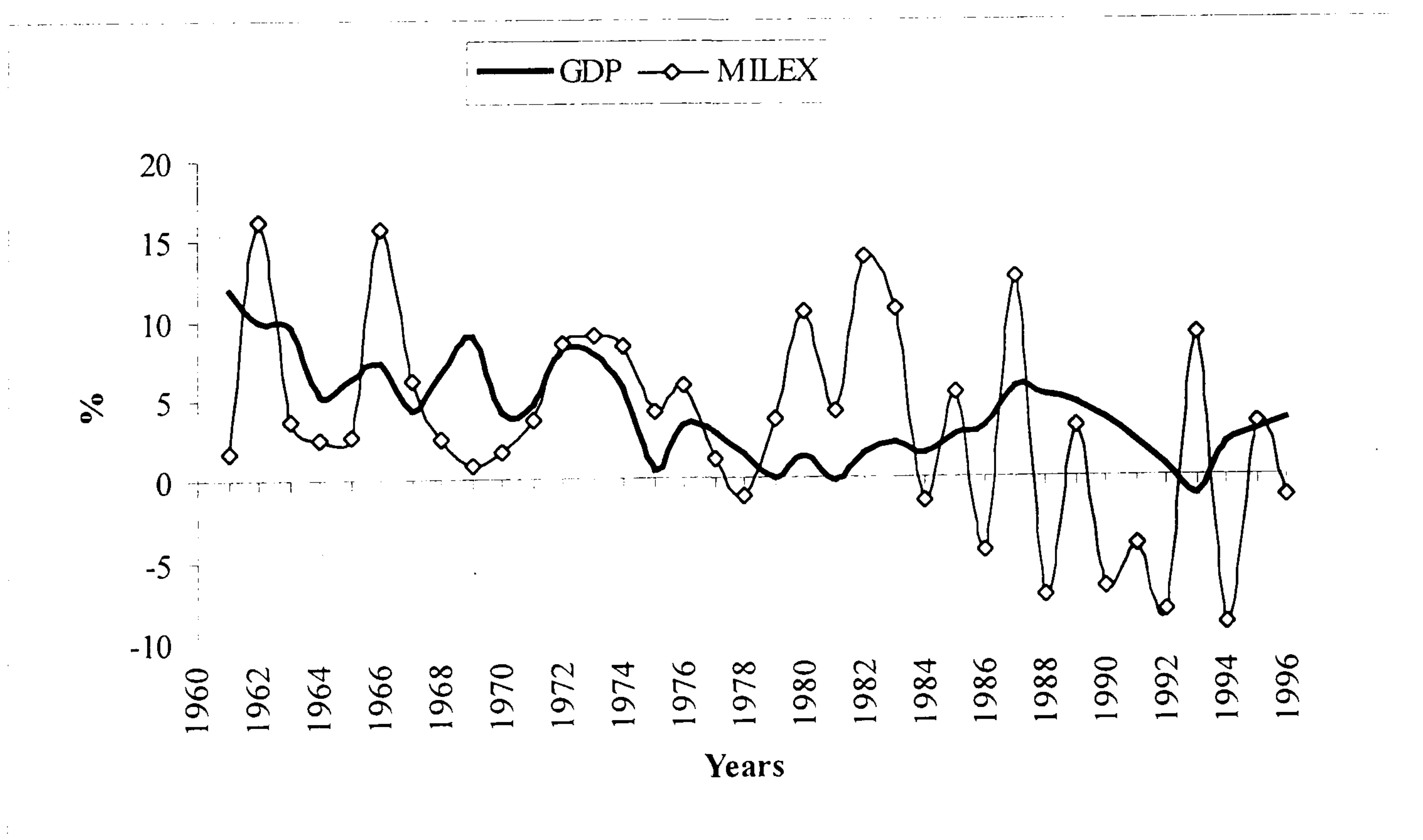
In particular, as Salmon (1995) notes "*membership of the EC altered the pattern of external relationships and redefined the position of Spain in the world from a protected national economy to an economy embedded in one of the world's core trading regions and within the corporate space of multinational companies*" (Salmon, 1995, p.67).

In the post-war period, Franco had continued the traditional Spanish strategy of seeking to protect domestic employment and profits behind high tariff walls both for manufactured goods and agriculture. During the 1940s and 1950s the Spanish economy grew only fitfully, and suffered from the constraints of a shortage of raw materials, a lack of technological innovation, and the persistence of a large, backward, agricultural sector. From 1951, Spain's importance for American military strategy in Europe led to gradual improvement in its international relations. Before 1960s, Spanish economy was

one of the most underdeveloped in Western Europe and it was sometimes characterised as a Third World economy.

Economic strategy radically changed in 1959 when Spain adopted the Stabilisation Plan supported by the IMF and the US, which marked the beginning of an outward-looking industrialisation policy. The main objectives of this Plan were economic growth through encouragement for foreign investment, limited deregulation of capital markets and a steady increase in raw materials. The period 1961 to 1970 was characterised by high economic growth, averaging 7.3% (see Table 9.2. on page 184 and Figure 9.4. below), with inflation at 6.5% per annum (more than Greece and Portugal).

Figure 9.4. Real Growth of Spanish Military Expenditure and GDP*

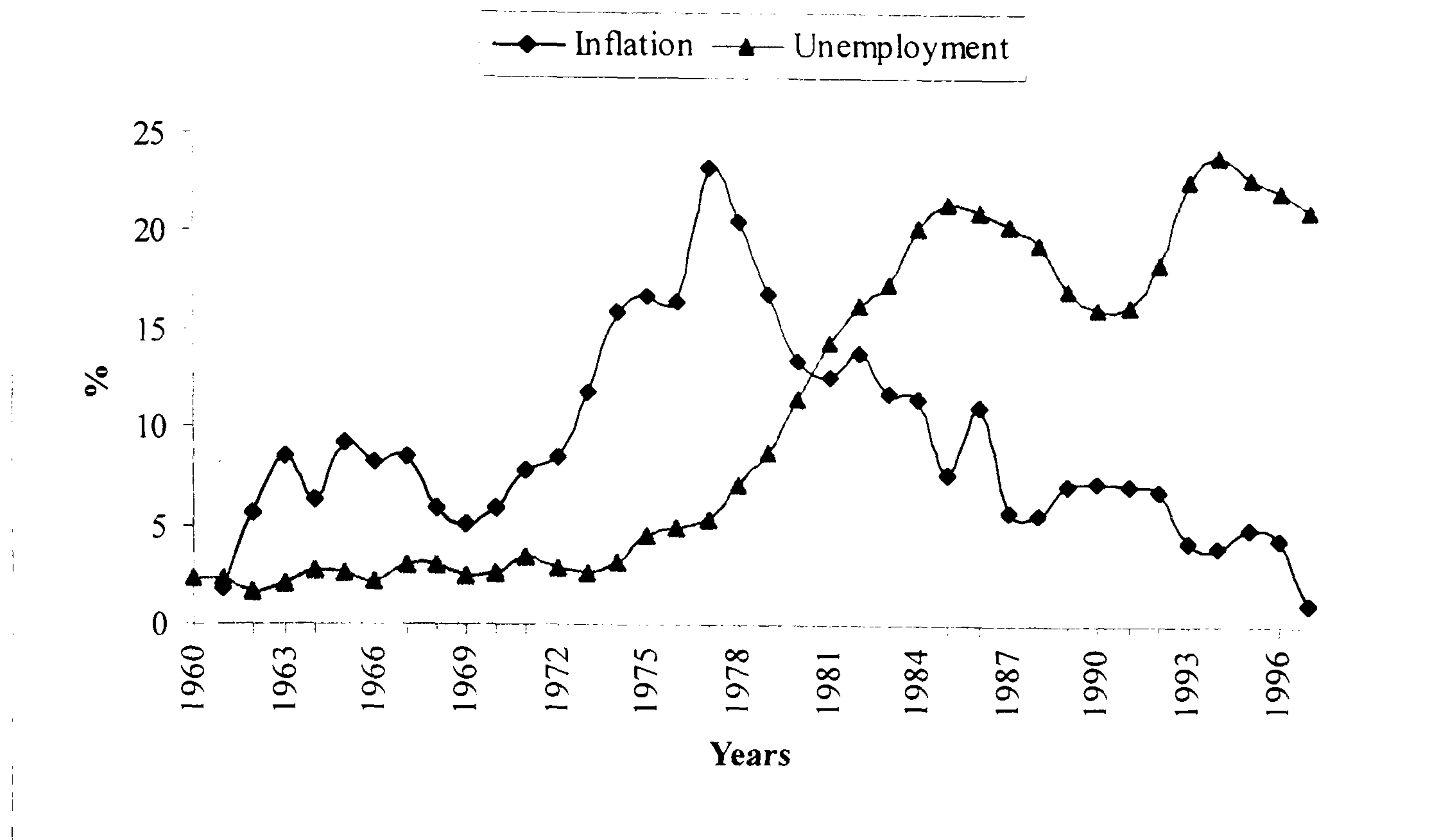


*Calculated from figures in constant 1990 mn US \$
 Source: SIPRI and EUROSTAT

The political transition of the 1970s coincided with the international energy crisis to which Spain was particularly vulnerable because of its dependence on imported fuels (Cox and Furlong, 1992). Also, the transition from Franco's rule to the constitutional monarchy (1978) saw a decision phase (1975-1978) during which the domestic dimension of politics played a primordial role, as the "*forces of freedom in Spain*" negotiated the new constitutional compromise (Eaton, 1981). During the 1970s economic expansion was replaced by recession, stagnation, high unemployment and inflation (See Figure 9.5). Growth was less than half the growth of the previous decade at 3.5% with a period of stagnation in 1979 and 1980.

Military expenditure during this period was growing at an average annual rate of 5.4% while military burden was kept at low levels (1.7% of GDP) compared to the high levels of Greece and Portugal. The Socialist government of Gonzalez Marquez that came to power in 1982 (the first government after Franco with absolute parliamentary majority) lowered inflation and promoted economic modernisation. While in power (1982-1986) this government faced three imperatives relating to economic policy: to win over business confidence while retaining the government's autonomy to impose unpopular measures, to restructure loss-making industries and to shift to export-led growth. This required assiduous cultivation of leading Western governments and welcoming Foreign Direct Investment as Solsten & Meditz (1998) mention.

Figure 9.5. Spanish Inflation and Unemployment Rates*



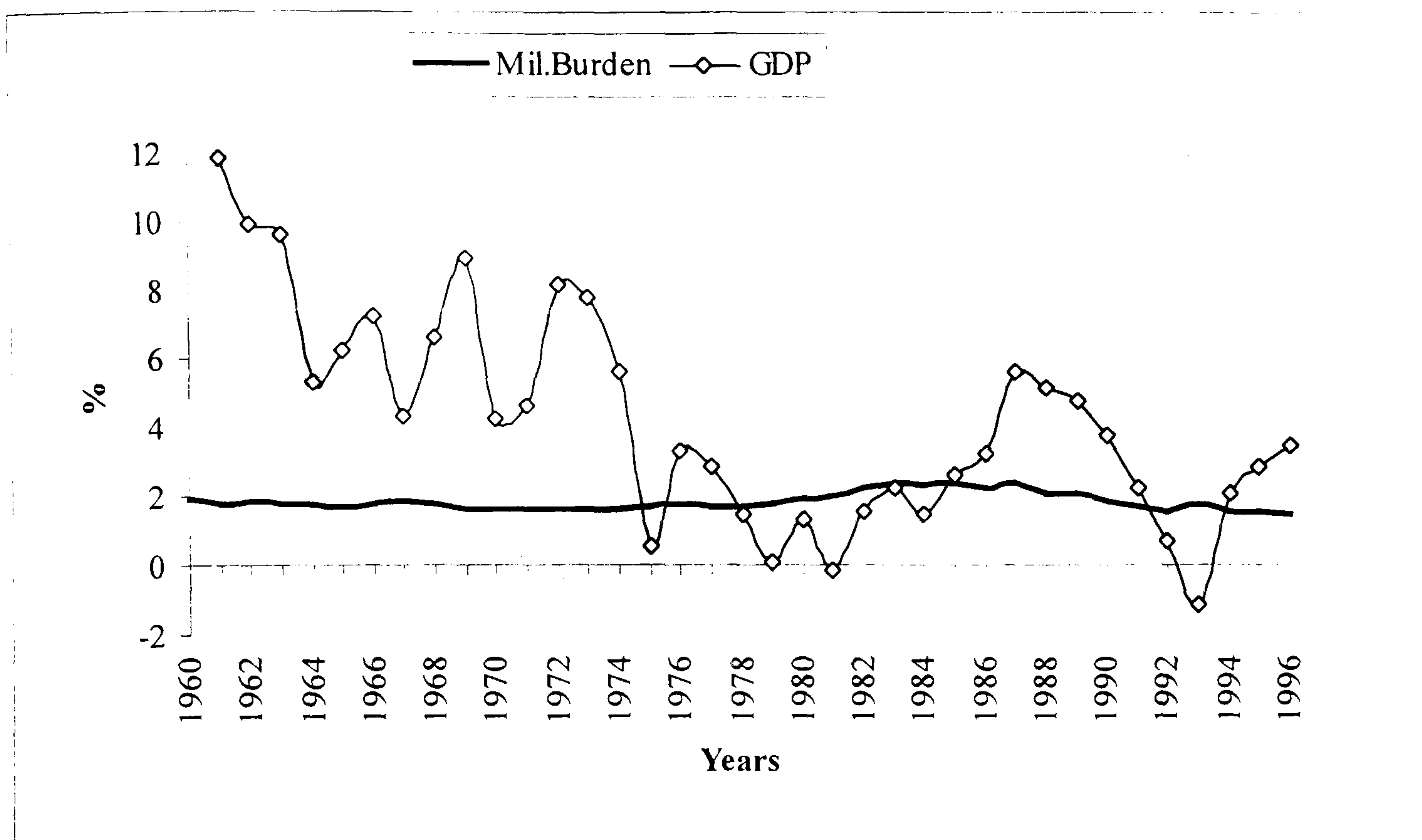
*unemployment as a percentage of the civilian labour force
Source: EUROSTAT & OECD

Table 9.2.
Spain: Main Economic Indicators (1961-1997)

	1961-70	1971-80	1981-90	1991-96	1992	1993	1994	1995	1996	1997
GDP growth (1990 prices)	7.3	3.5	3.0	1.5	0.7	-1.2	2.1	2.8	2.2	2.8
Inflation rate (%)	6.5	15.1	9.4	5.3	6.9	4.3	4.0	4.9	4.4	1.1
Gross Invest. (% of GDP)	24.2	24.4	21.4	21.0	21.8	19.8	19.7	20.6	20.3	19.8
Gov. Debt (% of GDP)	13.1	14.3	38.3	58.9	48.3	60.5	63.0	65.7	69.6	68.1
Employment (% change)	0.6	-0.6	0.8	-0.9	-1.5	-3.0	-0.5	1.7	1.4	1.9
Cur. Balance (% of GDP)	-1.3	-0.8	-1.1	-1.4	-3.6	-1.0	-1.3	0.4	0.7	1.0
Imports (% of GDP)	12.7	16.1	20.2	21.7	20.4	20.0	22.2	23.3	24.0	25.6
Exports (% of GDP)	9.9	14.5	19.6	20.9	16.7	16.2	16.8	16.5	15.8	15.8
Population (000s)	32330	35786	38402	39107	39008	39086	39150	39210	39270	39323

Source: EUROSTAT (Various years)

Figure 9.6. Spanish Military Burden and GDP Growth



Source: SIPRI & EUROSTAT

When Spain became a member of the EC in 1986, it did not experience any marked deterioration in its economic performance, as Greece and Portugal did. Actually, in the second half of the 1980s, the economy experienced growth and foreign capital investment that were the highest in Europe. But unemployment was still very high and the underground economy was very developed. In 1985 an estimated 18% of the labour force was working in the shadow economy. Growth for the decade averaged 3% (0.5% less than the previous decade) and inflation instead of increasing (as with Greece and Portugal) fell to 9.4%, almost 6% less than the previous decade. Military burden increased slightly to 2.2%, which was still considerably lower than that of the two other countries. In June 1989, the Spanish peseta joined the EC Exchange Rate Mechanism (ERM) in a move designed to hold down the peseta and thereby set the measure for future wage negotiations (Story, 1995, p.47). The period 1991-96 saw lower growth (1.5%), lower inflation (5.3%) and a lower military burden (1.6% of GDP) but higher

unemployment. Growth petered out in the early 1990s as Spain accompanied its European neighbours into recession slowly emerging from it in 1994. Table 9.2. presents the main economic indicators for Spain as averages for the decades and annually for the years 1992-1997.

9.3.2. National Security Concerns and Defence Industry

One of Spain's major foreign policy objectives since the advent of democracy has been to increase its influence in Latin America. Spain has a special interest in this area because of historical ties and a common linguistic, cultural and religious heritage. In the post-Franco years, economic investment and diplomatic initiatives were added to the more nostalgic links between Spain and its former colonies (Solsten & Meditz, 1998).

When war broke out between Britain and Argentina over the Falkland islands (Malvinas) in the spring 1982, Spain supported Argentina's claim to the islands. Also, Spain took active part in the Contadora group, an association of Latin American republics seeking peaceful solutions to the bloody struggles in El Salvador, Guatemala and Nicaragua. Spain's long-established policy of neutrality ended with its conditional accession to NATO in 1982 which was confirmed by referendum in 1986. Defence spending remained well below the average for the alliance since then.

As far as the Spanish defence industry is concerned it is of an average technological content, however, definitely more advanced and developed than the defence industries in Greece and Portugal. The Spanish military industry became progressively more open to foreign influence after the 1953 Spanish-US Treaty that broke the political isolation of the country. Breaking the isolation under the Franco regime meant that Spanish

companies could absorb new foreign technology and eventually participate in international arms projects. But this Treaty (1953) on the one hand was beneficial to Spain, through the presence of foreign capital and the participation in transnational arms programmes, but on the other hand, was harmful for the development of an indigenous arms industry as Spain relied on the large number of American military equipment given to Spain either as grants or as subsidised sales. Reliance on American equipment and lack of effort to develop a domestic defence industry continued throughout the 1960s and until the late 1970s after which the situation changed. Starting from the late 1970s until the first half of the 1980s, defence production in Spain was highly developed due to three important production programmes³ that gave life to the almost dying firms.

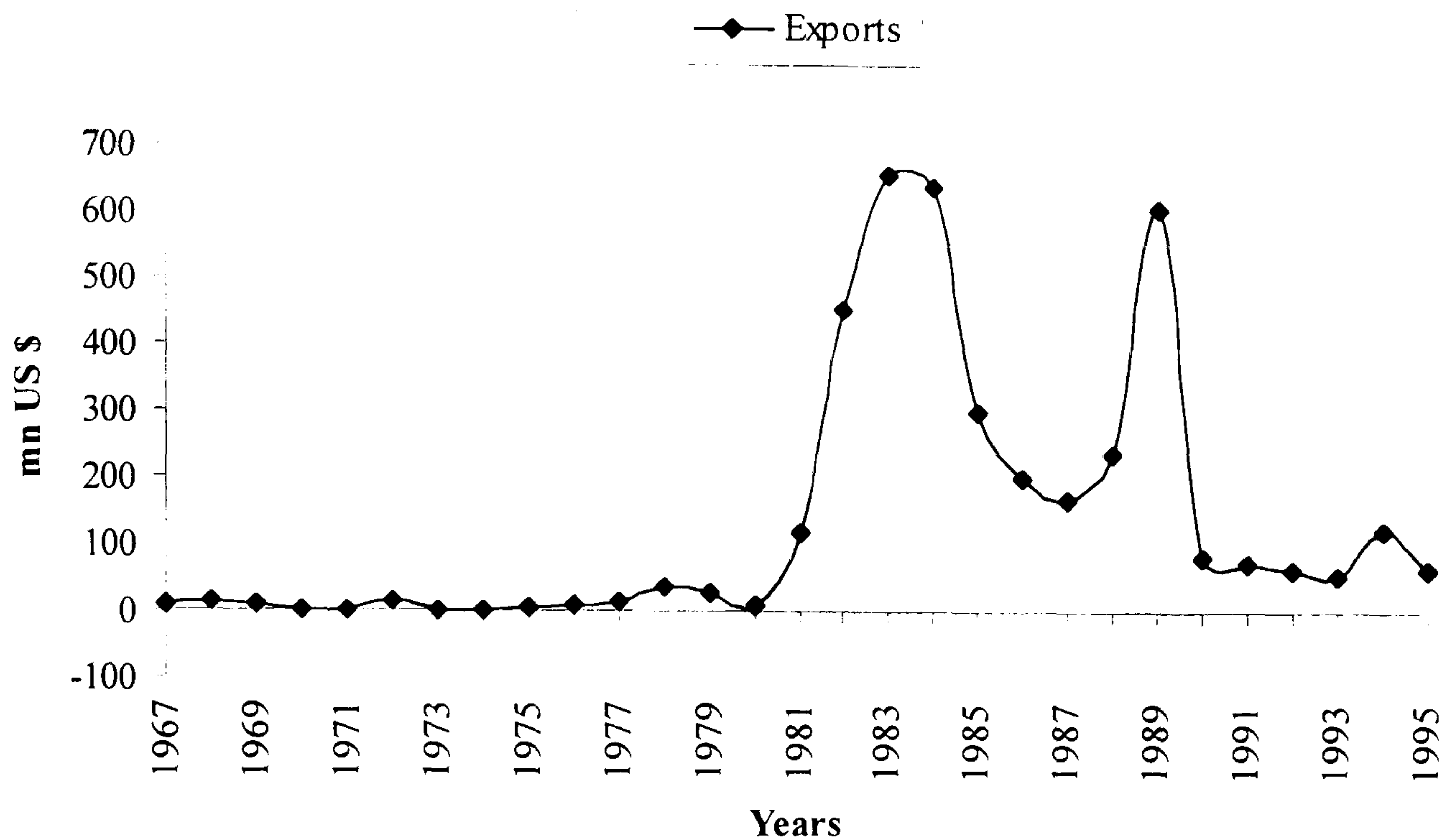
In the 1980s, five companies (all part of the public holding Instituto Nacional de Industria) were responsible for most of the military production which was carried out by public firms. The Instituto Nacional de Industria also includes a 'Defence Division' consisting of three firms:

- a) Construcciones Aeronauticas, SA (aerospace firm)
- b) Empresa Nacional Bazan de Construcciones Navales Militares (military shipyards)
- c) Empresa Nacional Santa Barbara de Construcciones Militares (arms conglomerate for all sort of munitions, firearms and artillery).

Two other public firms which are, however, outside the Defence Division are ENASA (lorry and trucks manufacturer) and INISEL (electronics).

³ The three production programmes were: a) in aeronautics (the construction under licence of 70 Northrop's F-5 contracted to CASA in 1965), b) in shipbuilding (the construction of five frigates under American licence and two submarines under French licence) and c) in land weapons (the construction of 280 tanks under French licence), Mollas-Gallard, (1992)

Figure 9.7. Spanish Exports of Major Weapons to Third World*



*in constant 1990 US \$

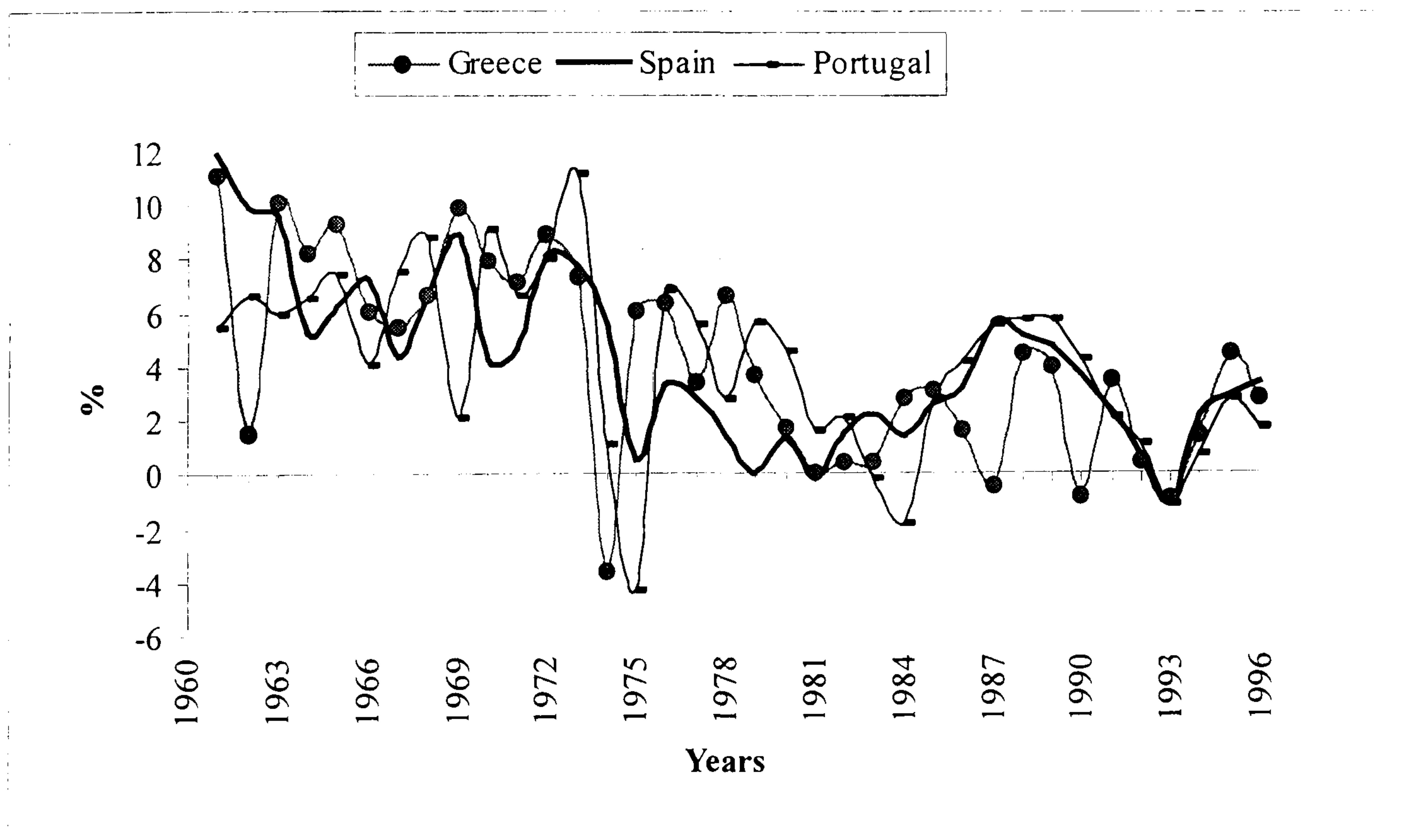
Source: SIPRI

As in the case of Greece and Portugal, the private sector plays a secondary role in military production, manufacturing mostly light weaponry, ammunition, sub-systems and components. In the early 1980s, Spanish defence industries were very successful in arms exports (see Figure 9.7.) mainly because of the relatively small scale of Spain's own military orders. By 1987, it had risen to eighth rank as a world exporter with a number of clients in the Middle East and Latin America. But this optimistic sign changed after the changes in Eastern Europe in the late 1980s. After 1988, Spain enforced sales embargoes against countries accused of human rights violations (S.Africa, Chile, Paraguay), Warsaw Pact and other communist countries as well as active belligerents (Iran, Iraq), (Mollas-Gallard, 1992). However, Solsten & Meditz (1998) point out that the Spanish press has often reported violations of these controls.

9.4. A Comparison between Greece, Portugal and Spain

After the brief analysis of the Portuguese and Spanish economies, one can easily note many similarities with Greece as far as their economic performance is concerned but, at the same time some differences as far as the pattern of their military expenditure is concerned. Looking at Figure 9.8. that presents the real growth of GDP for the three countries, it is obvious that Greece and Portugal move in a more similar pattern than that of Spain which performed slightly better during the period examined.

Figure 9.8. Real Growth of GDP for Greece, Portugal and Spain*



*calculated from figures in 1990 mn US \$

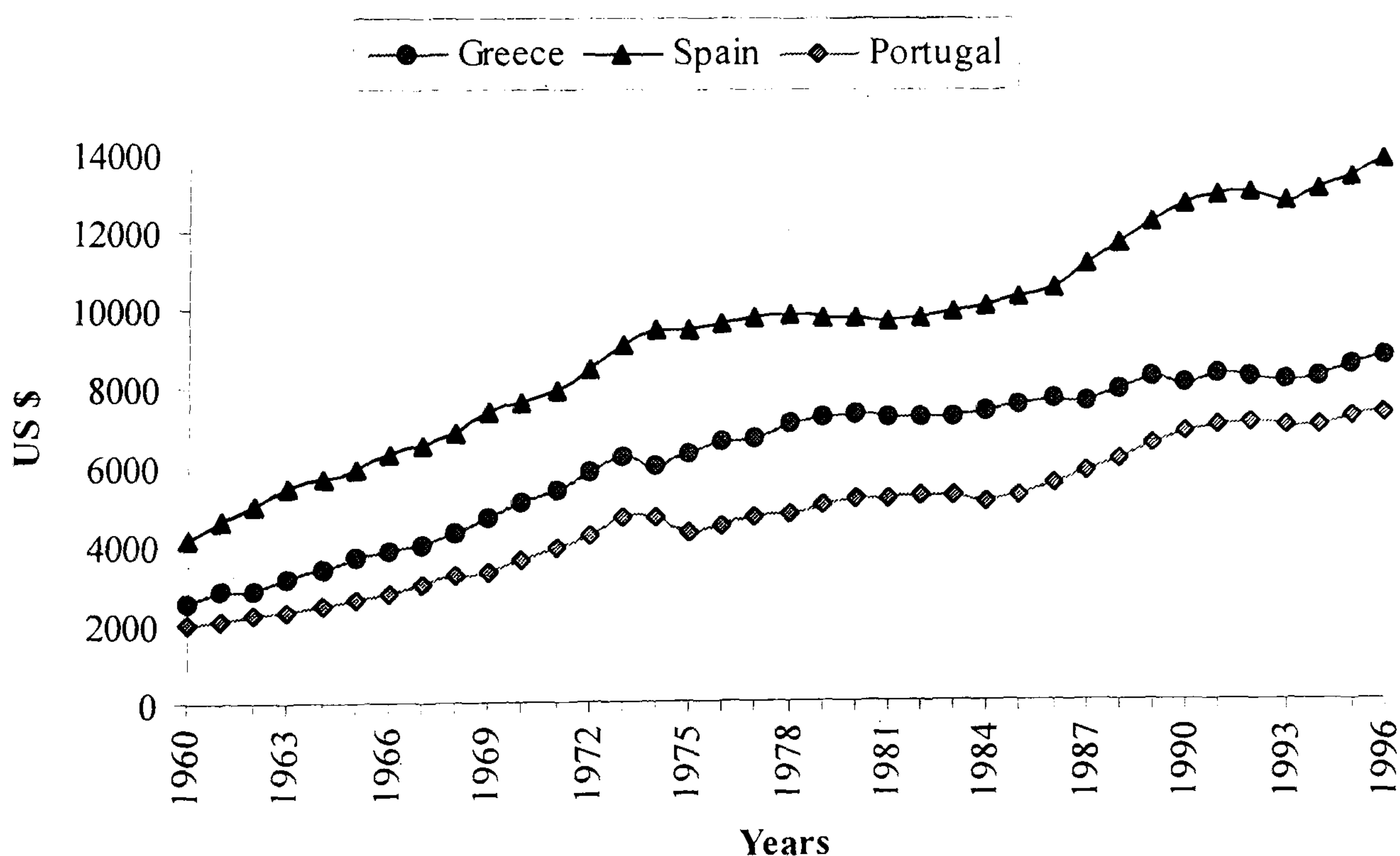
Source: EUROSTAT

The depression of the early 1970s which coincided with the collapse of the dictatorships in all three countries (for Greece these coincided with the Turkish invasion of Cyprus as well) is reflected in the negative growth of GDP, reaching at around -4% for Greece and Portugal in 1974 and 1975, respectively, while Spain managed to avoid the “below zero” rate. The Greek economy was in crisis more often than the two other countries (in

1981-83, 1987 and 1990) while all three countries reached a crisis in 1993. Among the three economies, Spain seems to have performed better. In terms of social indicators, for example, GDP per capita is higher in Spain with Greece and Portugal following, if GDP per capita is taken in constant 1990 mn US \$ (see Figure 9.9.). But as it can be seen from Figure 9.10., if GDP per capita is taken in Purchasing Power Parity (PPP), then the Portuguese GDP per capita is higher than Greek after 1990.

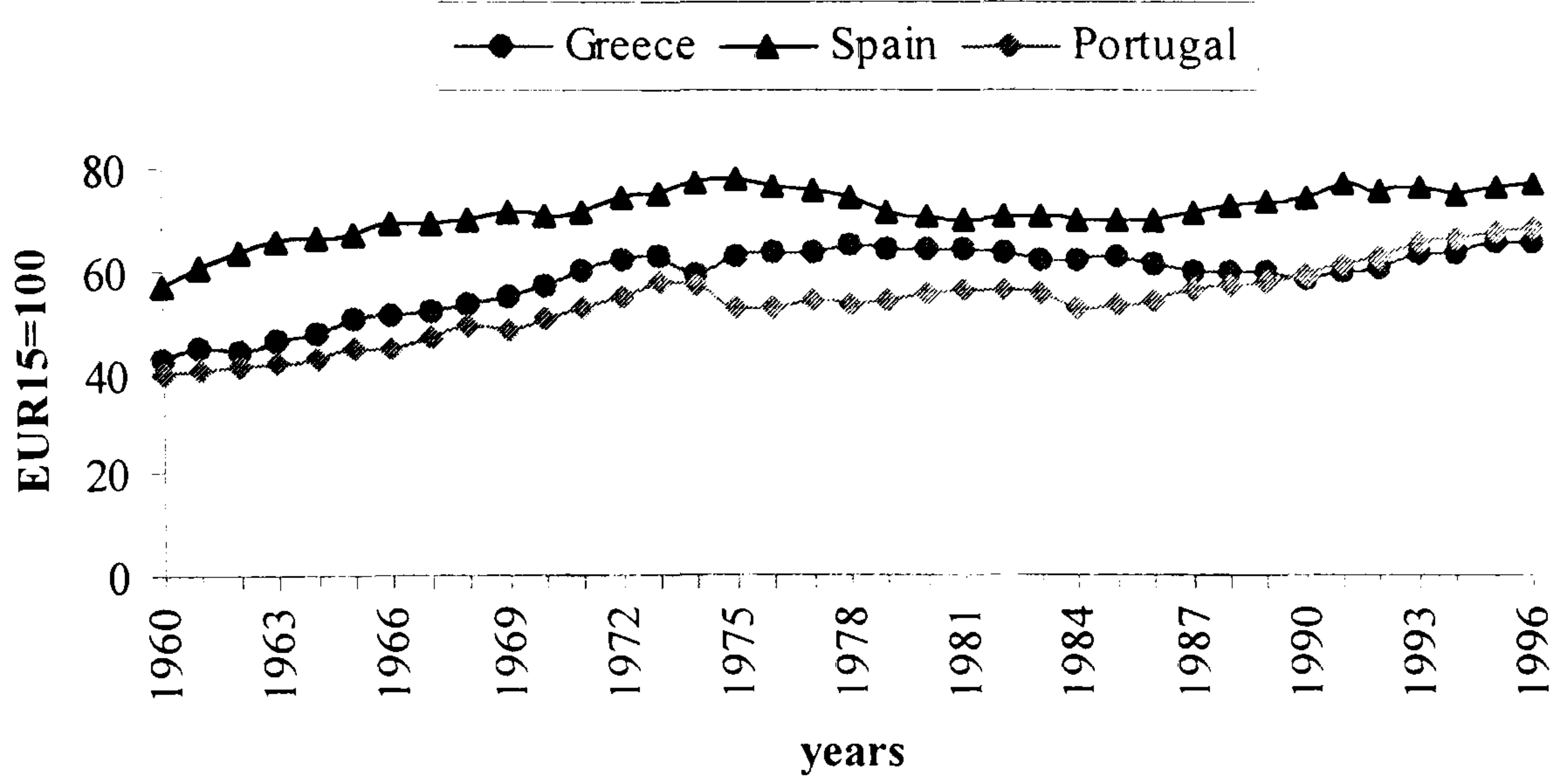
As far as inflation is concerned (see Figure 9.11), one could say that the pattern is quite similar for the three economies which all faced low inflation rates until the early 1970s, but high rates since then, with Spain having the lowest inflation rate among the three after the early 1980s. But this is not the case as far as the unemployment rate is concerned with Spain having the highest rates of unemployment from the beginning of the 1980s (see Figure 9.12).

Figure 9.9. GDP per capita in 1990 US \$



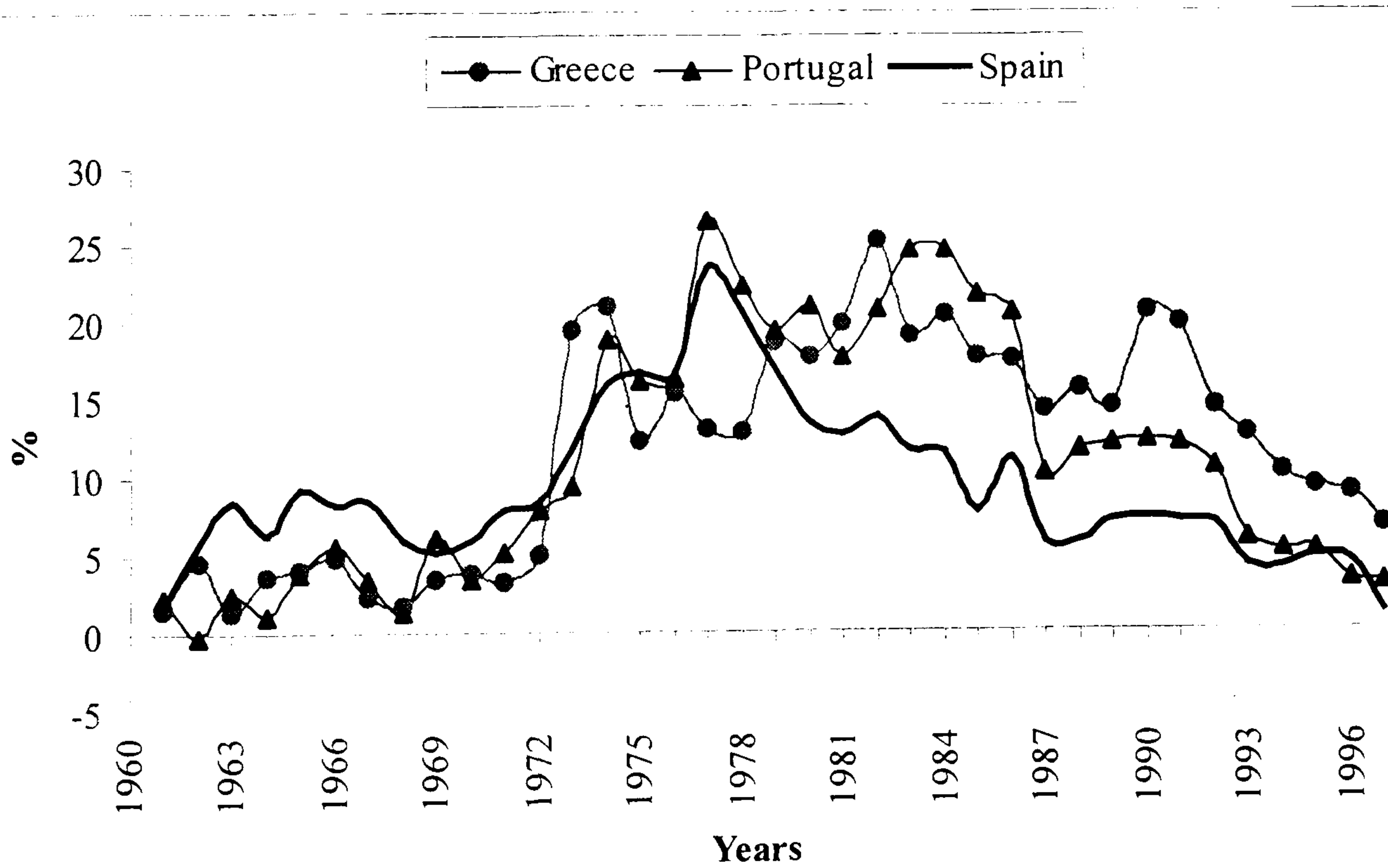
Source: EUROSTAT

Figure 9.10. GDP per capita in PPP (EUR15=100)



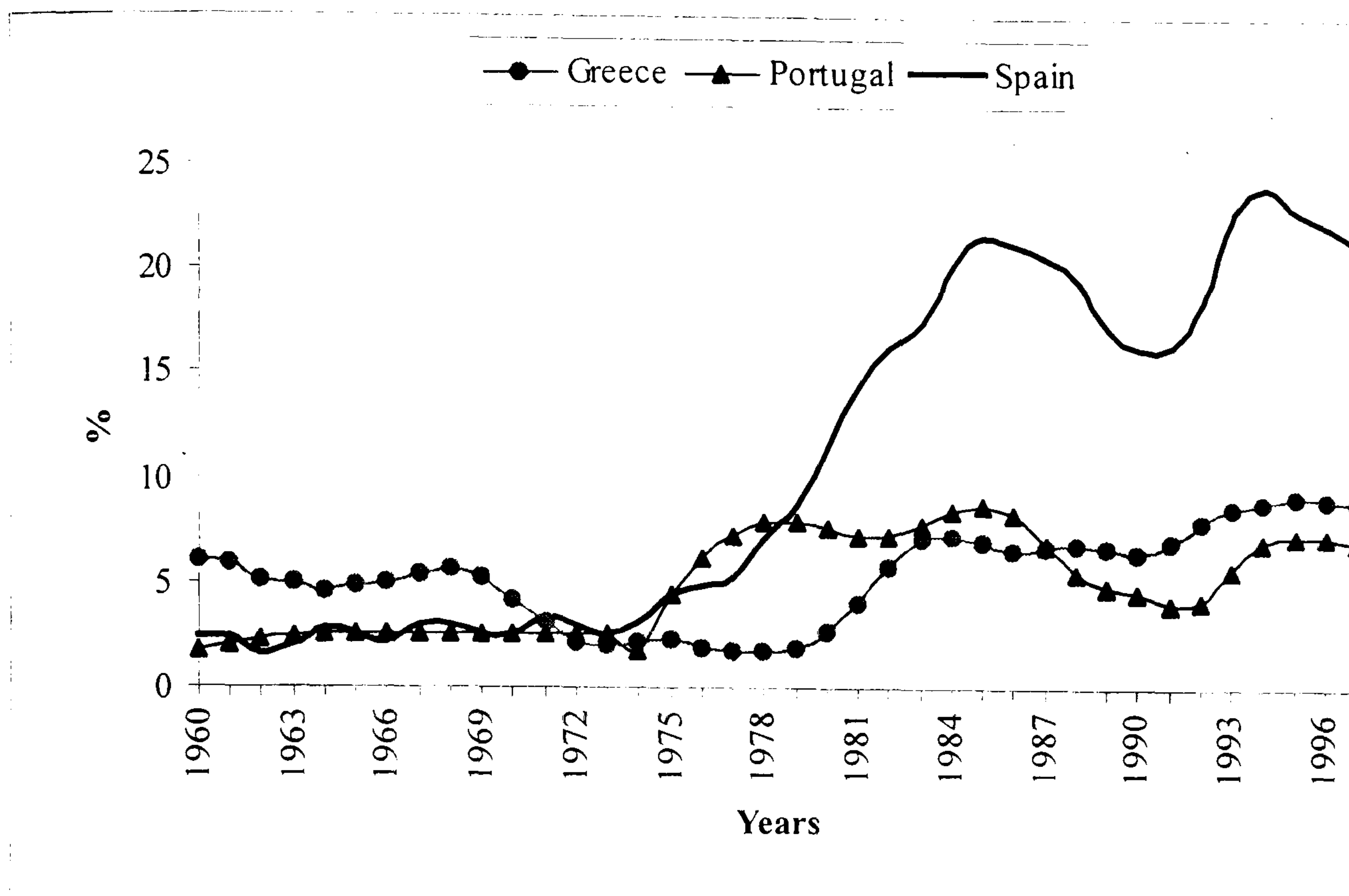
Source: EUROSTAT

Figure 9.11. Inflation Rate for Greece, Portugal, Spain



Source: EUROSTAT

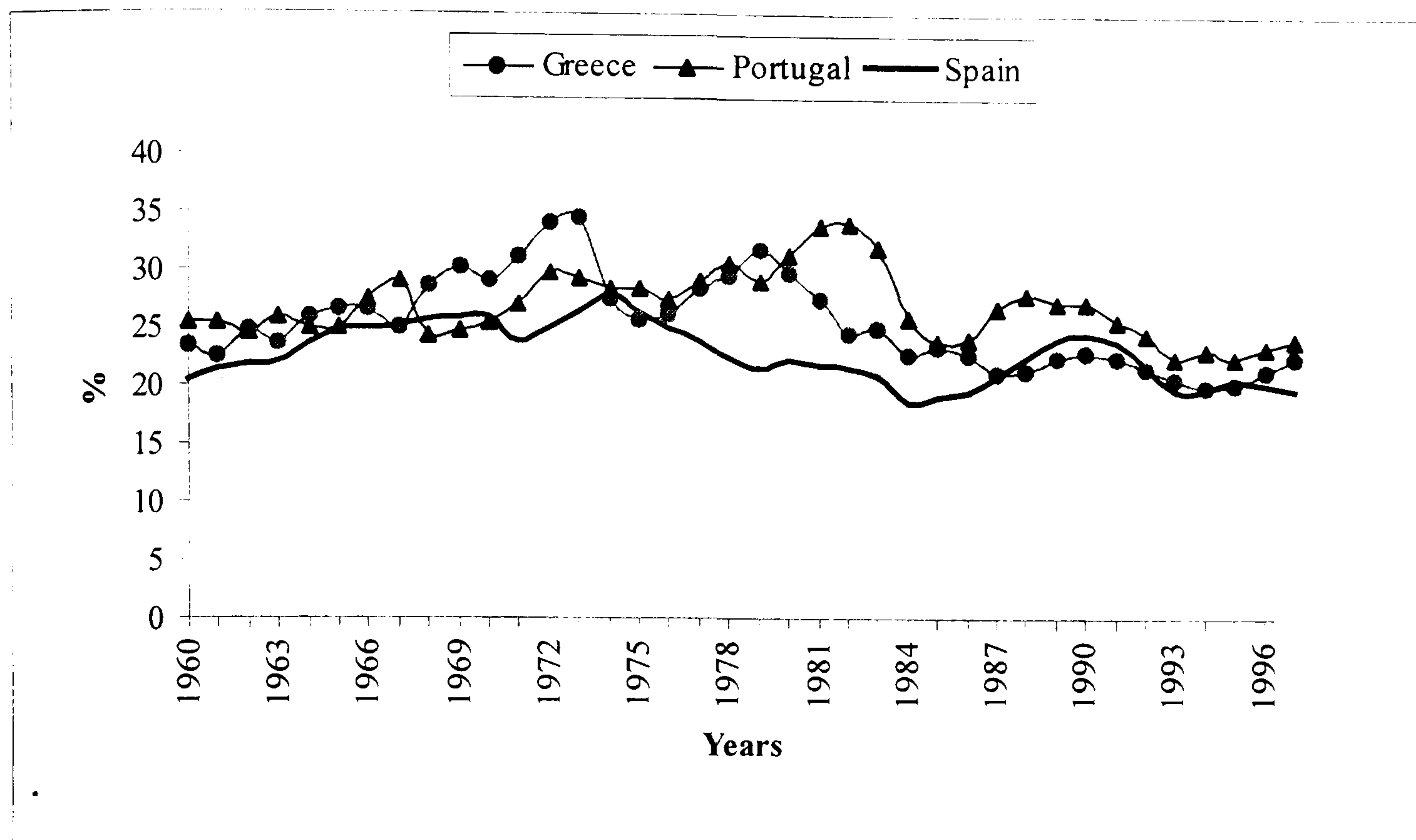
Figure 9.12. Unemployment Rate for Greece, Portugal and Spain*



*percentage of civilian labour force
Source: OECD

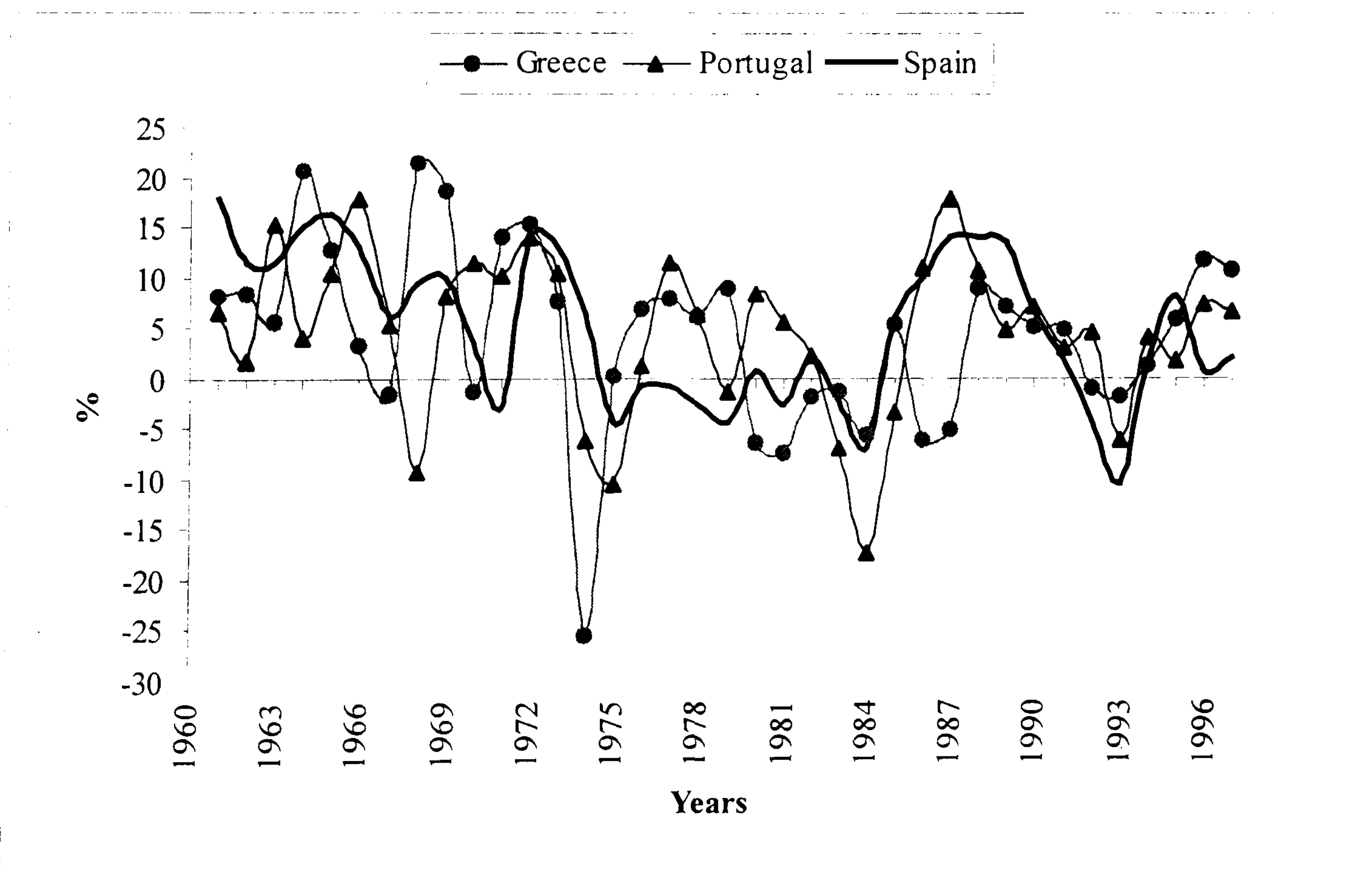
Looking at the pattern of investment as a percentage of GDP (Figure 9.13.) one can note a very similar behaviour for all three countries with only Spain having a relatively smaller share than that of Greece and Portugal for the period starting at mid-1970s to mid-1980s. In terms of growth rates of investment (Figure 9.14.), 1974 was a bad year for Greece as the annual percentage change in investment dropped by 30% during that year, while this drop was less dramatic for Portugal and Spain a year later (1975). Investment had negative growth rates in all countries in 1984 and 1993.

Figure 9.13. Investment as a percentage of GDP for Greece, Portugal, Spain



Source: EUROSTAT

Figure 9.14. Growth rate of Investment in Greece, Portugal, Spain*

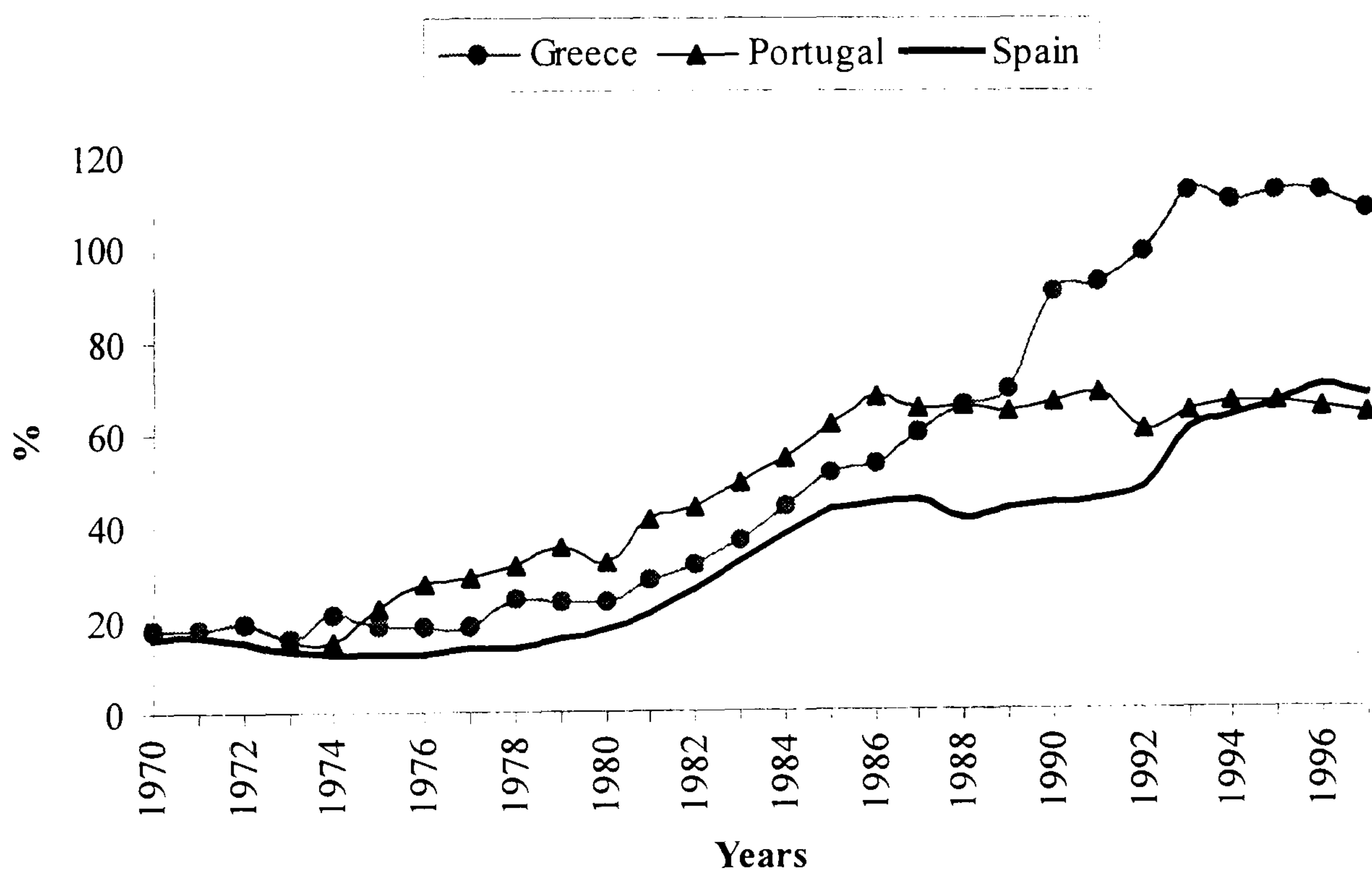


*calculated from figures in 1990 mn US \$

Source: EUROSTAT

Another important economic characteristic to be considered is the gross national debt of the three countries (see Figure 9.15). In the early 1970s it was quite low for all three countries at around 20% of GDP. After 1975, slight increases are observed only in the case of Greece and Portugal while, after the early 1980s, for all three countries. What is most interesting though, is the dramatic increase in the Greek debt after 1988 which reached very high levels that remained high until 1997 (above 100% of GDP). Portugal, on the other hand, used to have higher debt than Greece prior to 1988 but managed to reduce it substantially, achieving in 1995 a lower debt than Spain, which had the lowest debt among the three for the period prior to 1995.

Figure 9.15. Consolidated Gross Debt for Greece, Portugal and Spain*

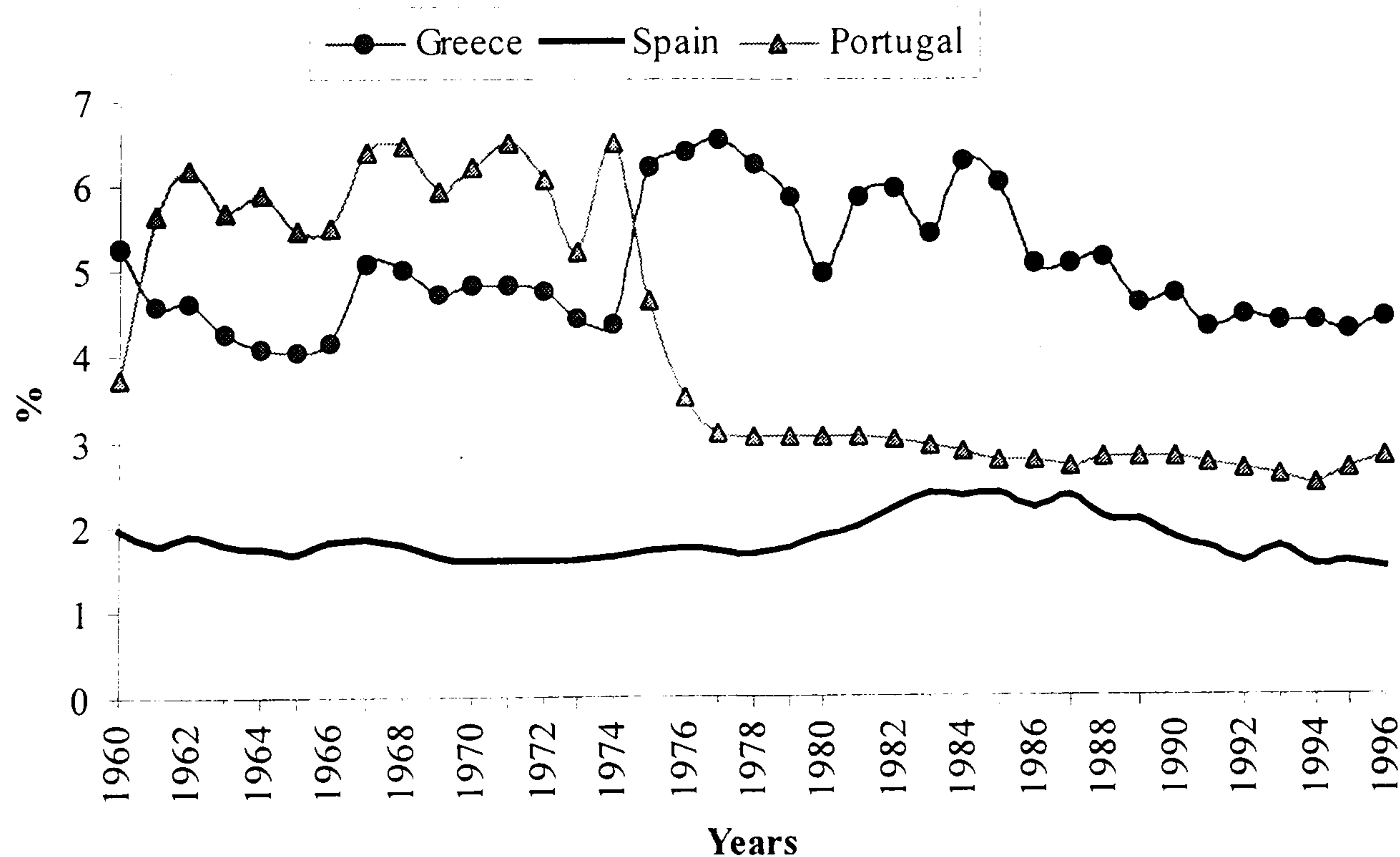


*percentage of GDP
 Source: EUROSTAT

Although economic indicators seem to move quite closely in all three countries, this is not the case for their military expenditure. Spain had throughout the period the lowest military burden among the three countries, and it remained stable at around 2% of GDP,

with a slight increase in the 1980s (due to the development of the arms industry and the expansion of production). But when it comes to Portugal and Greece, things are quite different. Setting 1974 as the critical year for both countries, as can be seen from Figure 9.16., Portugal had a high military burden (higher than Greece) for the years prior to 1974 and after that a dramatically decreased one. Exactly the opposite pattern is observed for Greece that before 1974 had a lower military burden compared to the years after 1974. The reduction of the Portuguese military burden after 1974 was attributed to the end of the dictatorship but most importantly to the end of the Colonial Empire. For Greece the Turkish invasion of Cyprus in 1974 marked a huge increase in military burden which has remained high since then due to continuous disagreements and conflicts with the neighbouring country.

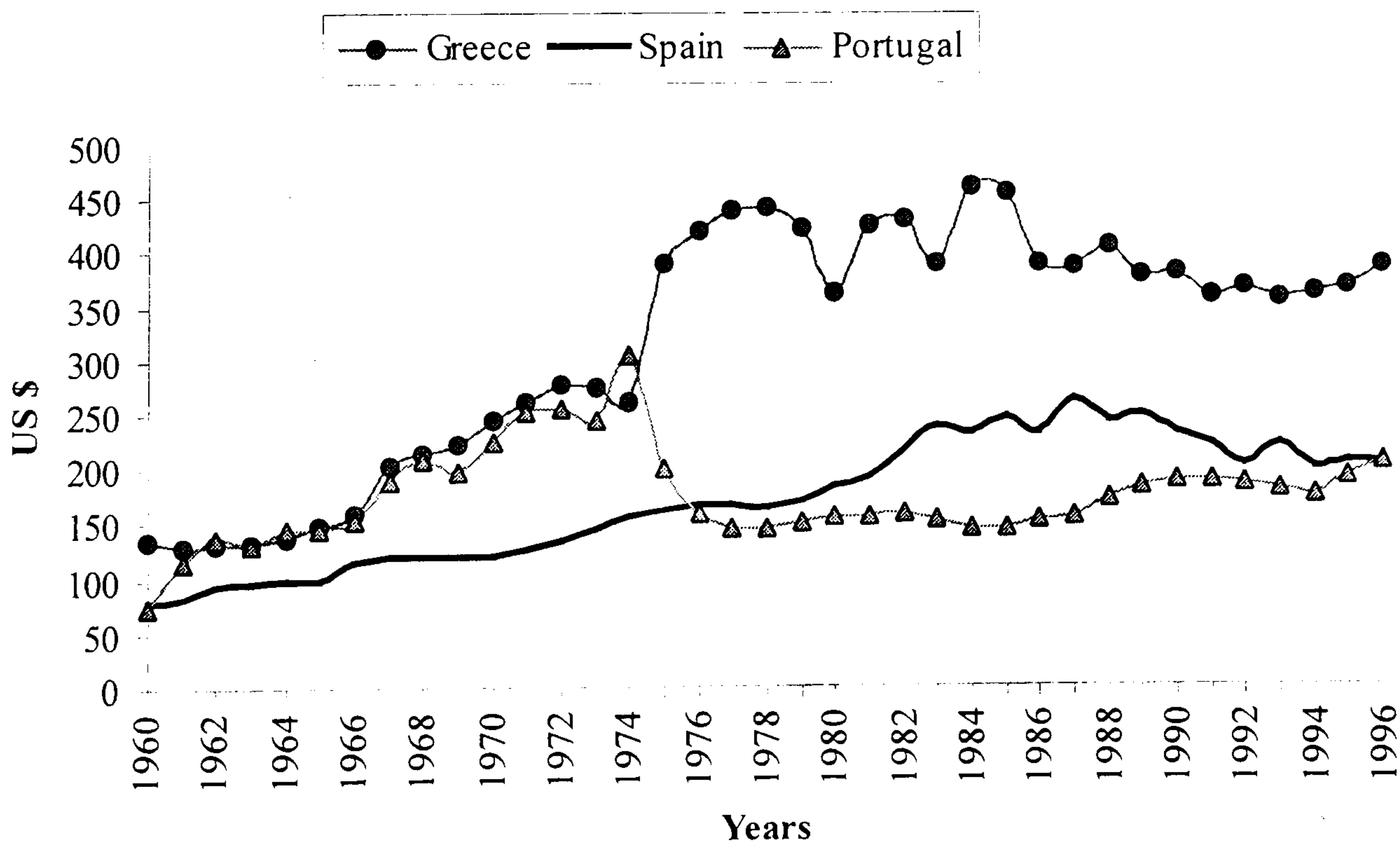
Figure 9.16. Military Burden for Greece, Portugal and Spain



Source: SIPRI

Looking at figure 9.17., an increased level of per capita military expenditure is observed for Greece after 1974. In contrast, Portugal after 1974 experienced a reduced level of per capita spending for the same reasons reported previously, when the military burden was under pressure (Portugal did not have to fight colonian wars anymore while Greece was facing the Turkish threat). Spain, on the other hand, has had the highest level of military expenditure among the three (see Figure 9.18. that presents military expenditure in 1990 mn US \$). With a population four times bigger than Greece's and Portugal's, per capita spending is much lower than Greece and a slightly higher than Portugal only after 1974 (the year after which dramatically reduced its defence spending, see Figure 9.19.). Data on disaggregated military expenditure data can be found on Table F1 in Appendix F. Also see Figures F1, F2 and F3 for a comparison between military personnel and military equipment expenditure in the three countries.

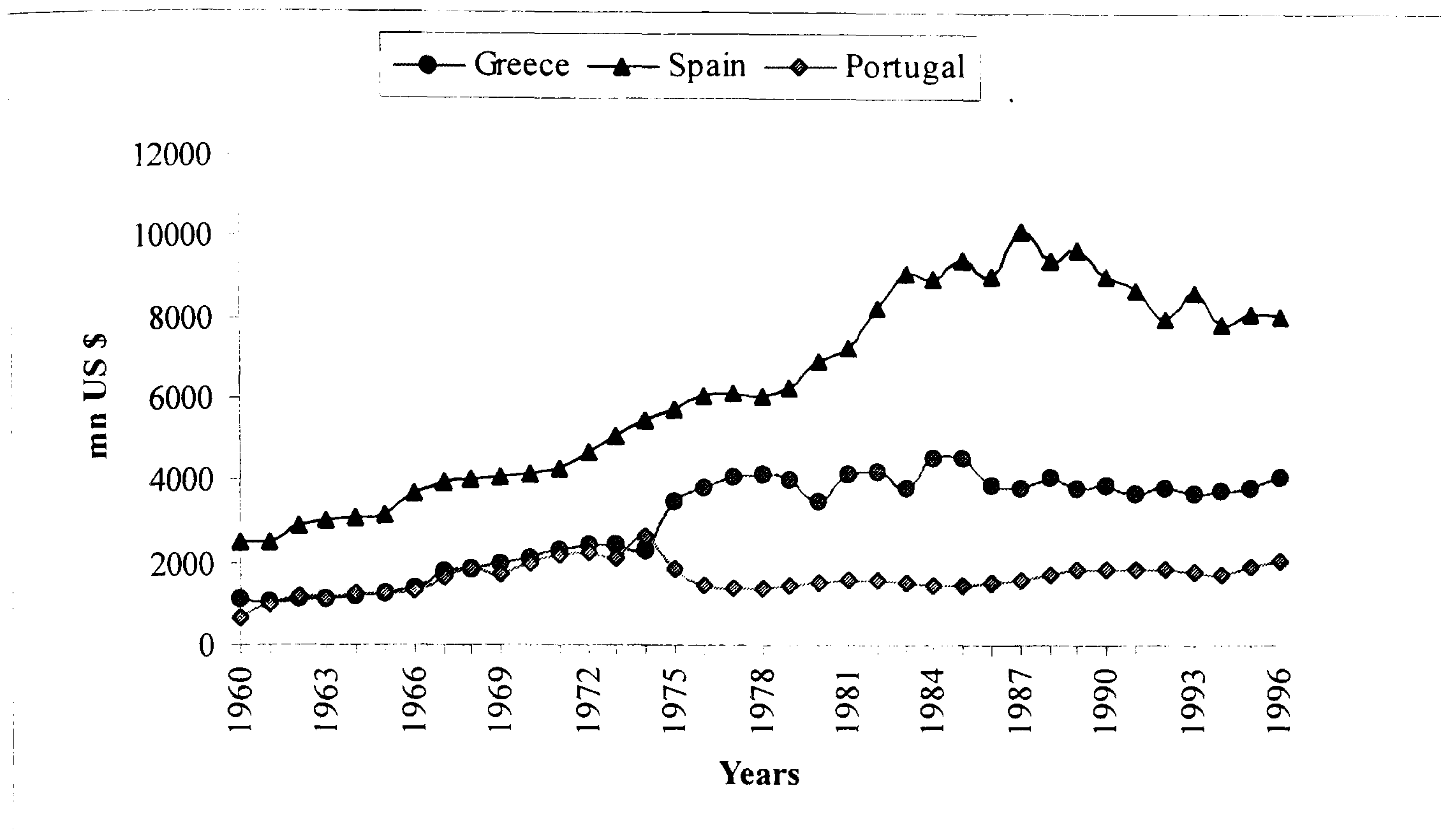
Figure 9.17. Military Expenditure per capita in Greece, Portugal, Spain*



*in '000s US \$

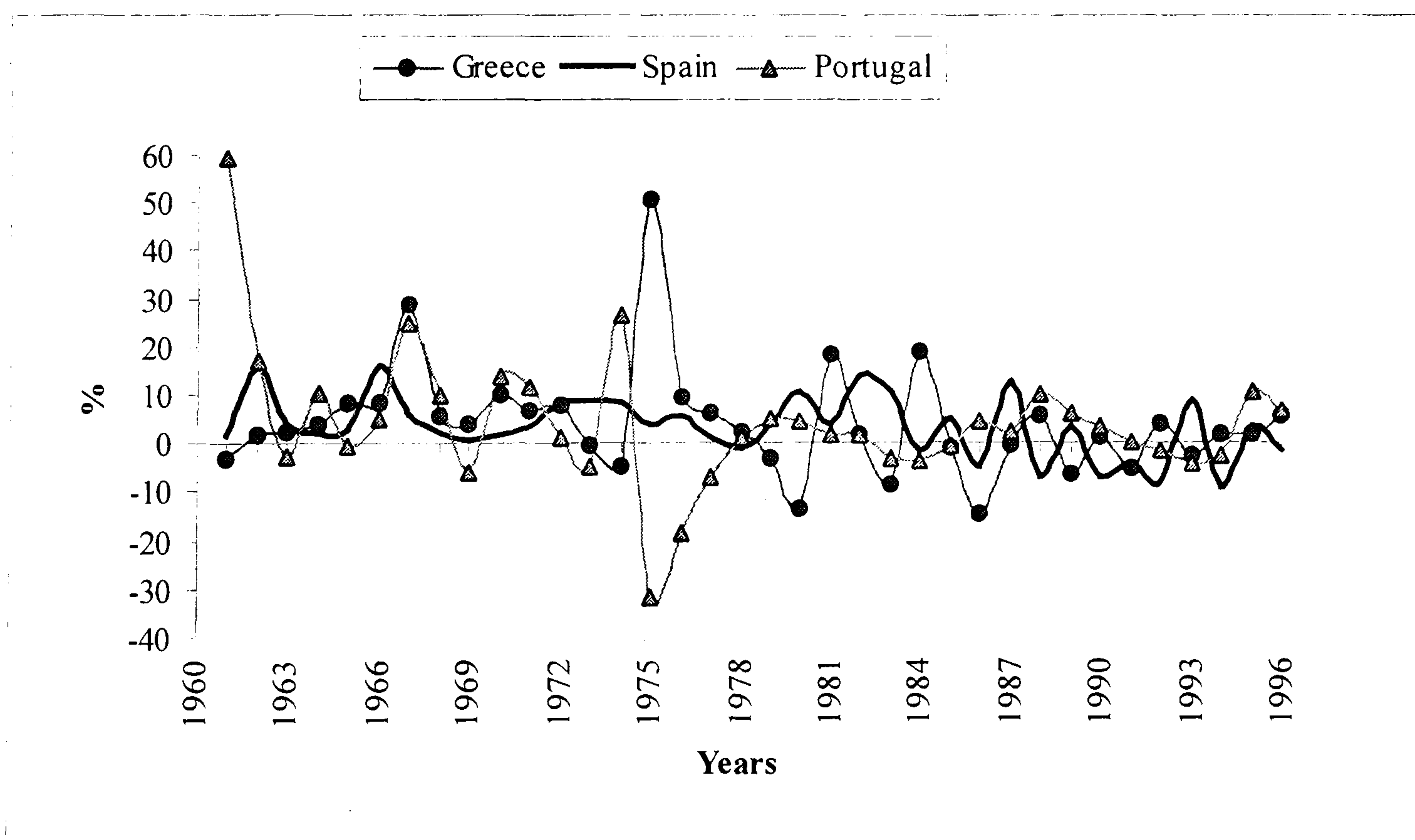
Source: SIPRI and EUROSTAT

Figure 9.18. Military Expenditure for Greece, Portugal and Spain in 1990 mn US \$



Source: SIPRI

Figure 9.19. Real Growth of Greek, Spanish and Portuguese Military Expenditure*



*calculated from figures in constant 1990 mn US \$

Source: SIPRI

9.5. Conclusions

This Chapter has provided a background analysis of the two Iberian economies, Portugal and Spain, over the last three and a half decades. Under no circumstances should this analysis be considered exhaustive. This would be an enormous task that could justify a separate thesis. The intention was simply to provide some background information of their economic performance and the evolution of their military expenditure prior to empirical analysis.

During 1960-1973 all three countries enjoyed higher rates of growth than the rest of the EC or even any individual member country (Tsoukalis, 1981). In the same period all three countries had low inflation and unemployment rates but this situation was soon followed by a period of both high inflation and unemployment. High unemployment constitutes a more severe problem in Spain. Also the crisis of the mid-1970s led to a huge drop in investment for all the countries. Government debt has also risen a lot after 1975 and has become a serious economic problem during the last two decades, especially for Greece.

High rates of economic growth have been observed in both periods of high and low military expenditure for all countries. Portugal was a big defence spender during the 1960s and early 1970s mainly because of the need to keep its colonies. But after the colonial wars ended, Portugal reduced its military burden which is kept at quite low levels since then. Greece on the other hand, started to be a big defence spender after 1974, the year of the Turkish invasion of Cyprus. Since then, the continuous disagreements and conflicts with Turkey have left Greece with no alternative but to keep

a high military burden. Spain throughout the period examined has maintained a low military burden, mainly because it lost its colonies at an early stage.

Having in mind the aforementioned features of the three economies will be particularly important and useful when analysing empirically the defence-growth relationship. Knowledge of the specific economic, political and strategic features of each country will be taken into account when the empirical estimation takes place. In this way, the empirical analysis can be particularly valuable and informative as it does not miss out important structural changes as is usually the case with cross-sectional studies of large groups of countries.

The next Chapter, reconsiders the models developed for Greece and employs them to analyse the defence-growth relationship for Portugal and Spain adjusting them only to account for the country-specific information. Once the models are estimated for Portugal and Spain, a comparative analysis on the defence-growth relationship for the three countries follows.

THE DEFENCE-GROWTH RELATIONSHIP IN PORTUGAL AND SPAIN: A COMPARISON WITH GREECE

10.1. Introduction

The purpose of this chapter is to investigate whether defence spending in Portugal and Spain has similar economic effects to those found in the case of Greece. As discussed previously, the three countries followed a common pattern of development during the period examined (1960-1996), sharing many economic characteristics, and being characterised as “the peripheral countries of the EU”. As such, one would expect defence spending to have similar economic effects in all three countries. However, given that only Greece among the three has important security considerations (the Turkish threat) that necessitate high defence spending which is primarily financed by imports, it is possible that the negative effects of defence found for Greece, will not apply to Portugal¹ and Spain. This may be particularly true for Spain as it is an arms exporter. But these are just some speculations that must be tested via empirical analysis.

¹ Portugal was a big defence spender during the 1960s and 1970s mainly because of the need to keep its colonies but since then it gradually reduced its military burden. As for Spain and because it lost its colonies earlier than Portugal military burden is much lower than Greece’s and Portugal’s during the

For consistency, the method and empirical analysis for Portugal and Spain will be the same as those undertaken in the case of Greece. Specifically, the same models that were developed for Greece (with only minor necessary changes) will be applied to Portuguese and Spanish data. In this way, possible differences in the results will not be attributed to different theoretical frameworks and model specifications. Furthermore, the sample period for the two countries will be the same as that of Greece (1960-1996) and the data will come from the same sources (SIPRI and EUROSTAT). So, leaving aside differences in methodologies employed, time periods and data sources chosen, which tend to constitute the main reasons for the diversity in results, but, at the same time, taking into account the socioeconomic development of each country, the empirical analysis can provide unbiased and consistent results for an inter-country comparison.

The Chapter starts with the Granger causality approach, followed by the supply side and the demand and supply model for Portugal and Spain. Once this is done, a comparison with Greece is undertaken both in terms of the results obtained from the different models employed and in terms of general economic effects of defence spending in the three countries.

period examined (1960-1996). For more information, see Solsten (1993) and Solsten & Meditz (1998).

10.2. Statistical Causality for Portugal and Spain

Following exactly the methodology employed for Greece in Chapter 6, the statistical causality between GDP growth and military burden is now investigated for Portugal and Spain. Prior to anything else the integration properties of the two series are established by applying the Dickey-Fuller (1979) tests for unit roots. In case the two series are integrated of the same order the existence of a long-run relationship between them is investigated by testing for cointegration within the Johansen (1988) framework. The existence of a cointegrating relationship will have important consequences when the short-run Granger causality between the two series is investigated. Also, the existence of structural breaks in the data is taken into consideration by allowing for certain dummies to capture significant changes due to specific incidents in each country. Recalling (from Chapter 6) the standard Granger causality test which can only be applied on stationary data and postulates that the information for the prediction of the variables X_t and Z_t is contained only in the time-series data of these variables. The test involves estimating the following regressions:

$$X_t = \sum_{i=1}^k \alpha_i Z_{t-i} + \sum_{j=1}^k \beta_j X_{t-j} + u_{1t} \quad (1)$$

$$Z_t = \sum_{i=1}^m \lambda_i Z_{t-i} + \sum_{j=1}^m \delta_j X_{t-j} + u_{2t} \quad (2)$$

And as in the case of Greece, for both Portugal and Spain three specifications of the Granger causality model are presented: the standard Granger causality (eq. 3, 4), the one augmented by the Error Correction Term (ECT) (eq.5, 6), and finally the one augmented by both the ECT and the country-specific dummy variables (eq.7, 8).

Using the same notation as that used for the case of Greece, the three specifications are:

$$\Delta Y = a_0 + a_1 \Delta Y(-1) + a_2 \Delta Y(-2) + a_3 \Delta SM(-1) + a_4 \Delta SM(-2) + u \quad (3)$$

$$\Delta SM = \beta_0 + \beta_1 \Delta SM(-1) + \beta_2 \Delta SM(-2) + \beta_3 \Delta Y(-1) + \beta_4 \Delta Y(-2) + \varepsilon \quad (4)$$

$$\Delta Y = a_0 + a_1 \Delta Y(-1) + a_2 \Delta Y(-2) + a_3 \Delta SM(-1) + a_4 \Delta SM(-2) + ECT(-1) + u \quad (5)$$

$$\Delta SM = \beta_0 + \beta_1 \Delta SM(-1) + \beta_2 \Delta SM(-2) + \beta_3 \Delta Y(-1) + \beta_4 \Delta Y(-2) + ECT(-1) + \varepsilon \quad (6)$$

$$\Delta Y = a_0 + a_1 \Delta Y(-1) + a_2 \Delta Y(-2) + a_3 \Delta SM(-1) + a_4 \Delta SM(-2) + ECT(-1) + D + u \quad (7)$$

$$\Delta SM = \beta_0 + \beta_1 \Delta SM(-1) + \beta_2 \Delta SM(-2) + \beta_3 \Delta Y(-1) + \beta_4 \Delta Y(-2) + ECT(-1) + D + \varepsilon \quad (8)$$

The null hypothesis in equations 3,5 and 7 is that $\Delta SM(-1)$ and $\Delta SM(-2)$ do not Granger cause ΔY ($H_0: a_3 = a_4 = 0$) and in equations 4, 6 and 8 that $\Delta Y(-1)$ and $\Delta Y(-2)$ do not Granger cause ΔSM ($H_0: \beta_3 = \beta_4 = 0$).

10.2.1. Empirical Results for Portugal

Starting with Portugal, the integration properties of the logarithm of Portuguese GDP (Y) and of the Portuguese military burden (SM), are examined by the DF and ADF tests for unit roots (see Appendix G, Tables G1, G2, G3). When only an intercept is included (Table G1 in Appendix G) the null hypothesis of a unit root is rejected for the GDP variable but it is not rejected for the military burden variable which seems to be $I(1)$ (integrated of order one). But before concluding about the integration

properties of the series, the DF tests with an intercept and a linear trend must also be examined. According to these results (Table G2 in Appendix G) both series are non-stationary or integrated of order one. To justify this, DF tests for the differenced series are also presented on Table G3 in Appendix G. According to the tests the differenced series are proved to be stationary, and by induction, the level series must be I(1) - integrated of order one. So, the two series (Y and SM) are treated as non-stationary.

Table 10.1. Cointegration Tests for Portuguese GDP and Military Burden

Cointegration with unrestricted intercepts and restricted trends in the VAR				
36 observations from 1961 to 1996. Order of VAR = 1				
List of variables included in the cointegrated vector: Y, SM, Trend				
List of eigenvalues in descending order: .37236 .24021 0.0000				
Cointegration LR test based on Maximal Eigenvalue of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r = 1	16.7681	19.2200	17.1800
r ≤ 1	r = 2	9.8896	12.3900	10.5500
Cointegration LR test based on Trace of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r ≥ 1	26.6578	25.7700	23.0800
r ≤ 1	r = 2	9.8896	12.3900	10.5500
Choice of r using Model Selection Criteria				
Rank	Max. LL	AIC	SBC	HQC
r=0	206.1652	204.1652	202.5816	203.6125
r=1	214.5492	208.5492	203.7987	206.8912
r=2	219.4940	211.4940	205.1600	209.2833

AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion
HQC = Hannan-Quinn Criterion

Given that the two series are integrated of the same order, the existence of a long-run relationship among them is a possibility. Testing for cointegration in a VAR(1) model (see Table G4 in Appendix G for the selection criteria for the order of the VAR) within the Johansen framework, the LR test based on the Eigenvalues of the

stochastic matrix does not reject the null hypothesis of no cointegration in favour of the alternative while the LR test based on the trace of the stochastic matrix clearly rejects the null of no cointegration in favour of one cointegrating vector. Furthermore, the Schwarz and Hannan-Quinn criteria² also indicate the existence of one cointegrating vector.

As such, the conclusion is that there is a cointegrating vector or a long-run relationship between the two variables which must be taken into consideration when the short-run causality is examined by including the Error Correction Term (ECT) from this long-run relationship. The ECT is nothing more than the lagged value of the estimated residuals from the following cointegrating relationship:

$$Y_t = 11.56 - 22.74 SM_t + \varepsilon_t \quad (9)$$

(88.9) (7.7)

Having these in mind, the cointegrating series can be modelled under a VAR(1) specification. Starting with the standard Granger causality test, the null hypothesis in equation 3 is that $\Delta SM(-1)$ does not Granger cause ΔY ($H_0: \alpha_3 = \alpha_4 = 0$) and in equation 4 that $\Delta Y(-1)$ does not Granger cause ΔSM ($H_0: \beta_3 = \beta_4 = 0$). The results in Table 10.2. for equation 3, show that the lagged value of the change in military burden is negatively related to growth but its effect is insignificant. Furthermore, the LR, LM and F tests indicate absence of any causal relationship from SM to Y. But results for the military burden equation (equation 4) indicate a positive and

² It is very commonly observed that different tests and selection criteria give conflicting results. It is very uncommon for all tests to point to the same conclusion (Pesaran & Pesaran, 1997)

significant effect of growth on military burden and the LR, LM and F tests support the existence of causality. So, the standard test suggests that growth Granger causes defence with the effect being positive while there is no evidence of defence causing growth. Moving on to the next specification which includes the ECT (equations 5, 6), results on the same Table (Table 10.2.) show that the models are better specified now, the direction of causality continues to be the same while the ECT is significant in both the military burden and the growth equation.

Finally, the third specification considers important structural changes that the Portuguese economy underwent by including a shock dummy (D74) to capture the instability that the collapse of the military government brought about in Portugal. The inclusion of this dummy significantly alters the results (see Table 10.2., equations 7, 8). Growth is not causally prior to defence any longer. But what is more interesting is that the negative effect of the military burden in the growth equation, now becomes significant. The LM, LR and F tests suggest that military burden Granger causes growth with the effect being negative. There is some evidence of serial correlation in the military burden equation which is sustained even if more lags are introduced. But in the context of the formulated model, no remedies for serial correlation are satisfactory, and as such, results are presented with this caveat.

Table 10.2. Granger Causality Results for Portugal

Dependent ΔY				Dependent ΔSM		
	Eq. 3	Eq. 5	Eq. 7	Eq. 4	Eq. 6	Eq. 8
$\Delta Y(-1)$	0.41 (2.50)**	0.39 (2.44)**	0.54 (3.28)***	0.05 (1.79)*	0.04 (1.70)*	0.01 (0.37)
$\Delta SM(-1)$	-0.93 (1.08)	-0.98 (1.18)	-1.55 (1.89)*	-0.06 (0.42)	-0.07 (0.51)	0.06 (0.48)
Intercept	0.02 (2.68)**	0.02 (2.98)***	0.02 (2.48)**	-0.003 (1.99)*	-0.002 (1.82)*	-0.001 (1.15)
ECT(-1)	—	-0.04 (1.86)*	-0.03 (1.44)	—	-0.008 (2.07)**	-0.01 (3.03)***
D74	—	—	-0.07 (2.21)**	—	—	0.02 (3.26)***
R^2	0.17	0.26	0.36	0.09	0.20	0.41
SE	0.03	0.03	0.03	0.005	0.005	0.004
DW	1.86	1.89	2.05	2.16	2.01	1.17
Diagnostic Tests						
Serial Correl.	$X^2(1)=0.35$ [.552] F(1,31)=0.3 [.578]	$X^2(1)=0.47$ [.492] F(1,30)=0.4 [.527]	$X^2(1)=0.27$ [.605] F(1,29)=0.2 [.640]	$X^2(1)=1.33$ [.249] F(1,31)=1.2 [.277]	$X^2(1)=0.15$ [.699] F(1,30)=0.1 [.722]	$X^2(1)=15.8$ [.000] F(1,29)=24 [.000]
Funct. Form	$X^2(1)=6.69$ [.010] F(1,31)=7.3 [.011]	$X^2(1)=6.08$ [.014] F(1,30)=6.3 [.018]	$X^2(1)=5.42$ [.020] F(1,29)=5.3 [.028]	$X^2(1)=0.09$ [.761] F(1,31)=0.1 [.776]	$X^2(1)=8.17$ [.004] F(1,30)=9.1 [.005]	$X^2(1)=8.64$ [.003] F(1,29)=9.5 [.004]
Normal.	$X^2(2)=0.77$ [.682]	$X^2(2)=0.72$ [.698]	$X^2(2)=1.25$ [.534]	$X^2(2)=8.25$ [.016]	$X^2(2)=0.70$ [.706]	$X^2(2)=8.68$ [.013]
Heterosk	$X^2(1)=0.72$ [.397] F(1,33)=0.7 [.412]	$X^2(1)=0.11$ [.737] F(1,33)=0.1 [.746]	$X^2(1)=0.02$ [.882] F(1,33)=0.0 [.886]	$X^2(1)=3.63$ [.057] F(1,33)=3.8 [.059]	$X^2(1)=8.02$ [.005] F(1,33)=9.8 [.004]	$X^2(1)=0.28$ [.594] F(1,33)=0.3 [.607]
Causality Tests						
LM	$X^2(1)=1.24$ [.266]	$X^2(1)=1.51$ [.219]	$X^2(1)=3.72$ [.054]*	$X^2(1)=3.18$ [.075]*	$X^2(1)=2.99$ [.084]*	$X^2(1)=0.16$ [.686]
LR	$X^2(1)=1.26$ [.262]	$X^2(1)=1.54$ [.214]	$X^2(1)=3.93$ [.047]**	$X^2(1)=3.33$ [.068]*	$X^2(1)=3.12$ [.077]*	$X^2(1)=0.16$ [.686]
F	F(1,32)=1.2 [.287]	F(1,31)=1.4 [.246]	F(1,30)=3.5 [.069]*	F(1,32)=3.2 [.083]*	F(1,31)=2.8 [.099]*	F(1,30)=0.1 [.710]

***: significant at 1%, **: significant at 5%, *: significant at 10%

Figures in parentheses are t-ratios

Figures in square brackets are probabilities

10.2.2. Empirical Results for Spain

Moving on to Spain, the integration properties of the logarithm of Spanish GDP (Y) and those of the Spanish military burden (SM), are examined by the DF and ADF tests for unit roots (see Appendix G, Tables G5, G6 and G7). When only an intercept is included (Table G5 in the Appendix) the null hypothesis of a unit root is rejected for the GDP variable but it is not rejected for the military burden variable which seems to be I(1) (integrated of order one). But before concluding about the integration properties of the series, the DF tests with an intercept and a linear trend must be examined. According to these results (Table G6 in the Appendix) the null hypothesis of no unit roots is rejected for both series. To justify whether the two series are integrated of order one or of a higher order, DF tests for the differenced series are also presented on Table G7 in Appendix G. According to the tests the differenced series are still non-stationary, and they only become stationary when they are differenced twice suggesting that the level series are I(2) - integrated of order two. This is very uncommon particularly for the GDP series. It seems unlikely that a rate of change of GDP would exhibit a unit root, because once disturbed, the probability of returning to the initial growth rate would be zero. *“All empirical evidence of GDP growth, however, suggests that these series do revert to mean growth rate”*, (Macnair et al, 1995, p.853). As for the military burden (the share of military expenditure in GDP) the results are equally strange suggesting it is I(2). Furthermore, the interpretation of the coefficients is completely lost if the series are differenced twice. Given the large literature³ questioning the ability of the ADF tests to distinguish between unit roots and stationarity in finite samples, one might consider that in the case of the Spanish variables the ADF tests give invalid

conclusions. Having a sample size of 36 observations and losing 3 due to the lag structure justifies a finite sample argument. Therefore, the probability of committing a type II error (accepting the unit root hypothesis when it is false) is high. Following this, the two series (Y and SM) are treated as non-stationary, integrated of order one.

Table 10.3. Cointegration Tests for Spanish GDP and Military Burden

Cointegration with restricted intercepts and no trends in the VAR				
35 observations from 1962 to 1996. Order of VAR = 2				
List of variables included in the cointegrated vector: Y, SM, Trend				
List of eigenvalues in descending order: .38237 .053673 0.0000				
Cointegration LR test based on Maximal Eigenvalue of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r = 1	16.8656	15.8700	13.8100
r ≤ 1	r = 2	1.9309	9.1600	7.5300
Cointegration LR test based on Trace of the stochastic matrix				
Null	Alternative	Statistic	95% critical value	90% critical value
r = 0	r ≥ 1	18.7964	20.1800	17.8800
r ≤ 1	r = 2	1.9309	9.1600	7.5300
Choice of r using Model Selection Criteria				
Rank	Max. LL	AIC	SBC	HQC
r=0	276.1553	272.1553	269.0446	271.0814
r=1	284.5880	276.5880	270.3667	274.4404
r=2	285.5535	275.5535	267.7767	272.8689

AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion
HQC = Hannan-Quinn Criterion

Given that the two series are integrated of the same order, the existence of a long-run relationship among them is a possibility. Testing for cointegration in a VAR(2) model (see Table G8 in the Appendix the selection criteria for the order of the VAR) within the Johansen framework (see Table 10.3), the LR test based on the Eigenvalues of the stochastic matrix does not reject the null hypothesis of no cointegration in favour of the alternative while the LR test based on the trace of the

³ See Campbell, J.Y. & Perron, P. (1991) and Cochran, J.H. (1991)

stochastic matrix rejects the null of no cointegration in favour of one cointegrating vector at 10% level of significance. Furthermore, this is also supported by the Akaike, Schwarz and Hannan-Quinn criteria⁴.

As such, the conclusion is that there is a cointegrating vector or a long-run relationship between the two variables which must be taken into consideration when the short-run causality is examined by including the Error Correction Term (ECT) from this long-run relationship. The ECT is nothing more than the lagged value of the estimated residuals from the following cointegrating relationship:

$$Y_t = 12.42 + 13.90 SM_t + \varepsilon_t \quad (10)$$

(25.56) (0.5)

Having these in mind, the cointegrating series can be modelled under a VAR specification. The selection criteria for the order of the VAR point to a VAR(2) model (see Table G8 in Appendix G). Starting with the standard Granger causality test, the null hypothesis in equation 3 is that $\Delta SM(-1)$ does not Granger cause ΔY ($H_0: \alpha_3 = \alpha_4 = 0$) and in equation 4 that $\Delta Y(-1)$ does not Granger cause ΔSM ($H_0: \beta_3 = \beta_4 = 0$). Results on Table 10.4. show that the lagged value of the change in military burden is positively related to growth but that its effect is insignificant. Furthermore, the LR, LM and F tests indicate the absence of any causal relationship from SM to Y. Results for the military burden equation (equation 4), also indicate absence of any significant relationship from growth to military burden and the LR,

⁴ It is very commonly observed that different tests and selection criteria give conflicting results. It is very uncommon for all tests to point to the same conclusion (Pesaran & Pesaran, 1997)

LM and F tests reject the existence of causality. So, the standard test suggests that there is absolutely no causal relationship between growth and defence in Spain⁵.

Table 10.4. Granger Causality Results for Spain

	Dependent ΔY			Dependent ΔSM		
	Eq. 3	Eq. 5	Eq. 7	Eq. 4	Eq. 6	Eq. 8
$\Delta Y(-1)$	0.64 (3.44)***	0.47 (2.52)**	0.50 (2.78)***	-0.01 (1.24)	-0.02 (1.73)*	-0.02 (1.85)*
$\Delta Y(-2)$	0.05 (0.28)	-0.20 (1.03)	-0.06 (0.28)	0.006 (0.57)	-0.004 (0.32)	-0.01 (0.78)
$\Delta SM(-1)$	0.95 (0.33)	-2.73 (0.88)	-0.98 (0.32)	-0.01 (0.09)	-0.15 (0.83)	-0.23 (1.18)
$\Delta SM(-2)$	0.51 (0.18)	-2.56 (0.87)	-1.04 (0.36)	0.43 (2.67)**	0.31 (1.78)*	0.25 (1.38)
Intercept	0.01 (1.72)*	0.03 (2.97)***	0.02 (2.28)**	0.001 (0.60)	0.001 (1.54)	0.001 (1.88)*
ECT(-1)	—	-0.04 (2.33)**	-0.03 (1.55)	—	-0.001 (1.47)	-0.002 (1.84)*
D75	—	—	-0.04 (1.89)*	—	—	0.001 (1.24)
R^2	0.51	0.59	0.64	0.26	0.31	0.35
SE	0.02	0.02	0.02	0.001	0.001	0.001
DW	2.03	1.93	1.82	1.91	1.99	1.97

Diagnostic Tests

Serial Correl.	$X^2(1)=3.04$ [.081] $F(1,28)=2.7$ [.109]	$X^2(1)=0.25$ [.617] $F(1,27)=0.2$ [.658]	$X^2(1)=1.41$ [.235] $F(1,26)=1.1$ [.299]	$X^2(1)=0.28$ [.595] $F(1,28)=0.2$ [.631]	$X^2(1)=0.47$ [.491] $F(1,27)=0.4$ [.542]	$X^2(1)=0.02$ [.890] $F(1,26)=0.0$ [.904]
Funct. Form	$X^2(1)=0.28$ [.598] $F(1,28)=0.2$ [.635]	$X^2(1)=0.31$ [.578] $F(1,27)=0.2$ [.623]	$X^2(1)=1.26$ [.262] $F(1,26)=1.0$ [.326]	$X^2(1)=2.19$ [.139] $F(1,28)=1.9$ [.176]	$X^2(1)=0.45$ [.503] $F(1,27)=0.4$ [.553]	$X^2(1)=0.02$ [.889] $F(1,26)=0.0$ [.904]
Normal.	$X^2(2)=0.21$ [.901]	$X^2(2)=1.64$ [.441]	$X^2(2)=0.73$ [.695]	$X^2(2)=1.43$ [.490]	$X^2(2)=1.72$ [.423]	$X^2(2)=1.18$ [.554]
Heterosk	$X^2(1)=1.11$ [.293] $F(1,32)=1.1$ [.307]	$X^2(1)=1.28$ [.258] $F(1,32)=1.2$ [.271]	$X^2(1)=2.29$ [.131] $F(1,32)=2.3$ [.139]	$X^2(1)=0.001$ [.970] $F(1,32)=0.0$ [.971]	$X^2(1)=0.18$ [.670] $F(1,32)=0.2$ [.681]	$X^2(1)=0.02$ [.897] $F(1,32)=0.0$ [.900]

Causality Tests

LM	$X^2(2)=0.16$ [.924]	$X^2(2)=1.39$ [.499]	$X^2(2)=0.2$ [.900]	$X^2(2)=1.98$ [.371]	$X^2(2)=4.27$ [.118]	$X^2(2)=5.6$ [.060]*
LR	$X^2(2)=0.16$ [.924]	$X^2(2)=1.42$ [.492]	$X^2(2)=0.2$ [.899]	$X^2(2)=2.04$ [.360]	$X^2(2)=4.57$ [.102]	$X^2(2)=6.1$ [.046]**
F	$F(2,29)=0.1$ [.935]	$F(2,28)=0.6$ [.558]	$F(2,27)=0.1$ [.919]	$F(2,29)=0.9$ [.418]	$F(2,28)=2$ [.153]	$F(2,27)=2.7$ [.087]*

⁵ For Spain, no cointegration could be suggested, in which case equations 3 and 4 are correct.

Moving on to the next specification which includes the ECT (equations 5, 6), results on Table 10.4. show that the models are better specified now but there is still no causality running from defence to growth. The ECT is significant in both the military burden and the growth equation and furthermore there is evidence of some causality running from growth to defence, with the effect being negative. Finally, the third specification considers important structural changes that the Spanish economy underwent by including a shock dummy (D75) to capture the instability that the collapse of the military government brought about in Spain. The inclusion of this dummy does have a negative effect in the growth equation and now the ECT is no longer significant. In the military burden equation, growth continues to be causally prior to defence and its significance increases. The LM, LR and F tests suggest that growth Granger causes defence with the effect being negative. The ECT is significant but only at the 10% level.

10.2.3. Comparison with Greece

Following the extended approach to the standard Granger causality testing (by taking into account the long-run information that might exist between the military burden and growth variables as well as the possible structural breaks in the data) empirical results for the defence-growth relationship appear to be quite different in each of the three countries. Table 10.5. summarises these results and also shows that the extended tests give different results to the standard tests for each country. Clearly, the simple Granger causality tests give misleading results.

Table 10.5. Granger Causality Tests for Greece, Portugal and Spain

	Dependent ΔY			Dependent ΔSM		
	Greece	Portugal	Spain	Greece	Portugal	Spain
$\Delta Y(-1)$	-0.02 (0.10)	0.54 (3.28)***	0.50 (2.78)***	-0.04 (0.76)	0.01 (0.37)	-0.02 (1.85)*
$\Delta Y(-2)$	-0.08 (0.47)	—	-0.06 (0.28)	0.02 (0.47)	—	-0.01 (0.78)
$\Delta SM(-1)$	0.88 (0.96)	-0.98 (1.18)	-0.98 (0.32)	0.11 (0.50)	0.06 (0.48)	-0.23 (1.18)
$\Delta SM(-2)$	-0.25 (0.27)	—	-1.04 (0.36)	0.03 (0.16)	—	0.25 (1.38)
Intercept	0.07 (3.40)***	0.02 (2.48)**	0.02 (2.28)**	0.003 (0.58)	-0.001 (1.15)	0.001 (1.88)*
ECT(-1)	-0.06 (3.33)***	-0.03 (1.44)	-0.03 (1.55)	0.006 (1.36)	-0.01 (3.03)***	-0.002 (1.84)*
D75	-0.04 (2.71)**	-0.07 (2.21)**	-0.04 (1.89)*	-0.003 (0.81)	0.02 (3.26)***	0.001 (1.24)
R²	0.65	0.36	0.64	0.14	0.41	0.35
SE	0.02	0.03	0.02	0.005	0.004	0.001
DW	1.99	2.05	1.82	2.08	1.17	1.97
Causality Tests						
LM	X ² (2)=1.20 [.549]	X ² (1)=3.72 [.054]*	X ² (2)=0.2 [.900]	X ² (2)=1.09 [.579]	X ² (1)=0.16 [.686]	X ² (2)=5.6 [.060]*
LR	X ² (2)=1.22 [.543]	X ² (1)=3.93 [.047]**	X ² (2)=0.2 [.899]	X ² (2)=1.11 [.574]	X ² (1)=0.16 [.686]	X ² (2)=6.1 [.046]**
F	F(2,27)=0.5 [.615]	F(1,30)=3.5 [.069]*	F(2,27)=0.1 [.919]	F(2,27)=0.4 [.643]	F(1,30)=0.1 [.710]	F(2,27)=2.7 [.087]*

As can be seen from Table 10.5., in the case of Greece there is an absence of any causal relationship between military burden and economic growth, while for Portugal there is evidence of military burden Granger causing growth, with the effect being negative. As for Spain there is some evidence of causality from growth to defence with a negative effect. Overall, the results suggest that despite the similarities of the three countries in terms of their economic and political development, there is no common causal relationship between defence and growth.

10.3. The Supply-Side Model for Portugal and Spain

Reconsider the Feder-Ram model that was analysed in Chapter 7. Assuming only the size effects of each of the military, government and export sector on economic growth, the equation to be estimated is:

$$\dot{Y} = \alpha \frac{I}{Y} + \beta \dot{L} + \left[\left(\frac{\delta_g}{1 + \delta_g} \right) + C_G \right] \dot{G} \left(\frac{G}{Y} \right) + \left[\left(\frac{\delta_x}{1 + \delta_x} \right) + C_X \right] \dot{X} \left(\frac{X}{Y} \right) + \left[\left(\frac{\delta_m}{1 + \delta_m} \right) + C_M \right] \dot{M} \left(\frac{M}{Y} \right) \quad (11)$$

But when the size effects are separated from the externality effects, the ‘augmented’ model to be estimated is the following:

$$\begin{aligned} \dot{Y} = & \alpha_0 + \alpha \frac{I}{Y} + \beta \dot{L} + \left(\frac{\delta_g}{1 + \delta_g} \right) \dot{G} \left(\frac{G}{Y} \right) + \theta_g \left[\dot{G} \left(\frac{C}{Y} \right) \right] + \\ & + \left(\frac{\delta_x}{1 + \delta_x} \right) \dot{X} \left(\frac{X}{Y} \right) + \theta_x \left[\dot{X} \left(\frac{C}{Y} \right) \right] + \left(\frac{\delta_m}{1 + \delta_m} \right) \dot{M} \left(\frac{M}{Y} \right) + \theta_m \left[\dot{M} \left(\frac{C}{Y} \right) \right] \end{aligned} \quad (12)$$

10.3.1. Empirical Results for Portugal

Equations (11) and (12) were estimated by OLS using Microfit 4.0. As in the case of Greece, Table 10.6. gives results for the total (size) effects of each sector (equation 11) and Table 10.7. also gives the externality effects and the productivity differentials (equation 12). In each case the first column gives results from the two-sector model (military and civilian), the second column from the three-sector model (civilian, military and government) and the third column gives results from the four-sector model (civilian, military, government and export).

Table 10.6. OLS Results of the Feder Model for Portugal (1961-1996)

Dependent GDP Growth			
Indep.Var.	Eq. 11	Eq. 11	Eq. 11
<i>Intercept</i>	-0.11 (2.81)***	-0.13 (3.36)***	-0.14 (3.63)***
I / Y_{-1}	0.52 (3.82)***	0.53 (4.12)***	0.52 (4.19)***
$\Delta L / L_{-1}$	-0.18 (0.93)	-0.33 (1.64)	-0.31 (1.64)
$\Delta M / M_{-1}(M / Y_{-1})$	0.66 (1.10)	-0.29 (0.39)	-0.46 (0.64)
$\Delta G / G_{-1}(G / Y_{-1})$	-----	2.53 (2.07)**	3.03 (2.52)**
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	0.26 (1.89)*
R²	0.41	0.48	0.54
SE	0.03	0.03	0.02
DW	1.68	1.92	2.19
F-stat	F(3,32)=7.4***	F(4,31)=7.21***	F(5,30)=6.96***
Diagnostic Tests			
Serial Cor.	X ² (1)=0.77 [.379]	X ² (1)=0.01 [.967]	X ² (1)=0.64 [.423]
Funct.Form	X ² (1)=0.01 [.937]	X ² (1)=0.60 [.439]	X ² (1)=2.21 [.137]
Normality	X ² (2)=1.72 [.423]	X ² (2)=1.89 [.389]	X ² (2)=0.24 [.886]
Heterosc.	X ² (1)=2.13 [.144]	X ² (1)=0.08 [.774]	X ² (1)=0.04 [.844]

The top columns give the coefficients estimates followed by the t-ratios (in parentheses) while the bottom columns give the X² tests for Serial Correlation, Functional Form, Normality and Heteroskedasticity followed by the probabilities (in brackets). ***: significant at 1% level of significance, **: significant at 5% level of significance, *: significant at 10% level of significance.

Starting from equation 11, which describes the total (size) effects of each sector on economic growth, one can note that the overall performance of the model is not very satisfactory and it is quite similar to that of the Greek model. Starting from the two sector model (column 1 on Table 10.6.), the total effect of the military sector is positive but insignificant. Investment is positive and highly significant while labour force growth -as in the case of Greece- is the only variable that has an unexpected negative sign but unlike in the case of Greece it is insignificant. The model passes all tests for serial correlation, functional form, normality and heteroscedasticity.

On the second column of Table 10.6., the government sector (excluding the military) enters the equation with a positive sign (this was also the case for Greece) significant at 5%. As for the effect of the military sector, it became negative but still insignificant, while the signs and significance of the intercept, investment and labour force growth remain more or less the same. Finally, by adding the export sector (see column 3 of table 10.6.), all of the variables' signs and significance remain the same but the model is now better specified. Non-nested tests clearly indicated that the four-sector model was preferred to the three and two-sector ones. The effect of the export sector is positive and significant at 10% which was not the case for Greece. Again there are no problems of serial correlation, functional form, normality and heteroscedasticity.

Moving on to equation 12, which considers the externality and the relative productivity effects, results are slightly altered. The specification seems reasonable with no problems of serial correlation, structural form, normality and heteroscedasticity. The R^2 suggests that the equation explains 43% in the two-sector case, 51% in the three-sector case and 62% in the four-sector case of the variation in the dependent variable. Again, multicollinearity seems to be a problem especially in the two and three sector models given the high F statistic and the individual insignificance of the variables. But the problem is not as severe as in the case of Greece.

Table 10.7. OLS Results of the Augmented Feder Model for Portugal (1961-96)

Dependent GDP Growth			
Indep. Var.	Eq. 9	Eq. 9	Eq. 9
<i>Intercept</i>	-0.12 (2.92)***	-0.17 (3.28)***	-0.16 (3.90)***
I / Y_{-1}	0.54 (3.92)***	0.64 (3.85)***	0.60 (4.45)***
$\Delta L / L_{-1}$	-0.14 (0.70)	-0.34 (1.58)	-0.34 (1.71)*
$\Delta M / M_{-1} (M / Y_{-1})$	-2.24 (0.72)	-1.11 (0.25)	1.22 (0.36)
$\Delta G / G_{-1} (G / Y_{-1})$	—	6.10 (1.41)	7.48 (2.76)***
$\Delta X / X_{-1} (X / Y_{-1})$	—	—	-0.66 (1.33)
$\Delta M / M_{-1} (C / Y_{-1})$	0.17 (0.96)	0.08 (0.32)	-0.08 (0.29)
$\Delta G / G_{-1} (C / Y_{-1})$	—	-0.49 (0.84)	-0.82 (1.89)*
$\Delta X / X_{-1} (C / Y_{-1})$	—	—	0.34 (1.87)*
δ_m	-0.67	-0.51	-8.14
δ_g	—	-1.22	-1.18
δ_x	—	—	-0.24
R^2	0.43	0.51	0.62
SE	0.03	0.03	0.02
DW	1.74	2.09	2.38
F-stat	F(4,31)=5.78***	F(6,29)=5.09***	F(8,27)=5.41***
Diagnostic Tests			
Serial Cor.	X ² (1)=0.46 [.496]	X ² (1)=0.24 [.622]	X ² (1)=1.73 [.189]
Funct. Form	X ² (1)=0.01 [.971]	X ² (1)=0.40 [.528]	X ² (1)=3.12 [.077]
Normality	X ² (2)=1.39 [.498]	X ² (2)=0.25 [.882]	X ² (2)=1.58 [.454]
Heterosc.	X ² (1)=1.96 [.161]	X ² (1)=0.40 [.526]	X ² (1)=0.10 [.756]

The top columns give the coefficients estimates followed by the t-ratios (in parentheses) while the bottom columns give the X² tests for Serial Correlation, Functional Form, Normality and Heteroskedasticity followed by the probabilities (in brackets). ***: significant at 1% level of significance, **: significant at 5% level of significance, *: significant at 10% level of significance.

Starting from the two-sector model (civilian and military) in column 1 of Table 10.7., the size effect of the defence sector is negative while its externality is positive, with both effects being insignificant. This means that, although we can calculate the productivity differential (which is -0.67) we should not rely on it as it comes from

insignificant estimates. The joint test of zero restrictions on the military coefficients cannot be rejected (Likelihood Ratio $\chi^2(2)=2.38$) suggesting that the military sector cannot explain economic growth in Portugal.

The inclusion of the government sector gives similar results as far as the effects of the military sector are concerned with the total effect of the non-military government sector positive and its externality negative, with both insignificant. The government coefficients are jointly significant (Likelihood Ratio $\chi^2(2)=6.01$) while the military coefficients are again jointly insignificant (Likelihood Ratio $\chi^2(2)=0.26$). The further addition of the export sector certainly improves the model in terms of R^2 and unlike the case of Greece many of the variables are significant. Furthermore, non-nested tests clearly indicate that the four-sector model is preferred to the other ones. The overall effect of the government sector becomes positive and highly significant (at 1%) with its externality negative at 10%, (Likelihood Ratio $\chi^2(2)=10.92$). Calculation of the government sector's relative productivity suggests that the government sector is less productive than the civilian sector ($\delta_g = -1.18$). The signs of the size and externality effects of the military sector are insignificant, positive and negative, respectively, with the joint test of zero restrictions on these coefficients accepted again suggesting that military sector cannot explain economic growth (Likelihood Ratio $\chi^2(2)=0.24$). As for the export sector, it gives negative and insignificant size effects but positive externalities significant at 10% and also, the export terms are jointly significant (Likelihood Ratio $\chi^2(2)=7.38$).

10.3.2. Empirical Results for Spain

Now models 11 and 12 are applied on Spanish data and are again estimated by OLS.

Table 10.8. OLS Results of the Feder Model for Spain (1961-96)

Dependent GDP Growth			
Indep.Var.	Eq. 11	Eq. 11	Eq. 11
<i>Intercept</i>	-0.04 (1.05)	-0.05 (1.16)	-0.05 (1.05)
I / Y_{-1}	0.33 (1.74)*	0.33 (1.72)*	0.33 (1.68)*
$\Delta L / L_{-1}$	1.26 (2.17)**	1.12 (1.84)*	1.12 (1.78)*
$\Delta M / M_{-1}(M / Y_{-1})$	3.70 (0.98)	3.35 (0.87)	3.39 (0.84)
$\Delta G / G_{-1}(G / Y_{-1})$	-----	1.17 (0.80)	1.22 (0.67)
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	0.03 (0.04)
R²	0.26	0.28	0.28
SE	0.03	0.03	0.03
DW	0.64	0.62	0.62
F-stat	F(3,32)=3.76***	F(4,31)=2.95***	F(5,30)=2.28*
Diagnostic Tests			
Serial Cor.	X ² (1)=11.57 [.001]	X ² (1)=12.56[.000]	X ² (1)=12.68[.000]
Funct.Form	X ² (1)=0.31 [.577]	X ² (1)=1.28 [.258]	X ² (1)=1.67 [.196]
Normality	X ² (2)=13.07 [.001]	X ² (2)=8.12[.017]	X ² (2)=8.20 [.017]
Heterosc.	X ² (1)=0.49 [.484]	X ² (1)=0.03[.866]	X ² (1)=0.02 [.878]

The top columns give the coefficients estimates followed by the t-ratios (in parentheses) while the bottom columns give the X² tests for Serial Correlation, Functional Form, Normality and Heteroskedasticity followed by the probabilities (in brackets). ***: significant at 1% level of significance, **: significant at 5% level of significance, *: significant at 10% level of significance. For all estimations Microfit 4.0 was used.

Unlike the models for Greece and Portugal, in the case of Spain the OLS estimation of the Feder-Ram model is very problematic. For a start, the results (see Table 10.8.) suggest that economic growth can only partly be explained by the Feder-Ram model, given the very low R² and the insignificance of all the variables apart from the investment and labour variable. Furthermore, there is evidence of serial correlation for all three specifications, something that did not appear in the case of Greece and

Portugal. Finally, signs of multicollinearity are evident, given the high F but the low R^2 and individual significance of the variables. One possible reason for the unsatisfactory performance of the model is that it might not pick up the dynamics correctly. To allow for the dynamics⁶, the Autoregressive Distributed Lag (ARDL) method is considered which allows the data to determine the short-run dynamics (see Pesaran & Pesaran, 1997). Batchelor et al (1999) have used this method to deal with similar problems in a case study of South Africa.

Moving on to equation 12, which considers the externality effects and the productivity differentials with respect to the civilian sector in addition to the size effects of each sector, again the OLS estimators suffer from serial correlation in the first two specifications (the two and three sector models) while in the third specification (the four-sector model) serial correlation can be rejected at 5.6% (see Table 10.9, column 3).

⁶ Results from the Cochrane-Orcutt estimation procedure are also presented in Appendix G (Tables G9 and G10) as well as from an Autoregressive AR(1) model on Tables G11, G12, G13, G14.

Table 10.9. OLS Results of the Augmented Feder Model for Spain (1961-96)

Dependent GDP Growth			
Indep.Var.	Eq. 12	Eq. 12	Eq. 12
<i>Intercept</i>	-0.01 (0.29)	0.01 (0.04)	0.01 (0.01)
I / Y_{-1}	0.18 (0.90)	0.06 (0.28)	-0.03 (0.16)
$\Delta L / L_{-1}$	1.48 (2.58)**	1.52 (2.56)**	1.39 (2.71)**
$\Delta M / M_{-1}(M / Y_{-1})$	-40.41 (1.68)*	-32.85 (1.28)	-34.85 (1.88)*
$\Delta G / G_{-1}(G / Y_{-1})$	-----	-4.12 (0.88)	-1.49 (0.44)
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	-0.15 (0.20)
$\Delta M / M_{-1}(C / Y_{-1})$	0.87 (1.85)*	0.77 (1.29)	0.94 (1.81)*
$\Delta G / G_{-1}(C / Y_{-1})$	-----	0.94 (1.29)	0.88 (1.51)
$\Delta X / X_{-1}(C / Y_{-1})$	-----	-----	0.22 (2.13)**
δ_m			
δ_g	-----		
δ_x	-----	-----	
R^2	0.33	0.41	0.61
SE	0.03	0.03	0.02
DW	0.97	0.79	1.15
F-stat	F(4,31)=3.89**	F(6,29)=3.36**	F(8,27)=5.36***
Diagnostic Tests			
Serial Cor.	X ² (1)=6.71 [.010]	X ² (1)=9.51 [.002]	X ² (1)=3.66 [.056]
Funct.Form	X ² (1)=0.01 [.973]	X ² (1)=0.93 [.336]	X ² (1)=0.63 [.428]
Normality	X ² (2)=10.02 [.007]	X ² (2)=4.18 [.124]	X ² (2)=4.60 [.100]
Heterosc.	X ² (1)=0.08 [.776]	X ² (1)=0.17 [.681]	X ² (1)=0.10 [.751]

The top columns give the coefficients estimates followed by the t-ratios (in parentheses) while the bottom columns give the X² tests for Serial Correlation, Functional Form, Normality and Heteroskedasticity followed by the probabilities (in brackets). ***: significant at 1% level of significance, **: significant at 5% level of significance, *: significant at 10% level of significance.

Using equation 11 as the starting point, the ARDL results with the long-run coefficient estimates for the size effects of the military, government and export sectors are given on Tables 10.10., 10.11., and 10.12., respectively. ARDL estimates seem to give a much better specified model than the OLS estimates. For the two-

sector model (see Table 10.10.) the Schwarz Bayesian Criterion selected an ARDL(1,2,0,1) meaning that one lag should be introduced for the dependent, two for investment, no lags for the labour variable and one lag for the military variable. The ARDL model has a much better fit than the OLS one ($R^2 = 0.84$) which of course is expected given the inclusion of lags. No problem of serial correlation can be detected now. But in order to interpret the results, one should look at the long-run coefficients, according to which investment is positive and significant (as with Greece and Portugal), labour force growth positive but insignificant while the total effect of the military sector positive and significant at 5%.

Table 10.10. ARDL Results of the Feder Model for Spain (2 sectors)

ARDL(1,2,0,1) selected based on Schwarz Bayesian Criterion		
Dependent GDP Growth		
Indep. Var.	ARDL	Long Run Coefficients
$(Y/Y_{-1})_{-1}$	0.52 (4.98)***	—
I/Y_{-1}	1.36 (6.77)***	0.56 (2.76)***
$(I/Y_{-1})_{-1}$	-1.62 (5.24)***	—
$(I/Y_{-1})_{-2}$	0.53 (2.31)**	—
$\Delta L / L_{-1}$	0.17 (0.52)	0.37 (0.53)
$\Delta M / M_{-1}(M / Y_{-1})$	1.99 (1.14)	11.34 (2.12)**
$(\Delta M / M_{-1}(M / Y_{-1}))_{-1}$	3.39 (1.93)*	—
<i>Intercept</i>	-0.05 (2.00)**	-0.10 (2.13)**

$R^2 = 0.84$; SER = 0.01; DW = 2.05;

Serial Correlation $X^2(1)=1.33$ [.249]; Functional Form $X^2(1)=0.13$ [.716];

Normality $X^2(2)=2.54$ [.280]; Heteroscedasticity $X^2(1)=1.17$ [.279]

Table 10.11. ARDL Results of the Feder Model for Spain (3 sectors)

ARDL(1,2,0,1,1) selected based on Schwarz Bayesian Criterion		
Dependent GDP Growth		
Indep.Var.	ARDL	Long Run Coefficients
$(Y/Y_{-1})_{-1}$	0.55 (5.32)***	—
I/Y_{-1}	1.24 (6.09)***	0.53 (2.58)**
$(I/Y_{-1})_{-1}$	-1.53 (5.06)***	—
$(I/Y_{-1})_{-2}$	0.53 (2.41)**	—
$\Delta L/L_{-1}$	0.27 (0.82)	0.61 (0.82)
$\Delta M/M_{-1}(M/Y_{-1})$	0.45 (0.24)	9.79 (1.80)*
$(\Delta M/M_{-1}(M/Y_{-1}))_{-1}$	3.91 (2.24)**	—
$\Delta G/G_{-1}(G/Y_{-1})$	0.80 (1.13)	-1.66 (0.90)
$(\Delta G/G_{-1}(G/Y_{-1}))_{-1}$	-1.54 (1.99)*	—
<i>Intercept</i>	-0.04 (1.59)	-0.09 (1.73)*

$R^2 = 0.87$; SER = 0.01; DW = 2.27;

Serial Correlation $X^2(1)=3.17$ [.075]; Functional Form $X^2(1)=0.52$ [.473];

Normality $X^2(2)=1.13$ [.567]; Heteroscedasticity $X^2(1)=1.09$ [.296]

The inclusion of the government sector (with one lag) slightly improves the performance of the model. Looking again at the long-run coefficients there is a slight decrease in the significance of the investment and military variables (from 1% and 5% levels to 5% and 10%, respectively) while the insignificant effect of labour force growth remains unchanged. The non-military government sector in Spain does not affect growth in a significant way (unlike the case of Greece and Portugal, where the government sector had a significant positive effect on economic growth).

Table 10.12. ARDL Results of the Feder Model for Spain (4 sectors)

ARDL(2,1,0,1,2,0) selected based on Schwarz Bayesian Criterion		
Dependent GDP Growth		
Indep. Var.	ARDL	Long Run Coefficients
$(Y/Y_{-1})_{-1}$	0.27 (2.32)**	—
$(Y/Y_{-1})_{-2}$	0.28 (2.91)***	—
I/Y_{-1}	1.22 (7.21)***	0.42 (2.52)**
$(I/Y_{-1})_{-1}$	-1.04 (6.55)***	—
$\Delta L/L_{-1}$	-0.21 (0.75)	-0.47 (0.72)
$\Delta M/M_{-1}(M/Y_{-1})$	1.96 (1.19)	15.06 (2.65)**
$(\Delta M/M_{-1}(M/Y_{-1}))_{-1}$	4.73 (2.97)***	—
$\Delta G/G_{-1}(G/Y_{-1})$	2.52 (3.38)***	-0.24 (0.13)
$(\Delta G/G_{-1}(G/Y_{-1}))_{-1}$	-1.25 (1.83)*	—
$(\Delta G/G_{-1}(G/Y_{-1}))_{-2}$	-1.38 (1.93)*	—
$\Delta X/X_{-1}(X/Y_{-1})$	1.04 (3.75)***	2.35 (2.82)***
<i>Intercept</i>	-0.04 (1.92)*	-0.09 (2.11)**

$R^2 = 0.91$; SER = 0.01; DW = 2.32;

Serial Correlation $X^2(1)=1.46$ [.227]; Functional Form $X^2(1)=4.69$ [.030];

Normality $X^2(2)=0.62$ [.733]; Heteroscedasticity $X^2(1)=0.80$ [.371]

On Table 10.12., the final inclusion of the export sector (with no lags according to the Schwarz Bayesian Criterion) has a very significant positive effect on economic growth. Labour force growth and the government sector remain insignificant (as before) while investment continues to be significant with a positive effect. But now the military sector appears to have a positive and significant effect at 5% suggesting that the military sector in Spain is growth promoting.

Considering equation 12 which separates the externality and relative productivity effects, the two-sector model gives insignificant total and externality effects of the defence sector (see Table 10.13.). Although there are no problems with the diagnostic tests, the only significant variables are investment and the intercept term.

Table 10.13. ARDL Results of the Augmented Feder Model for Spain (2 sectors)

ARDL(1,2,0,1,0) selected based on Schwarz Bayesian Criterion		
Dependent GDP Growth		
Indep.Var.	ARDL	Long Run Coefficients
$(Y/Y_{-1})_{-1}$	0.54 (4.60)***	—
I/Y_{-1}	1.37 (6.59)***	0.58 (2.44)**
$(I/Y_{-1})_{-1}$	-1.63 (5.14)***	—
$(I/Y_{-1})_{-2}$	0.53 (2.28)**	—
$\Delta L/L_{-1}$	0.15 (0.43)	0.33 (0.44)
$\Delta M/M_{-1}(M/Y_{-1})$	4.93 (0.40)	17.97 (0.62)
$(\Delta M/M_{-1}(M/Y_{-1}))_{-1}$	3.41 (1.91)*	—
$\Delta M/M_{-1}(C/Y_{-1})$	-0.06 (0.24)	-0.12 (0.24)
<i>Intercept</i>	-0.05 (1.96)*	-0.11 (1.92)*

$\delta_m = -1.06$; $R^2 = 0.84$; $SER = 0.01$; $DW = 2.06$;

Serial Correlation $X^2(1)=1.39$ [.239]; Functional Form $X^2(1)=0.36$ [.547];

Normality $X^2(2)=2.32$ [.313]; Heteroscedasticity $X^2(1)=1.20$ [274]

The three-sector augmented model (see Table 10.14.) is clearly better specified in terms of R^2 and now all the variables apart from labour force growth are significant. The inclusion of the government sector turned the total effect of the military sector into positive and significant with negative externalities and productivity differential.

As for the government sector itself, gave a negative overall effect but positive externality effect.

Table 10.14. ARDL Results of the Augmented Feder Model for Spain (3 sectors)

ARDL(2,1,1,2,0,2,0) selected based on Schwarz Bayesian Criterion		
Dependent GDP Growth		
Indep. Var.	ARDL	Long Run Coefficients
$(Y/Y_{-1})_{-1}$	0.20 (1.46)	—
$(Y/Y_{-1})_{-2}$	0.34 (3.19)***	—
I/Y_{-1}	1.64 (8.32)***	1.10 (3.01)***
$(I/Y_{-1})_{-1}$	-1.14 (6.84)***	—
$\Delta L/L_{-1}$	0.41 (1.07)	-1.60 (1.56)
$(\Delta L/L_{-1})_{-1}$	-1.15 (2.89)***	—
$\Delta M/M_{-1}(M/Y_{-1})$	13.57 (1.14)	213.74 (2.51)**
$(\Delta M/M_{-1}(M/Y_{-1}))_{-1}$	46.96 (3.37)***	—
$(\Delta M/M_{-1}(M/Y_{-1}))_{-2}$	38.56 (3.29)***	—
$\Delta G/G_{-1}(G/Y_{-1})$	-7.38 (3.06)***	-15.92 (2.39)**
$\Delta M/M_{-1}(C/Y_{-1})$	-0.26 (0.97)	-4.60 (2.43)**
$(\Delta M/M_{-1}(C/Y_{-1}))_{-1}$	-0.96 (3.10)***	—
$(\Delta M/M_{-1}(C/Y_{-1}))_{-2}$	-0.91 (3.44)***	—
$\Delta G/G_{-1}(C/Y_{-1})$	1.24 (3.26)***	2.68 (2.54)**
Intercept	-0.10 (3.13)***	-0.22 (2.71)**

$$\delta_m = -1.01 \quad \delta_g = -0.93$$

$$R^2 = 0.92; \text{ SER} = 0.01; \text{ DW} = 2.18;$$

$$\text{Serial Correlation } X^2(1)=1.89 \text{ [.169]}; \text{ Functional Form } X^2(1)=0.15 \text{ [.703]};$$

$$\text{Normality } X^2(2)=0.61 \text{ [.737]}; \text{ Heteroscedasticity } X^2(1)=10.98 \text{ [.001]}$$

Table 10.15. ARDL Results of the Augmented Feder Model for Spain (4 sectors)

ARDL(2,2,0,1,2,2,0,0,2) selected based on Schwarz Bayesian Criterion		
Dependent GDP Growth		
Indep.Var.	ARDL	Long Run Coefficients
$(Y/Y_{-1})_{-1}$	0.26 (1.77)*	—
$(Y/Y_{-1})_{-2}$	0.32 (3.20)***	—
I/Y_{-1}	1.09 (6.49)***	0.59 (2.24)**
$(I/Y_{-1})_{-1}$	-1.29 (4.65)***	—
$(I/Y_{-1})_{-2}$	0.45 (1.96)*	—
$\Delta L/L_{-1}$	0.12 (0.43)	0.28 (0.43)
$\Delta M/M_{-1}(M/Y_{-1})$	-26.73 (2.76)**	-47.64 (1.62)
$(\Delta M/M_{-1}(M/Y_{-1}))_{-1}$	6.70 (3.13)***	—
$\Delta G/G_{-1}(G/Y_{-1})$	7.51 (3.18)***	10.22 (1.69)
$(\Delta G/G_{-1}(G/Y_{-1}))_{-1}$	-0.93 (1.28)	—
$(\Delta G/G_{-1}(G/Y_{-1}))_{-2}$	-2.29 (2.94)***	—
$\Delta X/X_{-1}(X/Y_{-1})$	0.52 (1.15)	3.54 (2.43)**
$(\Delta X/X_{-1}(X/Y_{-1}))_{-1}$	0.10 (0.25)	—
$(\Delta X/X_{-1}(X/Y_{-1}))_{-2}$	0.87 (1.87)*	—
$\Delta M/M_{-1}(C/Y_{-1})$	0.90 (3.18)***	2.14 (2.20)**
$\Delta G/G_{-1}(C/Y_{-1})$	-0.80 (2.06)*	-1.90 (1.58)
$\Delta X/X_{-1}(C/Y_{-1})$	0.17 (2.15)**	-0.06 (0.28)
$(\Delta X/X_{-1}(C/Y_{-1}))_{-1}$	0.07 (1.08)	—
$(\Delta X/X_{-1}(C/Y_{-1}))_{-2}$	-0.27 (3.66)***	—
Intercept	-0.06 (2.34)**	-0.16 (2.20)**

$\delta_m = -0.98 \quad \delta_g = -1.14 \quad \delta_x = -1.4$

$R^2 = 0.97$; SER = 0.007; DW = 2.05;

Serial Correlation $X^2(1)=0.08$ [.776]; Functional Form $X^2(1)=0.84$ [.359];

Normality $X^2(2)=2.77$ [251]; Heteroscedasticity $X^2(1)=1.61$ [.205]

Finally, as it can be seen on Table 10.15., the export sector enters the equation with a positive and significant overall effect but insignificant externalities. Now the military sector has a positive externality effect but an insignificant overall effect while the government sector is no longer significant. It is really obvious how sensitive the Feder-type model is to the inclusion of additional sectors. Preferring the less restrictive form of the model (four-sector) to the more restrictive (two-sector), a comparison with Greece follows in the next section.

10.3.3. Comparison with Greece

The Feder-type model, which was developed for Greece in Chapter 7, was successfully employed to Portugal but that was not the case for Spain. Both the “total effect” and the “augmented” models that worked relatively well for Greece and Portugal, did not “work” for Spain, with the OLS estimates being problematic, suffering from serial correlation and very low explanatory power. The unsatisfactory performance of the Feder-type model for Spain was attributed to possible failure to pick up the dynamics correctly. Following this, allowance for the dynamics was made by estimating the models for Spain under an ARDL methodology (see Batchelor et al, 1999). So, before even considering the actual results, the first thing to note is the inability of the Feder model to perform well for all the three countries.

Table 10.16. Feder Model Results for Greece, Portugal and Spain

Dependent GDP Growth			
Indep.Var.	Greece	Portugal	Spain
<i>Intercept</i>	-0.03 (1.29)	-0.14 (3.63)***	-0.09 (2.11)**
I / Y_{-1}	0.26 (2.39)**	0.52 (4.19)***	0.42 (2.52)**
$\Delta L / L_{-1}$	-0.83 (2.21)**	-0.31 (1.64)	-0.47 (0.72)
$\Delta M / M_{-1}(M / Y_{-1})$	0.37 (0.36)	-0.46 (0.64)	15.06 (2.65)**
$\Delta G / G_{-1}(G / Y_{-1})$	1.14 (2.05)**	3.03 (2.52)**	-0.24 (0.13)
$\Delta X / X_{-1}(X / Y_{-1})$	0.49 (0.90)	0.26 (1.89)*	2.35 (2.82)***
R²	0.48	0.54	0.91
SE	0.03	0.02	0.01
DW	1.54	2.19	2.32

Note: Results for Greece and Portugal are OLS estimates while for Spain are the long run ARDL coefficients.

The second thing to note that is common for all three countries - at least when the overall effects are considered - is that the less restrictive specification (the one that assumed four sectors in the economy) was preferred to the more restrictive ones (the two and three sector models). Moving on to the comparison of the actual results for the three countries (see Table 10.16. above) investment is positive and significant in all countries which is in accordance to the predictions of the economic theory about the growth promoting effect of investment. This is not the case for labour force growth, though, which doesn't seem to be growth promoting in any of the three Mediterranean countries. Specifically, labour force growth is insignificant for Spain and Portugal while it has a significantly negative effect on growth in the case of Greece⁷.

⁷ See discussion about the negative effect of labour force growth in Chapter 7.

The military sector which is of the most interest here, does not explain economic growth in Greece and Portugal (as it is insignificant in both cases) but this is not the case for Spain, where it appears to be growth promoting (at least at the 10% level of significance). The opposite effect is observed for the non-military government sector which is growth promoting in Greece and Portugal but insignificant for Spain. Finally, the export sector is growth promoting in Portugal and Spain but insignificant in Greece. According to these results, it's obvious that the defence sector doesn't have any significant effect on Greek and Portuguese economic growth while the non-defence government sectors in these countries are growth promoting. On the contrary, in Spain it is the defence sector that promotes growth with the non-defence government sector having no significant effect. This could be explained by the fact that defence industries in Spain are quite developed and contribute to exports.

For the augmented models⁸, results are less clearcut between the three and four sector specifications. However, they clearly indicate that the three sector specification should be preferred to the two sector one. Concentrating again on the four-sector augmented models for the three countries, one can note a better fit for Spain (compared to that for Greece and Portugal), but this should not be surprising given that the results for Spain come from ARDL estimates. In the case of Greece, the problem of multicollinearity is obvious given the high R^2 and the insignificance of all the variables (see Chapter 7 for a discussion of multicollinearity, pp.150-151).

⁸ The augmented models are not expected to perform well given the existence of multicollinearity which turn most of the estimates into insignificant. This is particularly the case for Greece.

Table 10.17. Augmented Feder Model Results for Greece, Portugal and Spain

Dependent GDP Growth			
Indep.Var.	GREECE	PORTUGAL	SPAIN
<i>Intercept</i>	-0.01 (0.23)	-0.16 (3.90)***	-0.16 (2.20)**
I / Y_{-1}	0.10 (0.89)	0.60 (4.45)***	0.59 (2.24)**
$\Delta L / L_{-1}$	-0.58 (1.60)	-0.34 (1.71)*	0.28 (0.43)
$\Delta M / M_{-1}(M / Y_{-1})$	-0.64 (0.13)	1.22 (0.36)	-47.64 (1.62)
$\Delta G / G_{-1}(G / Y_{-1})$	-0.70 (0.53)	7.48 (2.76)***	10.22 (1.69)
$\Delta X / X_{-1}(X / Y_{-1})$	-0.21 (0.23)	-0.66 (1.33)	3.54 (2.43)**
$\Delta M / M_{-1}(C / Y_{-1})$	0.03 (0.07)	-0.08 (0.29)	2.14 (2.20)**
$\Delta G / G_{-1}(C / Y_{-1})$	0.89 (1.36)	-0.82 (1.89)*	-1.90 (1.58)
$\Delta X / X_{-1}(C / Y_{-1})$	0.18 (1.23)	0.34 (1.87)*	-0.06 (0.28)
δ_m	-0.38	-8.14	-0.98
δ_g	0.23	-1.18	-1.14
δ_x	-0.02	-0.24	-1.4
R²	0.61	0.62	0.97
SE	0.02	0.02	0.007
DW	2.10	2.38	2.05

It appears that the overall effect of the defence sector on economic growth is insignificant for all three countries. As for the externality effect of the defence sector, it is only in Spain that it is positive and significant. Possibly the indigenous arms production in Spain provides technologies and other spin-offs to the civilian sector. This is not the case for either Greece or Portugal.

10.4. The Demand and Supply Model for Spain and Portugal

The SEM developed for Greece in Chapter 8 will now be used (with minor changes) to investigate the defence-growth relationship in Spain and Portugal. Recalling the general four-equation model that was estimated for Greece:

$$Y = Y(S, M, GDPC, L, TB)$$

$$S = S(M, Y, TB, INF, NG)$$

$$TB = TB(M, Y, INF, GDPC, EXCH, TB_{-1})$$

$$M = M(GDPC, POP, NG, TB, NATO, TM, M_{-1}, CYP, POL)$$

Making necessary changes (for example excluding the Turkish military burden which is irrelevant for both Portugal and Spain and using dummies unique to each country), the same process of “general to specific” specification search is followed. Again, special attention is paid to the integration properties of the data and to specific structural breaks.

10.4.1. Empirical Results for Portugal

All variables were tested for unit roots by Dickey-Fuller tests, were found to be non-stationary (apart from L and Y) while their first differences found no unit roots and so the differenced series are used for the estimations (the tests are reported in Appendix G, Table G16). In estimating this model over the period 1960-96, the data were allowed to determine the particular short-run dynamic form using a general to specific methodology for testing exclusion restrictions. After extensive

specificational searches, the SEM to be estimated for Portugal consists of the following equations:

$$Y = a_0 + a_1 S + a_2 DM + a_3 DL + a_4 DTB_{-1} + T$$

$$S = \beta_0 + \beta_1 DM + \beta_2 DTB_{-1} + \beta_3 DY_{-1} + \beta_4 DINFL_{-2} + \beta_5 DNG_{-2} + \beta_6 D7476$$

$$DTB = \gamma_0 + \gamma_1 DM + \gamma_2 DY_{-1} + \gamma_3 DINFL_{-1} + \gamma_4 DEX_{-1} + \gamma_5 D7476$$

$$DM = \delta_0 + \delta_1 DTB_{-1} + \delta_2 DGDPC_{-1} + \delta_3 DNG + \delta_4 DNATO + \delta_5 D7596 + \delta_6 DM_{-1}$$

Variables and their Description

Y: real growth rate of GDP

S: share of national savings in GDP

DTB: trade balance (exports of goods and services less imports of goods and services) as a share of GDP (first difference)

DM: share of military expenditure in GDP (first difference)

DEX: real exchange rate, Portuguese escudo to US \$ (first difference)

DNG: share of government spending (excluding military) in GDP (first difference)

DNATO: share of NATO's defence spending in GDP (first difference)

DINF: inflation rate (first difference)

DL: labour force growth (first difference)

DGDPC: GDP per capita in constant 1990 mn US \$ (first difference)

T: linear trend

D7476: dummy variable to capture the effect on savings and trade balance of the instability that followed the collapse of the dictatorship

D7596: dummy variable to account for the peaceful period (after the end of the colonia wars and the collapse of the military government)

Table 10.18. Estimation Results of the Demand and Supply Model for Portugal

	Exogenous variables	Estimation Method					
		OLS		2SLS		3SLS	
Growth Equation	intercept	-0.01	(0.47)	-0.01	(0.47)	0.004	(0.22)
	DS	0.30	(3.78)***	0.30	(3.78)***	0.24	(3.45)***
	DM	-0.0002	(0.03)	-0.0002	(0.03)	0.004	(0.71)
	L	0.005	(2.23)**	0.005	(2.23)**	0.006	(2.51)**
	TB _{.1}	0.25	(1.96)**	0.25	(1.96)**	0.24	(2.15)**
	T	-0.001	(3.16)***	-0.001	(3.16)***	-0.001	(3.68)***
	R-squared	0.66		0.66		0.65	
	DW	2.02		2.02		2.04	
Savings Equation	intercept	0.22	(17.64)***	0.22	(17.64)***	0.22	(20.11)***
	DM	-0.005	(0.35)	-0.005	(0.35)	-0.004	(0.30)
	TB _{.1}	0.32	(1.01)	0.32	(1.01)	0.30	(1.07)
	LY _{.1}	0.97	(4.31)***	0.97	(4.31)***	0.98	(4.96)***
	DINFL _{.2}	0.001	(0.66)	0.001	(0.66)	0.001	(0.80)
	DNG _{.2}	-0.02	(1.99)**	-0.02	(1.99)**	-0.02	(2.37)**
	D7476	-0.07	(2.43)**	-0.07	(2.43)**	-0.07	(2.76)***
	R-squared	0.61		0.61		0.60	
DW	1.70		1.70		1.74		
Trade Balance Equation	intercept	0.009	(1.42)	0.009	(1.42)	0.009	(1.62)
	DM	-0.01	(1.69)*	-0.01	(1.69)*	-0.013	(2.10)**
	DY _{.1}	-0.26	(2.31)**	-0.26	(2.31)**	-0.27	(2.65)***
	DINFL _{.1}	0.002	(2.81)***	0.002	(2.81)***	0.002	(2.77)***
	DEXCH _{.1}	0.001	(2.32)**	0.001	(2.32)**	0.001	(2.49)**
	D7476	-0.03	(2.95)***	-0.03	(2.95)***	-0.04	(3.38)***
	R ²	0.59		0.59		0.58	
	DW	2.25		2.25		2.22	
Military Expenditure Equation	intercept	-0.004	(0.04)	-0.004	(0.04)	0.01	(0.12)
	TB _{.1}	-1.48	(0.58)	-1.48	(0.58)	-2.01	(0.88)
	DGDPC _{.1}	3.56	(1.91)*	3.56	(1.91)*	3.13	(1.90)*
	DNG	-0.13	(0.94)	-0.13	(0.94)	-0.14	(1.15)
	DNATO	1.41	(3.67)***	1.41	(3.67)***	1.33	(3.91)***
	D7596	-1.84	(3.36)***	-1.84	(3.36)***	-1.93	(3.97)***
	DM _{.1}	0.04	(0.39)	0.04	(0.39)	0.04	(0.47)
	R-squared	0.66		0.66		0.66	
DW	2.01		2.01		2.00		

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

$DM/DY=0.0004$, $DM/DS= -0.0035$, $DM/DTB= -0.014$

As it can be seen on Table 10.18. the OLS results (column 1) are identical with the 2SLS results (column 2) as the equations are just identified. Starting with the single equation estimates we note that in the growth equation, the share of savings in GDP, labour force growth and trade balance are positively related to economic growth and they are all significant. In the savings equation, military burden has a negative but insignificant effect while previous year's growth of GDP has a significant and positive effect on savings. Trade balance and inflation have insignificant positive effects while non-military government expenditure as well as the dummy for 1974-76 crisis have a significant negative effect. In the trade balance equation, military burden has a negative effect significant at 10% level while inflation and exchange rate (both lagged) have a positive and significant effect. The dummy for 1974-76 has again a negative and significant effect and the same applies for previous year growth of GDP. The military burden equation is explained by GDP per capita (lagged once) which has a positive effect significant at 10% level. The trade balance and the non-military government expenditure have the expected negative sign but in both cases it is not significant. The inclusion of the NATO variable intended to capture whether Portugal follows the alliance line of spending and it seems that this is the case since it is positive and significantly related to military burden. The dummy for the years of democracy is significant and negatively related to military burden, suggesting that after the end of the dictatorship military burden is reduced. As for the lagged value of the dependent variable, it is positive but insignificant rejecting the argument of inertia.

As already discussed, to avoid problems of simultaneity and high covariances one should rely on system equation estimates. Looking at the 3SLS estimates on Table

10.18. (column 3), it is obvious that the results are very similar with only minor differences compared to the single equation estimates. Those variables that were significant under the OLS and 2SLS estimation continue to be significant and in some cases their significance is increased. Calculation of the relevant multipliers gives the net effect of military burden on growth, savings and trade balance. These are: $DM/DY=0.0004$, $DM/DS=-0.0035$ and $DM/DTB=-0.014$, suggesting that the net effect of defence is positive on growth, while negative through savings and trade balance.

10.4.2. Empirical Results for Spain

Following the same process, the system of equations to be estimated for Spain is:

$$Y = a_0 + a_1 DS + a_2 DM + a_3 DL + a_4 TB_{-1} + T$$

$$DS = \beta_0 + \beta_1 DM_{-1} + \beta_2 TB_{-1} + \beta_3 Y_{-1} + \beta_4 DINFL_{-1} + \beta_5 DNG + \beta_6 D7980$$

$$TB = \gamma_0 + \gamma_1 DM + \gamma_2 Y + \gamma_3 DINFL_{-1} + \gamma_4 DEX_{-1} + \gamma_5 D7275 + \gamma_5 TB_{-1}$$

$$DM = \delta_0 + \delta_1 TB + \delta_2 DGDPC + \delta_3 DNG + \delta_4 DNATO + \delta_5 DPOP + \delta_6 D7887 + \delta_7 DM_{-1}$$

where D in front of a variable indicates first difference. Dickey-Fuller tests for unit roots are reported on Table G16 in Appendix G.

Variables and their Description

Y: real growth rate of GDP

DS: share of national savings in GDP (first difference)

TB: trade balance (exports of goods and services less imports of goods and services) as a share of GDP

DM: share of military expenditure in GDP (first difference)

DEX: real exchange rate, Spanish peseta to US \$ (first difference)

DNG: share of government spending (excluding military) in GDP (first difference)

DNATO: share of NATO's defence spending in GDP (first difference)

DINF: inflation rate (first difference)

DL: labour force growth (first difference)

DPOP: population (first difference)

DGDPC: GDP per capita in constant 1990 mn US \$ (first difference)

T: linear trend

D7980: dummy variable to capture the effect on savings of the crisis in 1979-80, takes the value of 1 for the years 1979 and 1980, 0 elsewhere

D7275: dummy variable to capture the effect on trade balance, takes the value of 1 for the years 1972-75 and 0 elsewhere

D7887: dummy variable to capture the effect of the development of the arms industry during that period, takes the value of 1 for the years 1978-87 and 0 elsewhere

Table 10.19. Estimation Results of the Demand and Supply Model for Spain

	Exogenous variables	Estimation Method					
		OLS		2SLS		3SLS	
Growth Equation	intercept	0.08	(15.13)***	0.08	(12.90)***	0.08	(14.77)***
	DS	0.002	(0.82)	0.001	(0.68)	0.003	(1.75)*
	DM	-0.03	(1.49)	-0.02	(0.95)	-0.04	(2.21)**
	L	0.73	(5.27)***	0.78	(5.64)***	0.70	(5.76)***
	TB ₋₁	0.32	(2.74)***	0.25	(2.04)**	0.24	(2.22)**
	T	-0.002	(9.39)***	-0.002	(8.18)***	-0.002	(9.46)***
	R-squared	0.83		0.81		0.80	
	DW	1.76		1.90		2.08	
Savings Equation	intercept	0.41	(1.45)	0.41	(1.45)	0.41	(1.70)*
	DM ₋₁	-1.83	(1.48)	-1.83	(1.48)	-1.78	(1.78)*
	TB ₋₁	-1.10	(0.14)	-1.10	(0.14)	1.08	(0.16)
	DY ₋₁	3.60	(0.64)	3.60	(0.64)	2.34	(0.50)
	DINFL ₋₁	-0.05	(0.85)	-0.05	(0.85)	-0.03	(0.54)
	DNG	-2.45	(5.44)***	-2.45	(5.44)***	-2.15	(5.88)***
	D7980	-0.81	(1.20)	-0.81	(1.20)	-0.79	(1.48)
	R-squared	0.62		0.62		0.61	
DW	2.17		2.17		2.20		
Trade Balance Equation	intercept	0.005	(1.17)	0.005	(1.17)	0.005	(1.28)
	DM	-0.025	(1.30)	-0.025	(1.30)	-0.035	(2.29)**
	DY	-0.20	(2.25)**	-0.20	(2.25)**	-0.21	(2.78)***
	DINFL ₋₁	0.002	(1.91)*	0.002	(1.91)*	0.002	(2.21)**
	DEXCH ₋₁	0.001	(2.97)***	0.001	(2.97)***	0.001	(3.40)***
	D7275	-0.01	(1.86)*	-0.01	(1.86)*	-0.01	(2.05)**
	TB ₋₁	0.81	(7.56)***	0.81	(7.56)***	0.80	(8.42)***
	R ²	0.73		0.73		0.73	
DW	2.07		2.07		2.00		
Military Expenditure Equation	intercept	-0.06	(1.10)	-0.06	(1.10)	-0.07	(1.64)*
	TB	-1.34	(1.12)	-1.34	(1.12)	-1.70	(1.76)*
	DGDPC	-0.09	(0.90)	-0.09	(0.90)	-0.10	(1.18)
	DNG	-0.09	(1.47)	-0.09	(1.47)	-0.08	(1.69)*
	DNATO	0.28	(2.37)**	0.28	(2.37)**	0.26	(2.70)***
	DPOP	0.001	(1.77)*	0.001	(1.77)*	0.001	(2.10)**
	D7887	0.12	(2.34)**	0.12	(2.34)**	0.16	(3.72)***
	DM ₋₁	-0.38	(2.58)**	-0.38	(2.58)**	-0.39	(3.19)***
	R-squared	0.51		0.51		0.50	
DW	2.13		2.13		1.96		

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

$DM/DY = -0.053$, $DM/DS = -1.91$, $DM/DTB = -0.026$

Again the OLS results are very similar to the 2SLS results. Concentrating on the 3SLS estimates and starting with the growth equation, one can note that military burden has a significant negative effect on economic growth for Spain. All the other variables (with the exception of the trend) are positively related to growth. There are many problems with the savings equation as most of the variables are insignificant. Military burden has a negative effect on savings and the same applies for trade balance, inflation, non-military government expenditure and the dummy for 1979-80. Furthermore, there is a negative impact of the military burden on the trade balance. Spanish military expenditure is positively determined by population growth and by NATO's expenditure, indicating that Spain is a follower in the alliance.

10.4.3. Comparison with Greece

Comparing the empirical results obtained from the demand and supply model among the three countries, it is noticeable that all the different equations have a similar fit in terms of R^2 with the exception of the trade balance equation which in the case of Greece was poorly defined. That was not the case for Spain and Portugal.

Starting with the growth equation, the effect of military burden on economic growth is significantly negative only for Greece and Spain and the same applies when the savings equation is in question. Again military burden has a negative effect on savings only for Greece and Spain. For all three countries thought, the effect on trade balance is significantly negative.

Table 10.20. Estimation Results for Greece, Portugal, Spain (1960-1996)

	Exogenous variables	Estimation Method: 3SLS					
		GREECE		PORTUGAL		SPAIN	
Growth Equation	intercept	0.10	(17.05)***	0.004	(0.22)	0.08	(14.77)***
	DS	0.002	(3.45)***	0.24	(3.45)***	0.003	(1.75)*
	DM	-0.02	(4.85)***	0.004	(0.71)	-0.04	(2.21)**
	L	0.001	(1.22)	0.006	(2.51)**	0.70	(5.76)***
	TB ₋₁	-0.001	(0.24)	0.24	(2.15)**	0.24	(2.22)**
	GDPG	0.08	(7.27)***				
	T	-0.003	(10.88)***	-0.001	(3.68)***	-0.002	(9.46)***
	R-squared DW	0.85 1.30		0.65 2.04		0.80 2.08	
Savings Equation	intercept	-1.46	(2.15)**	0.22	(20.11)***	0.41	(1.70)*
	DM ₋₁	-2.04	(2.43)***	-0.004	(0.30)	-1.78	(1.78)*
	TB ₋₁	0.33	(1.02)	0.30	(1.07)	1.08	(0.16)
	DY ₋₁	34.42	(2.75)***	0.98	(4.96)***	2.34	(0.50)
	DINFL ₋₁	-0.17	(1.63)*	0.001	(0.80)	-0.03	(0.54)
	DNG	-0.44	(0.61)	-0.02	(2.37)**	-2.15	(5.88)***
	D7980			-0.07	(2.76)***	-0.79	(1.48)
	R-squared DW	0.51 1.91		0.60 1.74		0.61 2.20	
Trade Balance Equation	intercept	4.51	(4.34)***	0.009	(1.62)	0.005	(1.28)
	DM	-1.26	(2.60)***	-0.013	(2.10)**	-0.035	(2.29)**
	DY	-51.5	(3.95)***	-0.27	(2.65)***	-0.21	(2.78)***
	DINFL ₋₁	-0.10	(1.98)*	0.002	(2.77)***	0.002	(2.21)**
	DEXCH ₋₁	-0.04	(1.96)*	0.001	(2.49)**	0.001	(3.40)***
	DGDPC	-4.37	(2.83)***				
	D7275	-2.45	(3.20)***	-0.04	(3.38)***	-0.01	(2.05)**
	TB ₋₁	-0.30	(2.27)**			0.80	(8.42)***
	R ² DW	0.33 2.04		0.58 2.22		0.73 2.00	
Military Expenditure Equation	intercept	0.13	(2.00)**	0.01	(0.12)	-0.07	(1.64)*
	TB	-0.21	(4.49)***	-2.01	(0.88)	-1.70	(1.76)*
	DGDPC	-1.02	(1.62)	3.13	(1.90)*	-0.10	(1.18)
	DNG	-0.36	(3.87)***	-0.14	(1.15)	-0.08	(1.69)*
	DNATO	0.49	(1.58)	1.33	(3.91)***	0.26	(2.70)***
	DPOP					0.001	(2.10)**
	D7887	2.49	(7.82)***	-1.93	(3.97)***	0.16	(3.72)***
	DTM	0.43	(1.14)				
	DM ₋₁	-0.25	(1.61)	0.04	(0.47)	-0.39	(3.19)***
	R-squared DW	0.74 1.78		0.66 2.00		0.50 1.96	

10.5. Conclusions

This Chapter has empirically investigated the defence-growth relationship in Portugal and Spain, applying the models that were developed for Greece. Table 10.21 below, summarises the findings as far as the economic effects of military expenditures are concerned, for Greece, Portugal and Spain, under the three empirical approaches.

Table 10.21. Summary of the Empirical Results for the Defence-Growth Relationship

	GRANGER CAUSALITY	FEDER-TYPE MODEL	DEMAND AND SUPPLY MODEL
GREECE	No Granger Causality	No significant 'total' effect No significant externality effect	Growth eq.: (-) effect Savings eq.: (-) effect TB eq.: (-) effect Net effect: Negative
PORTUGAL	No Granger Causality	No significant 'total' effect No significant externality effect	Growth eq.: No effect Savings eq.: No effect TB eq.: (-) effect Net effect: Negative
SPAIN	Granger Causality from growth to military burden	Positive 'total' effect Insignificant size effect but positive externalities	Growth eq.: (-) effect Savings eq.: (-) effect TB eq.: (-) effect Net effect: Negative

Firstly, it has used Granger causality analysis. As with Greece, it has extended the standard methodology by testing for cointegration among the military burden and economic growth variables. A long-run relationship was found among the two variables for both Portugal and Spain (as it was the case for Greece) and was taken into consideration when examining the short-run causality. Furthermore, structural breaks in the data were accounted for by including some country specific dummies.

Comparing the findings of the extended Granger causality approach, (See Table 10.21., first column), one can note a similar pattern for the defence-growth relationship only for Greece and Portugal. That is, there is an absence of any causal relationship between the two variables. In contrast, for Spain, there is evidence of Granger causality running from economic growth to military burden with the effect being negative. This suggests that economic growth in Spain has preceded declines in the military burden, but that there is no evidence of military burden having causal effect on growth. Given the similarities of the three countries, lack of a common pattern of the defence-growth relationship, points to the fact that the effects of military spending on economic growth cannot be generalised among countries even if countries are similar.

Secondly, this Chapter has used a commonly employed supply-side model (the Feder-type) extending it to include government and export sectors. As in the case of Greece, special attention was given to the sensitivity of the model to the inclusion of additional sectors, either when the “overall” or the “augmented” model was considered. Although both the “overall” and the “augmented” models worked relatively well for Portugal, that was not the case for Spain where the OLS estimates were problematic, suffering from serial correlation and very low explanatory power. This unsatisfactory performance of the Feder-type model for Spain was attributed to a possible failure to pick up the dynamics correctly. To allow for the dynamics, the model for Spain was reestimated using an ARDL procedure. Another important issue that was pointed out in this Chapter was that for all three countries the less restrictive specification (the four-sector model) was preferred to the most restrictive one (the two-sector model). Concentrating on the results from the four-sector

“overall” model, (see Table 10.21., second column), it is obvious that only for Spain is the “total” effect of the defence sector significantly positive; for Portugal and Greece there is absence of any significant effect. As for the “augmented” models, the existence of multicollinearity constitutes an additional problem (see Chapter 7, pp.150-151 for a discussion on multicollinearity). Again, for Greece and Portugal there is absence of any significant “total” and “externality” effect while in the case of Spain the defence sector has significant positive externalities.

Finally, this Chapter has also used the demand and supply model (specified for Greece in Chapter 8) to investigate the defence-growth relationship in Portugal and Spain. This model allowed the specification of both demand and supply-side influences, took into account country specific dummies and gave both the direct and the indirect effects (through savings and the trade balance) of defence spending on economic growth. The fit of each of the four equations in the SEM was similar for all three countries with the exception of the Greek trade balance equation which was poorly defined. Looking at Table 10.21. (third column) that summarises the results of the demand and supply model for the three countries, one can note that in the case of Greece and Spain, military burden has a clear negative effect on growth, savings and trade balance with the net effect being negative. Results are less clear for Portugal, where there is no significant effect on growth and savings but there is a negative effect on trade balance.

Overall, the findings suggest that when the supply-side model is employed results for Spain and Portugal are very similar - that is there is no significant effect of defence on growth, while for Spain there is some evidence of a positive effect. On the other

hand, when the demand and supply model is employed, there is strong evidence of a negative effect for Greece and Spain and some evidence of a negative effect for Portugal. As for the direction of causality, the findings suggested absence of a causal relation between defence and growth for Greece and Portugal, and the existence of a unidirectional causality from growth to defence for Spain. Clearly then, based on the causal analysis and the supply-side model, the economic effects of defence are quite similar for Greece and Portugal while Spain seems to be different. But based on the demand and supply model, Greece and Spain give similar results and Portugal is different. In none of the cases though, there exists strong evidence of a positive effect defence on growth. Furthermore, the findings support the widely held view that different model specifications lead to different results.

SUMMARY AND CONCLUSIONS

11.1. Summary and Conclusions

This thesis has undertaken a comprehensive empirical analysis of the economics of military expenditure in Greece and a comparison with two very similar countries, Spain and Portugal. The focus of the analysis has been Greece as this country - even after the end of the Cold War - continues to allocate a significant share of its GDP for defence (in 1996 military burden for Greece was 4.5% compared to 2.8% for Portugal, 1.5% for Spain, and 2.9% for NATO for the same year). Furthermore, Greece faces important security considerations, the long-term hostility and turmoil with its neighbouring country Turkey, not to mention the unstable environment of the Balkans where it is situated. What makes the Greek security considerations even more complicated is the fact that both Greece and its adversary, Turkey, are members of the same alliance (NATO). Being the poorest member of the EU and struggling to improve its economic condition, high defence spending would seem irrational if it were not for these security considerations. The fact that Greece has followed a quite similar pattern of development to that of Spain and Portugal throughout the period examined (1960-1996), intrigued the author of the thesis to investigate whether defence spending had something to do with this.

As is commonly the case, prior to empirical analysis, one must know what are the theoretical and the empirical approaches to the economics of military spending. A review of the theoretical approaches was carried out in Chapter 2. It was argued that defence could be growth promoting in the Keynesian context since it could boost aggregate demand, when it was relatively low compared to aggregate supply, or fight underconsumption in the Marxist sense. Furthermore, in the Neoclassical framework, defence spending could stimulate growth through modernisation (due to advanced technologies that arise from defence) and other spin-off effects. On the other hand, it was argued that it would be equally possible for defence to crowd-out resources that could be more growth promoting if used by other sectors or that the technologies developed would not find applications in other sectors. In these cases, defence spending would retard growth.

Following this, a distinction was made between developed and less developed or developing countries as far as the economic effects of defence spending were concerned. In developed countries, where aggregate demand is usually lower than the potential aggregate supply, military expenditure could have the Keynesian effect of boosting aggregate demand and leading to higher economic growth or according to the Marxist theory, military spending could fight underconsumption and again promote growth. But in less developed countries insufficient demand rarely constitutes a problem. Rather, it is constraints on the supply-side that impose problems in these economies. LDCs, it was argued, might benefit from the infrastructure and advanced technologies that arise from defence, but only if the infrastructure created by defence was beneficial for civilian uses and the technologies could be applied outside the military sector. Finally, in countries with developed

indigenous arms industries and arms exports, defence was supposed to have a growth promoting effect in contrast to those countries that rely on huge military imports, which retards their growth through adverse effects on the trade balance.

The aforementioned theories only point to the ways and channels through which defence spending could affect economic growth. Clearly, the only way to determine the economic effects of military expenditure is through empirical analysis. Chapter 3 provided a review of the empirical studies on the defence-growth relationship, identifying the strengths and weaknesses of previous work and considering some methodological issues that arose from them. The Chapter concluded that the economic impact of defence spending depends on the relative importance of each of the channels through which defence spending operates in the economy. Despite the huge controversy in the empirical results and the lack of a general conclusion on the relationship between defence spending and economic growth, one could observe that supply-side models tended to support a positive effect of defence on growth (through modernisation, and other spin-offs), while demand-side models tended to support a negative effect (via crowding-out of investment, exports). Studies using a combination of the two types of models (demand and supply), most commonly found positive direct effects of defence on growth and negative indirect effects, through savings and trade balance, with a most commonly negative net effect. On the other hand, when it came to the more “atheoretic” Granger causality approach, empirical evidence was almost equally divided between interdependence, mutual dependence and one-sided dependence between defence spending and growth. It was not possible to specify a common finding.

What also became apparent from reviewing the studies was that in developed countries the economic effects of military spending on growth were quite different to those in LDCs. It was pointed out that developed countries might benefit from military expenditure, through increases in aggregate demand and increased utilisation of capital and labour, or they might be worse off if defence spending crowds-out investment from other sectors that are potentially more productive than the military. Also, if a country has domestic arms production and arms exports it is more likely to be positively affected by military expenditure than those countries that have high arms imports.

Lack of clear results from cross-country studies point to the need for studying individual countries. A researcher must have good knowledge of a country's background to be able to build a complete model that is not only consistent with a certain theory but most importantly takes into account those specific characteristics that are unique to the country. If these unique characteristics are not taken into account, there is a great possibility for mis-specification of the model (failing to account for structural changes, political or strategic factors) leading to misinterpretation of the results obtained.

Chapter 4 provided a background analysis of the Greek politics, economy, military spending and defence industries. It became clear that Greece is a country with many economic and security problems, with no developed defence industry, but with a large military burden. The absence of a developed indigenous arms industry and the existence of huge economic problems, made high defence spending seem irrational or unjustifiable by pure economic reasoning. But what did appear to force Greece to

spend a lot on defence were security concerns, mainly the perceived threat from Turkey and the instability of the Balkans. Certainly policy makers have used these threats to justify the substantial share of GDP that is allocated to defence each year, without considering the possible economic consequences of such spending. This thesis hypothesised that defence spending bears considerable responsibility for the delayed progress of the Greek economy and this hypothesis was thoroughly investigated empirically in Chapters 6, 7 and 8.

Prior to this, it seemed useful to empirically examine the determinants of Greek military expenditure to assess the relative importance of economic and security considerations. This issue was empirically investigated in Chapter 5, using two different models: an arms race model and a general model of aggregate defence spending.

The long-term animosity between Greece and Turkey has led historians and political commentators to argue that there exists an arms race between the two countries, which explains the high levels of their military expenditures. Although a widely held view, it was not fully supported by the empirical evidence provided by previous studies and by that provided in this thesis. The deficiencies of the classical Richardson arms race model were to be blamed for the poor empirical performance and the inconclusive results. Recent econometric techniques (unit root tests and cointegration) were applied to deal with most of the deficiencies that arose from the Richardson model. The analysis provided evidence of a long-run relationship between Greek and Turkish military burdens (suggesting that income variables were important) but not in the form of a long-run Richardson type arms race. So, although

it could be said that there was something going on between the two countries this was definitely not an arms race in the classical Richardson form. This might be due to the fact that both countries are in a more complex environment, especially Turkey with a number of conflicts and potential conflicts. Also, another important factor that might affect the spending patterns of the two countries is that they are both members of the NATO alliance. One implication of this could be that both countries, before the collapse of the Warsaw Pact, had a common threat (the containment of communism) and that this was affecting their procurement decisions. When the general model of aggregate defence spending was considered, the empirical findings suggested that strategic factors and not economic ones played an important role in determining Greek military burden. Specifically, the Greek military burden was determined by the Turkish military burden and the threat of war after 1974 (which was captured by a dummy variable).

Chapters 6, 7 and 8 investigated the defence-growth relationship in Greece using three different empirical specifications. First, Chapter 6 empirically investigated the existence of a causal relation between defence spending and economic growth in Greece over the period 1960-1996. It systematically analysed the presence and direction of the causal relationship between defence and growth, paying attention to the integration properties of the series and using the vector autoregression (VAR) approach. In this way it extended the methodology commonly employed and showed that the standard approach could lead to spurious findings of Granger causality. This was the case for Greece, since a positive effect of military burden on growth was found for the standard Granger causality test, but did not survive the introduction of long run information, nor a dummy to allow for the impact of the Cyprus invasion.

Granger causality tests have been widely criticised (Jacobs et al, 1979) for being sensitive to a wide variety of factors, including structural changes over the period examined, stationarity of and cointegration across the variables. But the methodology employed here has overcome many of the shortcomings that the standard Granger causality may have - especially when applied to a group of countries, in which case many of the unique characteristics of each country are ignored. Testing for Granger causality between growth and military burden is still useful prior to developing the structural models which followed in the next two Chapters.

Chapter 7, investigated the economic effects of military spending in Greece, using a supply-side model. The approach taken was to estimate the commonly used multi-sectoral Neoclassical model - the Feder-type - model with special attention given to the sensitivity of the model to the number of sectors included and to the specification of the externalities and the productivity differentials. Starting with the two-sector model, a positive effect of the defence sector on economic growth (significant at the 10% level) was found. However, this positive effect changed into a negative and insignificant one when either the government sector alone or both the government and the export sectors were introduced¹. Furthermore, the general performance and the explanatory power of the three and four-sector models was higher than that of the two-sector model and this was also supported by non-nested tests, suggesting that one should rely on estimates from these models rather than the more restrictive two sector ones which can lead to misspecification. The same story was repeated when

¹ The overall effect of the non-military government sector was positive and significant in both the three and four-sector model, while the export sector had a positive but insignificant effect on growth. The signs and significance of the intercept, the investment and the labour force variables remained unchanged.

the augmented models that gave separate estimates for the total and the externality effects of each sector were considered. Again, the two-sector augmented model was poorly defined compared to the three and four-sector ones, but this time it also gave insignificant total and externality effects of the military sector and most of the variables were insignificant. The four-sector model in particular showed absence of any statistical significance of the coefficients and as it is common with this type of model the problem of multicollinearity could not be avoided.

So, first of all the analysis provided in this Chapter pointed to the observation that the Feder-type model was very sensitive to the inclusion of additional sectors of the economy, especially when the size effects of the sectors were separated from their externalities in which case one got insignificant estimates. The results for Greece fully supported Biswas and Ram (1986) findings for a cross-section of countries.

Bearing in mind the limitations of the Feder-type model, the empirical evidence for Greece over the period 1961-96 indicated that the overall effect of the defence sector on growth was neither significantly positive nor negative, although the defence sector seemed to be less productive than the civilian sector. This suggested that shifts of resources (spending or investment) out of the military sector into the private sector were likely to bring about higher productivity. Given that the Feder-type model concentrates on the supply-side only, consideration of the demand-side seemed to be beneficial in assessing the economic effects of military spending in a more "complete" way.

This was carried out in Chapter 8 which analysed the effects of defence spending on economic growth using a demand and supply, simultaneous equation model (SEM) over the period 1960-96. A four-equation system was estimated using both single-equation methods (OLS, 2SLS) and system-equation methods (3SLS) to account for the interrelations between the variables. Findings suggested that both the direct effect of defence spending on economic growth and the indirect effects through savings and trade balance were significantly negative. The negative direct effect of defence on growth implied that there were no positive spin-offs or externalities from the defence sector to the economy. The negative indirect effect of defence through savings supported the crowding-out argument, that resources were misallocated through the growth of military burden. The negative indirect effect of military burden through the trade balance seemed reasonable for a country like Greece which is a big importer of military equipment and only has a very small and underdeveloped defence industry. Overall, the results suggested that the high military burden in Greece had been harmful to economic performance and had made a significant contribution to the backwardness of the economy and the huge problems it is facing.

Having completed the empirical investigation for the defence-growth relationship in Greece, Chapters 9 and 10 were dedicated to analysing two similar economies, Portugal and Spain. Specifically Chapter 9 provided a background analysis of the two Iberian economies and a comparison with Greece while Chapter 10 empirically investigated the economic effects of military spending in these countries applying the models already employed for Greece.

It became evident in Chapter 9 that the three countries faced a very similar pattern of development during the period examined (1960-1996). All of them enjoyed higher rates of growth than the rest of the EC or even any individual member country until the mid-1970s (Tsoukalis, 1981). In the same period all three countries had low inflation and unemployment rates but this situation was soon followed by a period of both high inflation and unemployment. High unemployment constituted a more severe problem in Spain. Also the crisis of the mid-1970s led to a huge drop in investment for all of the countries. Government debt had also risen markedly after 1975 and has become a serious economic problem during the last two decades, especially for Greece.

High rates of economic growth were observed in both periods of high and low military expenditure for all three countries. Portugal was a big defence spender during the 1960s and early 1970s mainly because of the need to keep its colonies. But after the colonial wars ended, Portugal reduced its military burden which was kept at quite low levels since then. Greece on the other hand, started to be a big defence spender after 1974, the year of the Turkish invasion of Cyprus. Since then, the continuous disagreements and conflicts with Turkey had left Greece with no alternative but to keep a high military burden. Spain throughout the period examined had maintained a low military burden, mainly because it lost its colonies at an early stage.

Knowledge of the specific economic, political and strategic features of each country was taken into account when the empirical estimation took place in Chapter 10. The Chapter, reconsidered the models developed for Greece and employed them to

analyse the defence-growth relationship for Portugal and Spain adjusting them only to account for the country-specific information. Once the models were estimated for Portugal and Spain, a comparative analysis on the defence-growth relationship for the three countries followed.

Comparing the findings of the Granger causality approach, one could note a similar pattern for the defence-growth relationship for Greece and Portugal. That is, the absence of any causal relationship between the two variables. As for Spain, there was evidence of Granger causality running from economic growth to military burden with the effect being negative. Given the similarities of the three countries, lack of a common pattern of the defence-growth relationship, pointed to the fact that the effects of military spending on economic growth cannot be generalised among countries even if countries are similar.

The same conclusion arose when the supply-side (Feder-type) model was used. Again, Greece and Portugal seemed to follow a common pattern in terms of empirical results with both countries having insignificant externality effects when the augmented model were in question. Again, Spain differed, having a positive 'total' effect and positive externalities. Moving to the third empirical approach, which could be considered more complete to the other two approaches, as it contains both demand and supply influences, the empirical results supported the existence of an overall negative effect of defence spending on growth for all countries.

11.2. Limitations of the Study

Although this thesis has provided a comprehensive empirical analysis of the economic effects of defence spending in Greece through a detailed case study, it still has a number of problems and limitations in terms of theory, data, levels of analysis and interpretation, most of which are shared with other empirical studies in the area.

In terms of applied work, and as mentioned in Chapter 2, there is no theoretical approach that considers military expenditure as a fundamental concept. As a result, researchers on the economic effects of military spending tend to develop ad hoc models or simply add in military expenditure to other theoretical models. In addition, different theories have different foci. Some might be demand-focused while others supply-focused. This leads to a wide range of empirical models in the literature. While little could be done about the first issue within the scope of the thesis, an attempt was made to address the second issue by undertaking a comprehensive analysis employing three different models. This provided a range of results upon which to base any empirical evaluation.

A second limitation of this study results from the data employed. As mentioned in Chapter 2, despite the efforts of international organisations in recent years to provide reliable military data, there are still many problems as far as its quality is concerned. There was, however, little that could be done apart from using the most reliable sources. Thirdly, in terms of levels of analysis, the economics of military expenditure could be examined at either the microeconomic or at the macroeconomic level and there are important issues at both levels. The present study focused at the macroeconomic level, and hence cannot deal with the important issues of

restructuring and conversion in any consistent manner. Focusing the analysis does, however, allow a detailed macroeconomic case study that is a valuable contribution to the literature.

Despite these limitations, the overall finding of the study that cuts in defence budgets in Greece would most likely lead to improved economic performance (especially if these resources were reallocated to other more productive sectors of the economy), does seem to be relatively robust. It would be very likely that a ‘peace dividend’ could exist. The problem is that military burden also appears to be determined by security concerns and if there is no improvement in relations with Turkey it seems unlikely that significant cuts will be on the agenda. The recognition that there are clear economic, as well as security, benefits to be gained by settling the disputes could hopefully provide a much needed incentive to move forward.

11.3. Suggestions for Future Research

These problems point to the need for further consideration of certain issues and suggest useful areas for future research. Given the poor performance and the number of problems associated with the Feder-type model, some consideration should be given to developing other models such as those based on a Cobb-Douglas production function, new growth theory models and public choice models for application in this area.

As mentioned earlier, there are possible problems with the quality of data. Future work might consider an assessment of the different sources – national and international. This would allow a better understanding of the problem and point to ways in which the data may be improved. Another important issue is the limitations of focusing on aggregate data. Consideration should be given to the use of disaggregated military data in empirical analysis, since the different components of military expenditure (i.e. military spending on equipment and personnel) might have different economic effects. As data sets improve this should become a more feasible research topic.

In the thesis Portugal and Spain were not covered in depth as they were used only for comparative purposes, yet they represent important case studies in the development of the literature. More detailed case studies of these two countries would be of considerable interest. A further avenue of potential value to the debate is the use of panel data methods to provide cross-country analyses. Future work should consider treating the three countries studied here as a panel and seek to identify general relationships and country specific effects. In the same spirit, an expansion of the sample of countries to include other small industrialised economies such as Turkey, South Africa, Argentina, Brazil, would be a valuable development of the research.

Finally, the study has focused on the development of military expenditure and economic growth over the last thirty years. European security issues, such as the development of the EU and the expansion of NATO, are likely to have important implications for the European peripheral economies. Studying these changes should be an important part of any future research agenda.

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Table A1. Greek Main Economic Indicators

	Imports ^a	Exports ^a	Savings ^a	Investment ^a	Unemployment ^b
1960	14.2	7.1	15.9	20.4	6.1
1961	14.0	7.2	21.0	21.4	5.9
1962	14.4	7.6	22.0	21.9	5.1
1963	15.3	7.8	25.3	22.1	5.0
1964	16.2	7.1	25.4	23.7	4.6
1965	17.3	7.0	26.2	24.9	4.8
1966	16.0	8.8	26.7	25.1	5.0
1967	15.4	8.3	24.7	25.2	5.4
1968	15.6	7.5	25.5	25.6	5.6
1969	15.9	7.6	28.9	26.0	5.2
1970	15.7	7.8	29.3	26.0	4.2
1971	15.7	8.0	32.7	23.8	3.1
1972	17.1	9.1	36.5	24.9	2.1
1973	21.5	11.1	40.4	26.4	2.0
1974	21.8	12.5	31.6	27.9	2.1
1975	22.9	13.1	29.5	26.4	2.3
1976	22.0	13.7	31.9	24.9	1.9
1977	21.5	13.1	30.8	23.9	1.7
1978	21.0	13.7	30.8	22.6	1.8
1979	21.5	13.6	32.8	21.5	1.9
1980	22.3	16.3	31.2	22.2	2.7
1981	23.1	16.0	25.4	21.9	4.0
1982	24.4	14.3	25.3	21.6	5.8
1983	25.6	15.4	24.7	20.8	7.1
1984	25.5	16.9	25.1	18.7	7.2
1985	27.9	16.5	21.9	19.2	7.0
1986	26.3	17.4	20.6	19.5	6.6
1987	27.0	19.1	19.1	20.8	6.7
1988	25.7	18.5	20.3	22.6	6.8
1989	27.5	18.2	18.0	24.	6.7
1990	28.1	16.8	18.0	24.5	6.4
1991	27.0	16.1	19.6	23.8	7.0
1992	27.0	16.7	19.1	21.8	7.9
1993	26.3	16.2	19.8	19.8	8.6
1994	26.4	16.8	19.8	19.7	8.9
1995	26.9	16.5	19.1	20.6	9.1
1996	26.5	15.8	19.5	20.3	9.0

(continued)

Table A1. Greek Main Economic Indicators (continued)

	GDP Growth^c	Inflation Rate^d	Industrial Production^c	Employment Growth^c	Investment Growth^c
1961	11.1	1.5	—	0.4	8.1
1962	1.5	4.6	—	-1.0	8.4
1963	10.1	1.4	9.7	-1.4	5.5
1964	8.3	3.7	11.3	-1.3	20.7
1965	9.4	4.0	8.7	-0.7	12.8
1966	6.1	4.9	16.0	-0.9	3.2
1967	5.5	2.4	4.5	-1.2	-1.6
1968	6.7	1.7	7.7	-1.2	21.4
1969	9.9	3.4	12.0	-0.3	18.6
1970	8.0	3.9	10.2	-0.1	-1.4
1971	7.1	3.2	11.4	0.3	14.0
1972	8.9	5.0	14.1	0.5	15.4
1973	7.3	19.4	15.3	1.0	7.7
1974	-3.6	20.9	-1.5	0.1	-25.6
1975	6.1	12.3	4.3	0.1	0.2
1976	6.4	15.4	10.6	1.2	6.8
1977	3.4	13.0	1.9	0.8	7.8
1978	6.7	12.9	7.6	0.4	6.0
1979	3.7	18.6	6.0	1.1	8.8
1980	1.8	17.7	1.0	1.4	-6.5
1981	0.1	19.8	0.9	5.2	-7.5
1982	0.4	25.1	0.9	-0.8	-1.9
1983	0.4	19.1	-0.3	1.1	-1.3
1984	2.8	20.3	2.3	0.4	-5.7
1985	3.1	17.7	4.2	1.0	5.2
1986	1.6	17.5	-1.0	0.4	-6.2
1987	-0.5	14.3	-1.5	-0.1	-5.1
1988	4.5	15.6	5.1	1.6	8.9
1989	3.8	14.4	1.8	0.3	7.1
1990	0	20.6	-2.3	1.3	5.0
1991	3.0	19.9	-1.4	-1.8	4.8
1992	0.5	14.5	-1.2	1.4	-1.0
1993	0.2	12.7	-2.1	0.8	-1.8
1994	2.2	10.1	0.9	1.9	1.2
1995	2.0	9.3	2.3	0.9	5.9
1996	2.6	8.9	1.3	1.0	11.8

^a: Percentage of gross domestic product at market prices

^b: Percentage of civilian labour force

^c: Real growth rates calculated from figures in 1990 mn US \$

^d: Real growth of GDP deflator (base year 1990)

Table A2. Greek and Turkish Military Figures

	GREECE			TURKEY		
	Share	ME ¹	ME growth	Share	ME ¹	ME growth
1960	4.9	861	----	5.1	1015	----
1961	4.2	836	-2.90	5.5	1094	7.78
1962	4	810	-3.11	5.1	1151	5.21
1963	3.9	843	4.07	4.7	1171	1.74
1964	3.6	852	1.07	4.8	1265	8.03
1965	3.5	913	7.16	5.0	1343	6.17
1966	3.6	992	8.65	4.4	1304	-2.90
1967	4.3	1269	27.92	4.5	1315	0.84
1968	4.7	1461	15.13	4.6	1391	5.78
1969	4.8	1639	12.18	4.4	1364	-1.94
1970	4.8	1756	7.14	4.3	1460	7.04
1971	4.7	1855	5.64	4.5	1709	17.05
1972	4.6	1964	5.88	4.3	1776	3.92
1973	4.1	1898	-3.36	4.1	1865	5.01
1974	4.3	1906	0.42	3.9	2040	9.38
1975	6.5	3088	62.01	6.1	3380	65.69
1976	6.9	3471	12.40	6.2	4143	22.57
1977	7.0	3655	5.30	5.8	3991	-3.67
1978	6.7	3719	1.75	5.4	3655	-8.42
1979	6.3	3615	-2.80	4.5	3242	-11.30
1980	5.7	3318	-8.22	4.9	3071	-5.27
1981	7.0	4081	23.00	5.0	3792	23.48
1982	6.9	4025	-1.37	5.6	4145	9.31
1983	6.3	3707	-7.90	5.2	3991	-3.71
1984	7.2	4334	16.91	4.9	3812	-4.48
1985	7.1	4358	0.55	4.5	4046	6.13
1986	6.1	3901	-10.49	4.8	4548	12.41
1987	6.3	3965	1.64	3.3	4343	-4.51
1988	5.2	4118	3.86	3.0	3787	-12.80
1989	4.6	3834	-6.90	3.3	4382	15.71
1990	4.7	3863	0.76	3.5	5296	20.86
1991	4.3	3708	-4.01	3.7	5463	3.15
1992	4.5	3895	5.04	3.8	5747	5.20
1993	4.4	3815	-2.05	3.8	6355	10.58
1994	4.4	3880	1.70	3.9	6213	-2.23
1995	4.4	3952	1.86	3.8	6200	-0.21
1996	4.5	4170	5.52	4.3	6306	1.71

Source: SIPRI

¹ Military expenditure (ME) in 1990 million US dollars.

Table B1. DF and ADF tests with an Intercept for MG, MT

The Dickey-Fuller regressions with an intercept					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable MG_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.1201	-233.1923	-235.1923	-236.6888	-235.6958
ADF(1)	-2.1251	-233.0056	-236.0056	-238.2504	-236.7609
ADF(2)	-2.2625	-231.7780	-235.7780	-238.7710	-236.7851
ADF(3)	-2.1098	-230.4298	-235.4298	-239.1711	-236.6886
Unit root tests for variable MG_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-3.2232	36.1711	34.1711	32.6746	33.6676
ADF(1)	-3.0718	36.1717	33.1717	30.9270	32.4164
ADF(2)	-3.1028	36.3905	32.3905	29.3975	31.3834
ADF(3)	-2.9548	37.8448	32.8448	29.1035	31.5859
Unit root tests for variable MT_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-0.29530	-243.9543	-245.9543	-247.4508	-246.4579
ADF(1)	-0.63693	-242.5504	-245.5504	-247.7951	-246.3057
ADF(2)	0.13453	-237.7392	-241.7392	-244.7322	-242.7463
ADF(3)	-0.048004	-237.5583	-242.5583	-246.2996	-243.8172
Unit root tests for variable MT_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.0612	24.3415	22.3415	20.8450	21.8380
ADF(1)	-1.1783	25.8565	22.8565	20.6118	22.1012
ADF(2)	-0.96865	28.9171	24.9171	21.9241	23.9101
ADF(3)	-0.95836	28.9274	23.9274	20.1862	22.6686

95% critical value for the ADF statistic= -2.9528

MG=Greek military expenditure in 1990 mn US \$

MT=Turkish military expenditure in 1990 mn US \$

Table B2. DF and ADF tests with an Intercept and a Linear Trend for MG, MT

The Dickey-Fuller regressions with an intercept and a linear trend					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable MG_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.5837	-233.0865	-236.0865	-238.3312	-236.8418
ADF(1)	-1.3785	-232.9732	-236.9732	-239.9662	-237.9803
ADF(2)	-0.90203	-231.7016	-236.7016	-240.4429	-237.9604
ADF(3)	-1.3447	-230.3692	-236.3692	-240.8587	-237.8798
Unit root tests for variable MG_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.7618	36.1898	33.1898	30.9451	32.4345
ADF(1)	-1.7012	36.1964	32.1964	29.2034	31.1893
ADF(2)	-1.5000	36.5276	31.5276	27.7863	30.2687
ADF(3)	-1.8763	37.8636	31.8636	27.3740	30.3530
Unit root tests for variable MT_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.5428	-240.6886	-243.6886	-245.9334	-244.4439
ADF(1)	-3.9214	-235.7109	-239.7109	-242.7039	-240.7179
ADF(2)	-2.4121	-234.3705	-239.3705	-243.1118	-240.6293
ADF(3)	-2.9610	-232.7359	-238.7359	-243.2255	-240.2465
Unit root tests for variable MT_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.8233	25.6303	22.6303	20.3855	21.8750
ADF(1)	-2.7885	29.1320	25.1320	22.1389	24.1249
ADF(2)	-1.7927	30.3412	25.3412	21.5999	24.0824
ADF(3)	-1.9134	30.6485	24.6485	20.1590	23.1379

95% critical value for the ADF statistic= -3.5514

Table B3. DF and ADF tests for the Differenced Series MG, MT

The Dickey-Fuller regressions with an intercept					
32 observations used in the estimation of all ADF regressions (1965-1996)					
Unit root tests for variable ΔMG_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-5.9273	-228.6682	-230.6682	-232.1339	-231.1540
ADF(1)	-4.9800	-227.8244	-230.8244	-233.0203	-231.5532
ADF(2)	-2.6371	-226.2963	-230.2963	-233.2278	-231.2680
ADF(3)	-2.5868	-226.1103	-231.1103	-234.7747	-232.3250
Unit root tests for variable ΔMG_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-4.8300	30.2081	28.2081	26.7424	27.7223
ADF(1)	-3.5938	30.2093	27.2093	25.0107	26.4806
ADF(2)	-2.1190	31.8967	27.8967	24.9653	26.9250
ADF(3)	-2.1533	32.0840	27.0840	23.4197	25.8694
Unit root tests for variable ΔMT_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-4.1677	-235.9052	-237.9052	-239.3710	-238.3911
ADF(1)	-5.7467	-231.0214	-234.0214	-236.2200	-234.7501
ADF(2)	-3.4401	-230.8431	-234.8431	-237.7746	-235.8148
ADF(3)	-3.6619	-229.8070	-234.8070	-238.4714	-236.0216
Unit root tests for variable ΔMT_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-4.0889	23.9068	21.9068	20.4411	21.4210
ADF(1)	-5.0751	27.1116	24.1116	21.9130	23.3828
ADF(2)	-3.5458	27.1144	23.1144	20.1829	22.1427
ADF(3)	-3.1868	27.2685	22.2685	18.6041	21.0538

95% critical value for the ADF statistic= -2.9558

ΔMG_t = First difference of the Greek military expenditure series

ΔMT_t = First difference of the Turkish military expenditure series

Table B4. DF and ADF tests with an Intercept for YG, YT

The Dickey-Fuller regressions with an intercept					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable YG_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.2309	-321.8380	-323.8380	-325.3346	-324.3416
ADF(1)	-1.2692	-321.3776	-324.3776	-326.6224	-325.1329
ADF(2)	-1.1667	-320.3790	-324.3790	-327.3721	-325.3861
ADF(3)	-1.1453	-320.3739	-325.3739	-329.1152	-326.6327
Unit root tests for variable YG_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.5697	44.2102	42.2102	40.7137	41.7067
ADF(1)	-2.3346	44.8286	41.8286	39.5839	41.0733
ADF(2)	-2.4739	45.6959	41.6959	38.7028	40.6888
ADF(3)	-2.3696	45.6984	40.6984	36.9571	39.4396
Unit root tests for variable YT_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-0.32093	-347.2530	-349.2530	-350.7495	-349.7565
ADF(1)	0.080340	-346.0352	-349.0352	-351.2800	-349.7905
ADF(2)	-0.17132	-345.7020	-349.7020	-352.6950	-350.7090
ADF(3)	-0.93721	-344.1349	-349.1349	-352.8762	-350.3937
Unit root tests for variable YT_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.0799	33.9229	31.9229	30.4264	31.4194
ADF(1)	-1.1050	35.1972	32.1972	29.9525	31.4419
ADF(2)	-1.0375	35.8684	31.8684	28.8754	30.8614
ADF(3)	-1.0771	36.2942	31.2942	27.5530	30.0354

95% critical value for the ADF statistic= -2.9528

YG = Greek GDP in 1990 mn US \$

YT = Turkish GDP in 1990 mn US \$

Both calculated from SIPRI estimates for shares and military expenditure

Table B5. DF and ADF tests with an Intercept and a Linear Trend for YG, YT

The Dickey-Fuller regressions with an intercept and a linear trend					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable YG_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.2409	-319.9842	-322.9842	-325.2290	-323.7395
ADF(1)	-2.7129	-318.4467	-322.4467	-325.4397	-323.4537
ADF(2)	-2.2562	-318.2716	-323.2716	-327.0129	-324.5305
ADF(3)	-2.2847	-318.0986	-324.0986	-328.5881	-325.6092
Unit root tests for variable YG_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.7961	45.9324	42.9324	40.6876	42.1771
ADF(1)	-3.0360	47.3071	43.3071	40.3140	42.3000
ADF(2)	-2.7867	47.6087	42.6087	38.8674	41.3499
ADF(3)	-2.7513	47.6547	41.6547	37.1651	40.1441
Unit root tests for variable YT_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.2719	-344.6433	-347.6433	-349.8881	-348.3986
ADF(1)	-1.9000	-343.8940	-347.8940	-350.8870	-348.9011
ADF(2)	-2.0368	-343.3426	-348.3426	-352.0839	-349.6014
ADF(3)	-2.5450	-341.0769	-347.0769	-351.5664	-348.5875
Unit root tests for variable YT_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.9232	35.5710	32.5710	30.3262	31.8157
ADF(1)	-1.2867	35.9332	31.9332	28.9402	30.9262
ADF(2)	-1.9634	37.7647	32.7647	29.0234	31.5059
ADF(3)	-2.7299	40.0241	34.0241	29.5346	32.5135

95% critical value for the ADF statistic= -3.5514

Table B6. DF and ADF tests for the Differenced Series YG, YT

The Dickey-Fuller regressions with an intercept					
32 observations used in the estimation of all ADF regressions (1965-1996)					
Unit root tests for variable ΔYG_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-4.7002	-312.8660	-314.8660	-316.3318	-315.3519
ADF(1)	-4.5539	-311.7877	-314.7877	-316.9863	-315.5165
ADF(2)	-3.5012	-311.7787	-315.7787	-318.7102	-316.7504
ADF(3)	-3.3135	-311.4487	-316.4487	-320.1130	-317.6633
Unit root tests for variable ΔYG_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-4.3897	41.0697	39.0697	37.6039	38.5838
ADF(1)	-4.0932	41.6305	38.6305	36.4319	37.9017
ADF(2)	-3.1081	41.6699	37.6699	34.7385	36.6982
ADF(3)	-2.7053	41.6700	36.6700	33.0057	35.4554
Unit root tests for variable ΔYT_t (in levels)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-6.7969	-335.9921	-337.9921	-339.4578	-338.4779
ADF(1)	-3.3948	-335.6922	-338.6922	-340.8908	-339.4210
ADF(2)	-1.8155	-334.6838	-338.6838	-341.6153	-339.6555
ADF(3)	-1.7296	-334.6595	-339.6595	-343.3238	-340.8741
Unit root tests for variable ΔYT_t (in logs)					
	Test Statistic	LL	AIC	SBC	HQC
DF	-6.9135	33.0126	31.0126	29.5468	30.5267
ADF(1)	-3.1659	33.7067	30.7067	28.5081	29.9779
ADF(2)	-2.0649	34.0544	30.0544	27.1229	29.0827
ADF(3)	-2.0828	34.2587	29.2587	25.5944	28.0441

95% critical value for the ADF statistic= -2.9558

ΔYG_t and ΔYt_t are the first differences of Greek and Turkish GDP respectively

Table B7. Diagnostic Tests for the Military Equations in the VECM

	Greek Equation (ΔMG_t)	Turkish Equation (ΔMT_t)
Serial Correlation	$X^2(1)= 0.03$ [.869]	$X^2(1)= 0.19$ [.659]
Functional Form	$X^2(1)= 1.17$ [.278]	$X^2(1)= 7.68$ [.006]
Normality	$X^2(2)= 1.30$ [.522]	$X^2(2)= 0.001$ [1.00]
Heteroscedasticity	$X^2(1)= 0.49$ [.482]	$X^2(1)= 3.62$ [.057]

Serial Correlation: Lagrange multiplier test on residuals

Functional Form: Ramsey's RESET test using the square of the fitted values

Normality: Based on a test of skewness and kurtosis of residuals

Heteroscedasticity: Based on the regression of squared residuals on squared fitted values

Table B8. VECM Results for Greek and Turkish GDP Equations

	ΔYG_t	ΔYT_t
Intercept	-0.41 (0.69)	1.67 (2.10)**
ΔMG_{t-1}	0.31 (2.62)**	-0.30 (1.93)*
ΔMT_{t-1}	-0.07 (0.59)	0.47 (3.18)***
ΔYG_{t-1}	0.21 (1.15)	0.08 (0.35)
ΔYT_{t-1}	0.37 (2.85)***	-0.49 (2.83)***
Z_{t-1}	-0.02 (0.71)	0.07 (2.03)**
CD	-0.09 (2.26)**	0.05 (1.08)
R²	0.43	0.38
S.E.R.	0.06	0.08
DW	2.06	1.90
F-stat(6,28)	3.56***	2.87**
Diagnostic Tests		
Serial Correlation	$X^2(1)= 0.28$ [.598]	$X^2(1)= 0.03$ [.870]
Functional Form	$X^2(1)= 0.77$ [.381]	$X^2(1)= 1.93$ [.165]
Normality	$X^2(2)= 0.06$ [.969]	$X^2(2)= 4.56$ [.102]
Heteroscedasticity	$X^2(1)= 6.08$ [.014]	$X^2(1)= 0.001$ [.978]

t-ratios in parentheses and probabilities for the diagnostic tests in brackets

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

Table B9. Dickey-Fuller tests for unit roots

Variable	Test Statistics			
	Levels		First Differences	
	Intercept	Intercept & trend	Intercept	Intercept & trend
M	-1.69	-1.60	-4.67	-4.73
TB	1.05	0.08	-4.08	-4.57
TM	-3.32	-3.35	-4.88	-4.80
NATO	-1.09	-2.26	-4.43	-4.40
NG	-0.78	-1.85	-4.29	-4.40
POP	-0.11	-3.54	-2.96	-2.70
GDPC	-2.58	-0.42	-3.19	-4.73
Critical Values (5%)				
	-2.95	-3.54	-2.95	-3.55

For all the estimations Microfit 4.0 (Pesaran & Pesaran) and EvIEWS 1.0 (Micro TSP) were used

Figure B1 . Plot of Residuals and Two Standard Error Bands

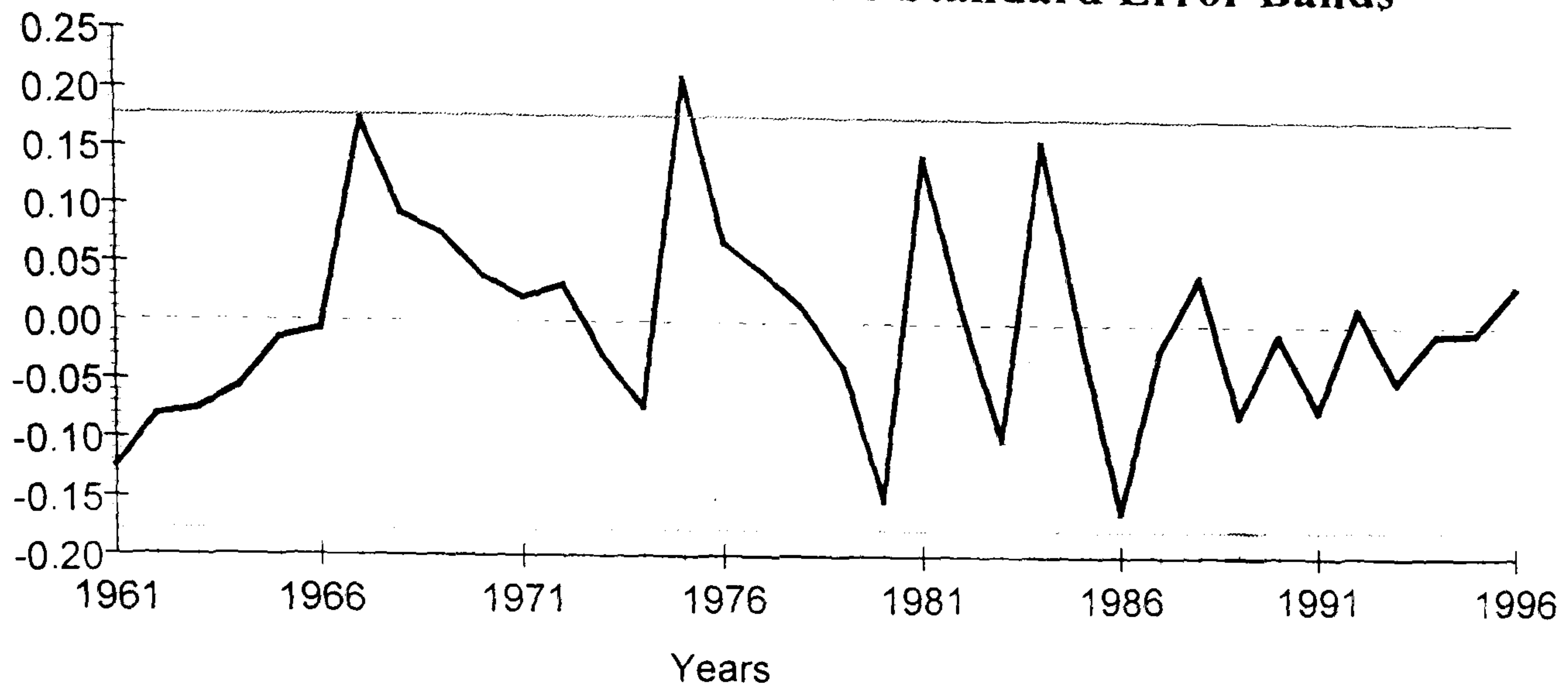


Figure B2. Plot of Residuals and Two Standard Error Bands

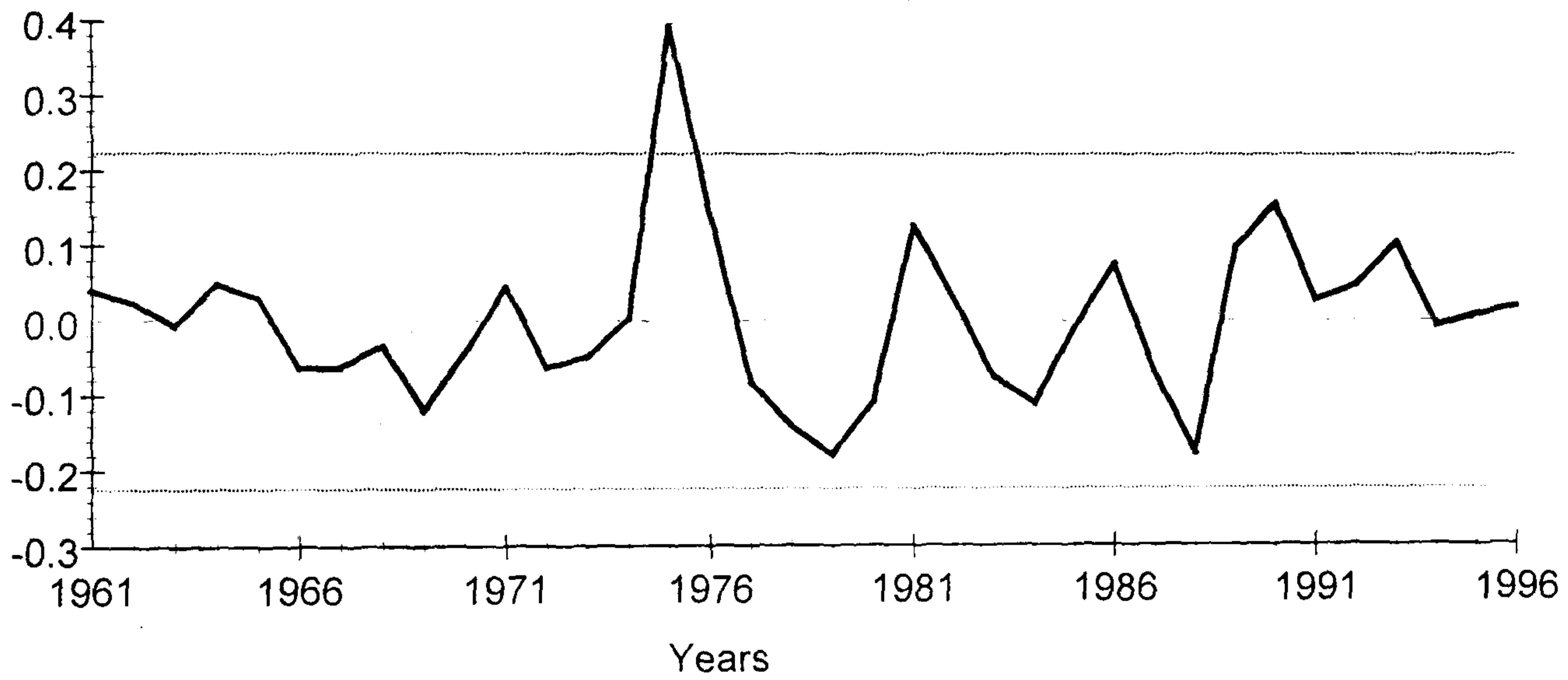


Figure B3. Persistence Profile of the effect of a system-wide shock to CV'(s)

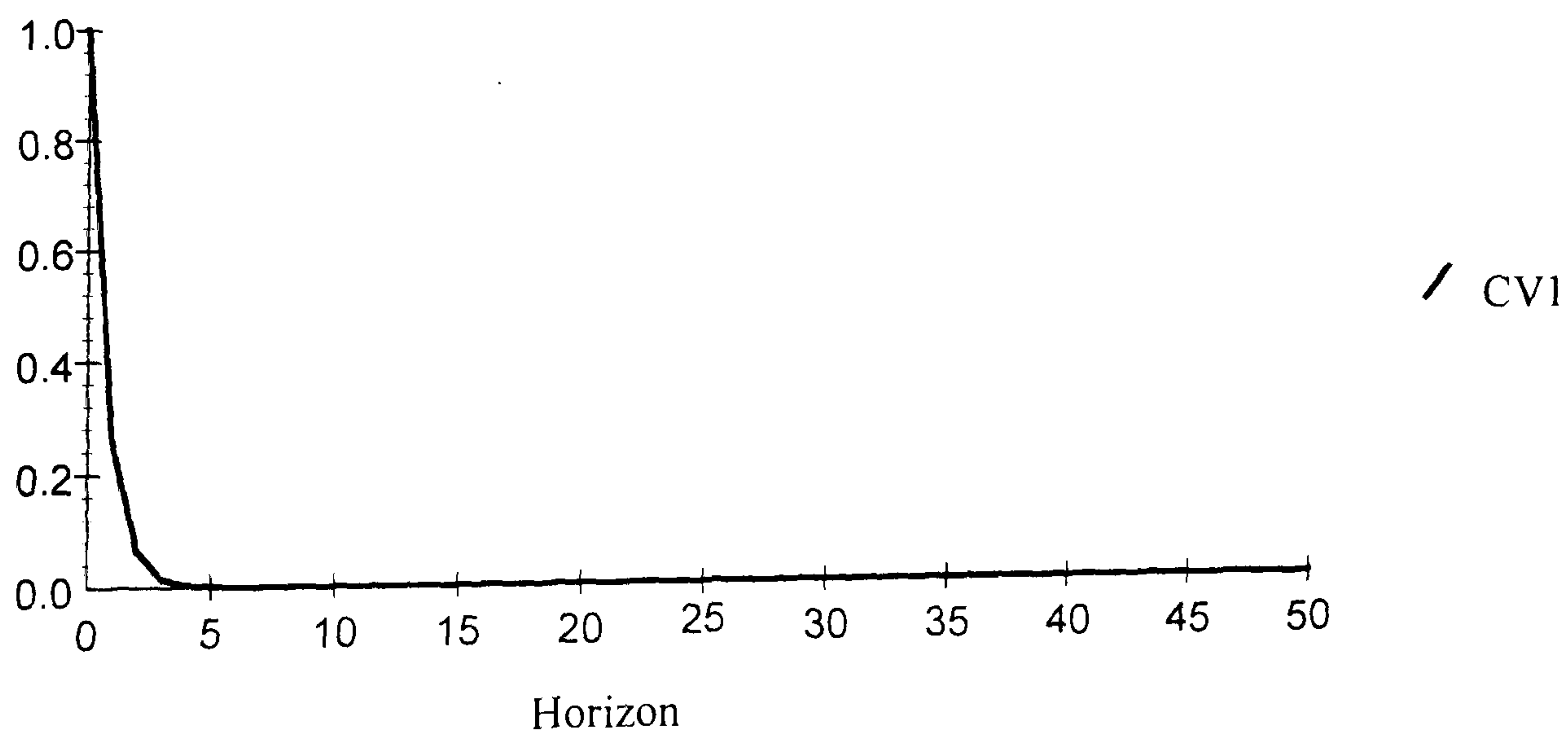


Figure B4. Plot of Cumulative Sum of Recursive Residuals*

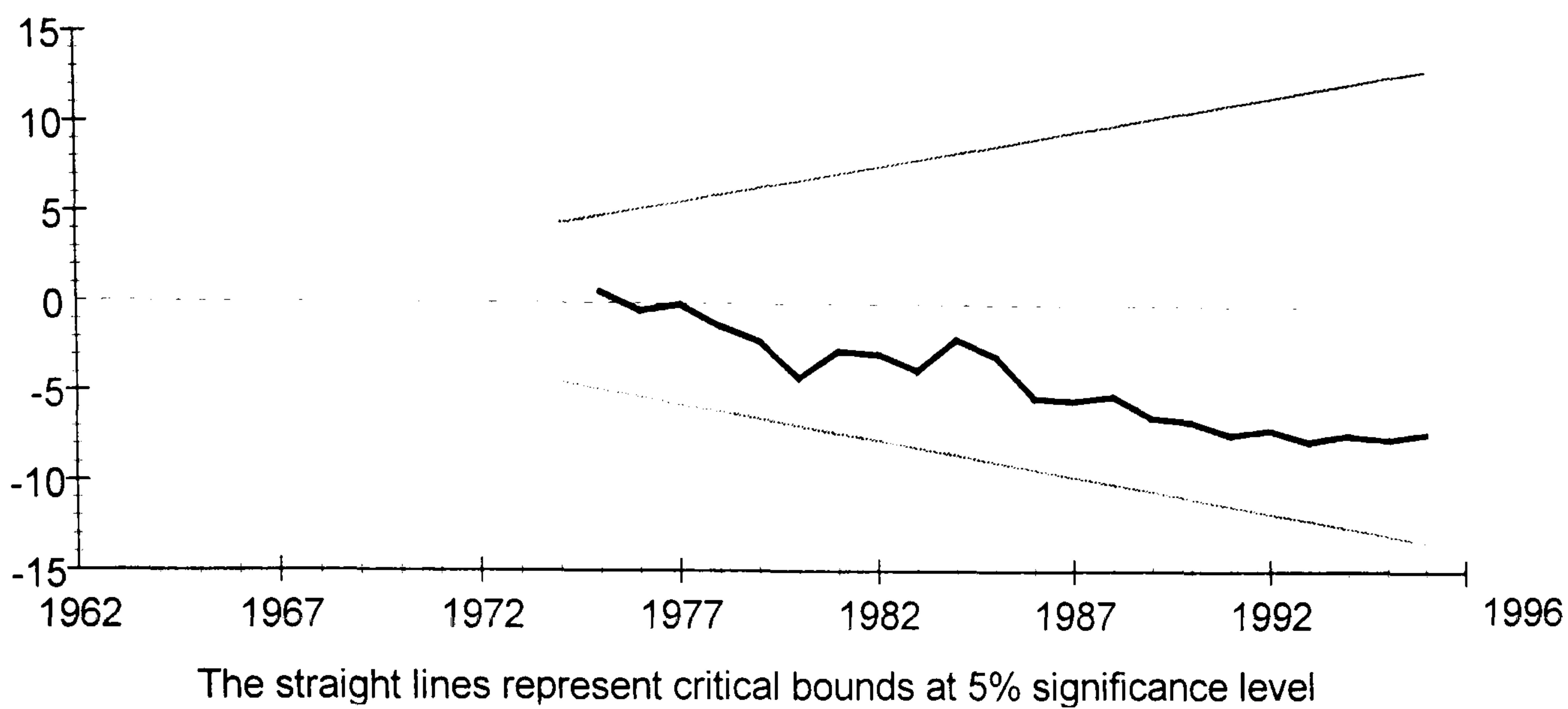
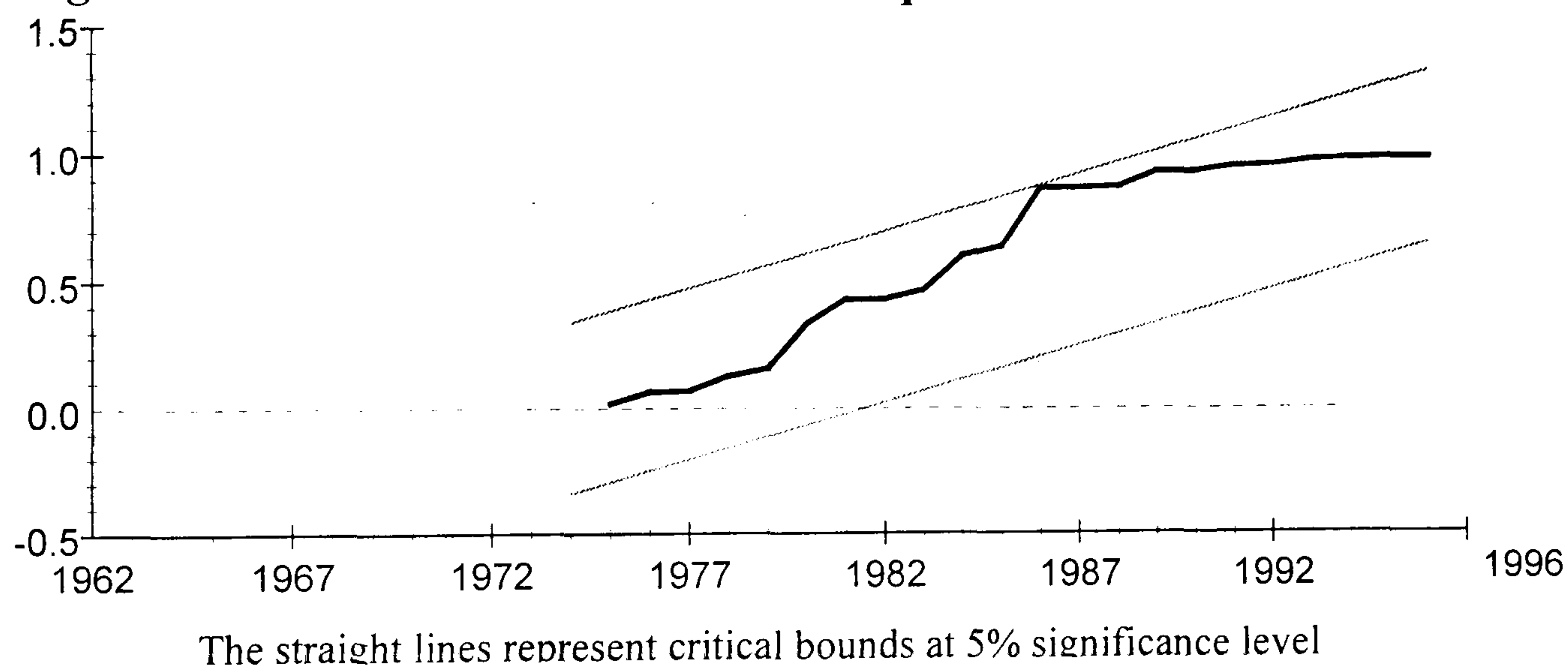


Figure B5. Plot of Cumulative Sum of Squares of Recursive Residuals*



*from the Greek equation

Figure B6. Plot of Cumulative Sum of Recursive Residuals**

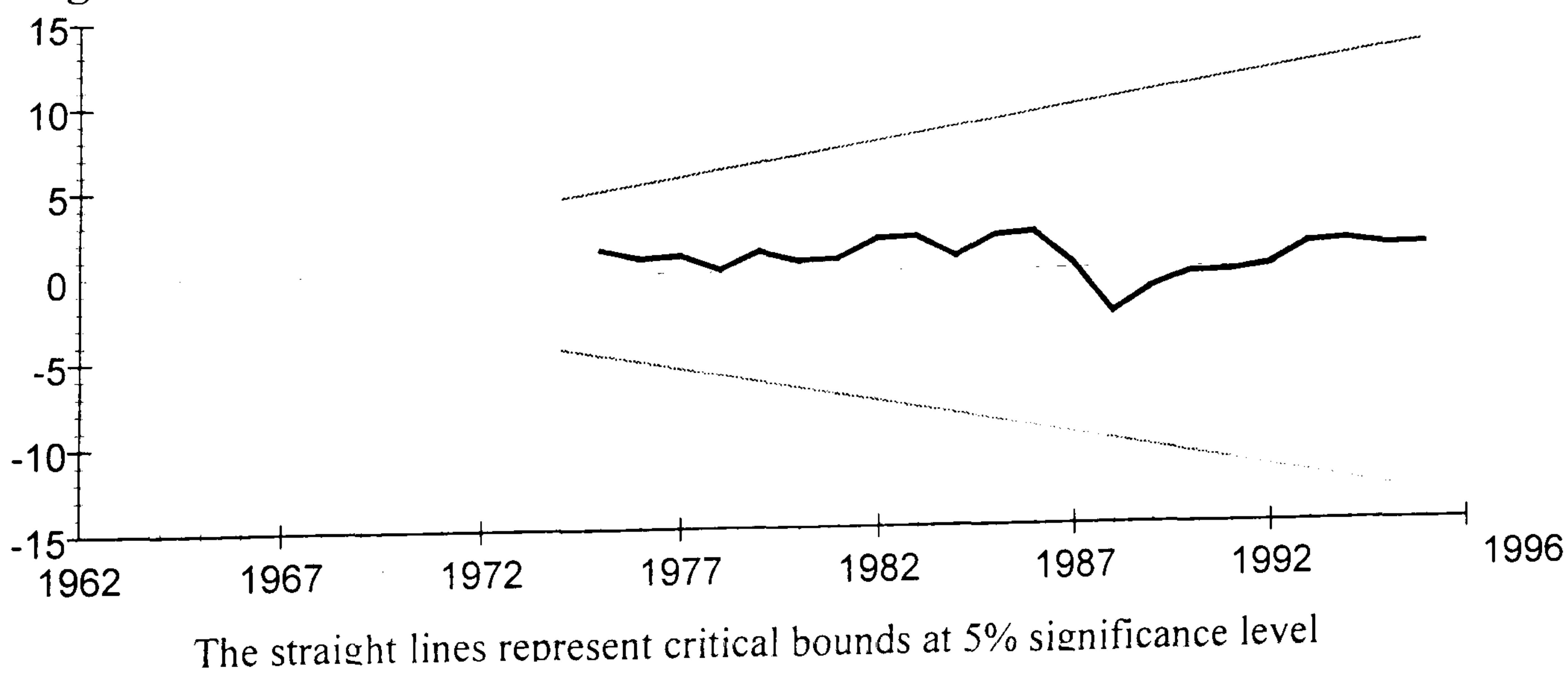
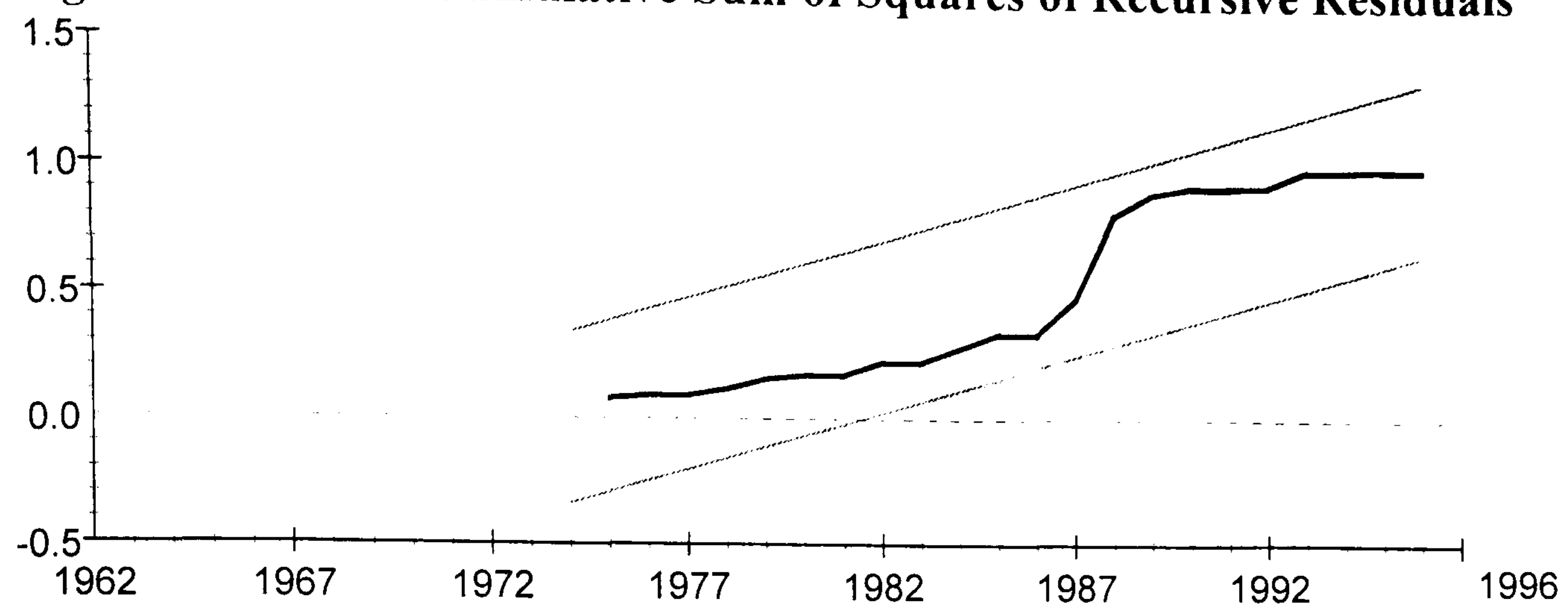


Figure B7. Plot of Cumulative Sum of Squares of Recursive Residuals**



The straight lines represent critical bounds at 5% significance level

**from the Turkish equation

Figure B8. Generalized Impulse Response to one S.E. shock in the eq. for MG

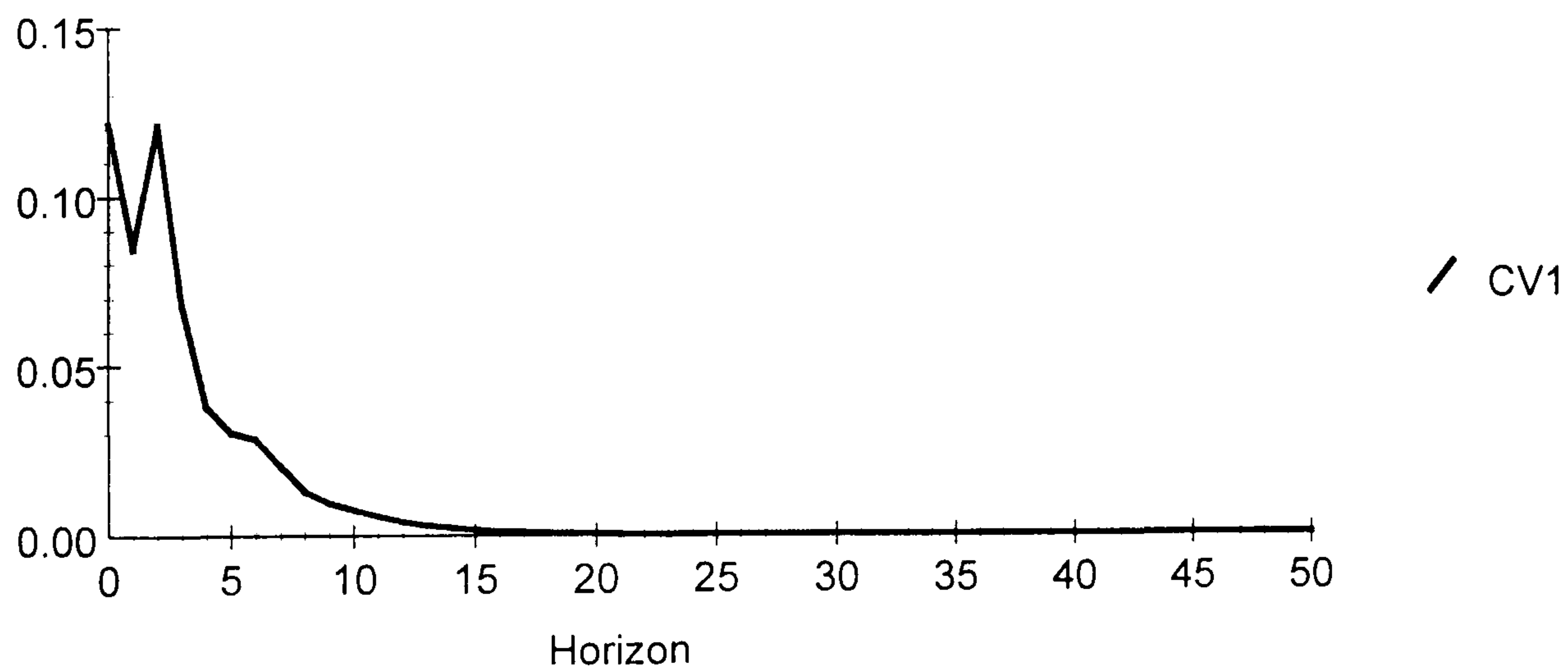


Figure B9. Generalized Impulse Response to one S.E. shock in the eq. for MT

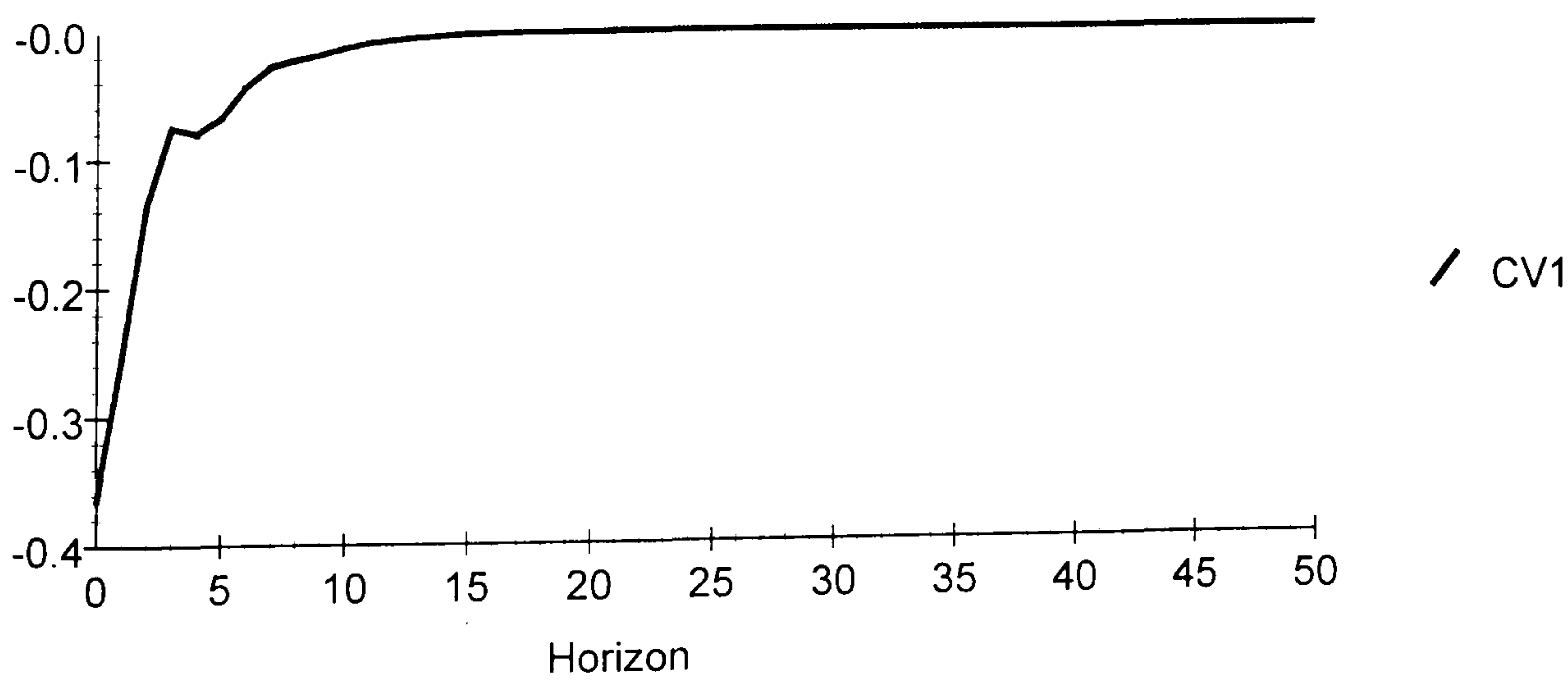


Figure B10. Persistence Profile of the effect of a system-wide shock to CV

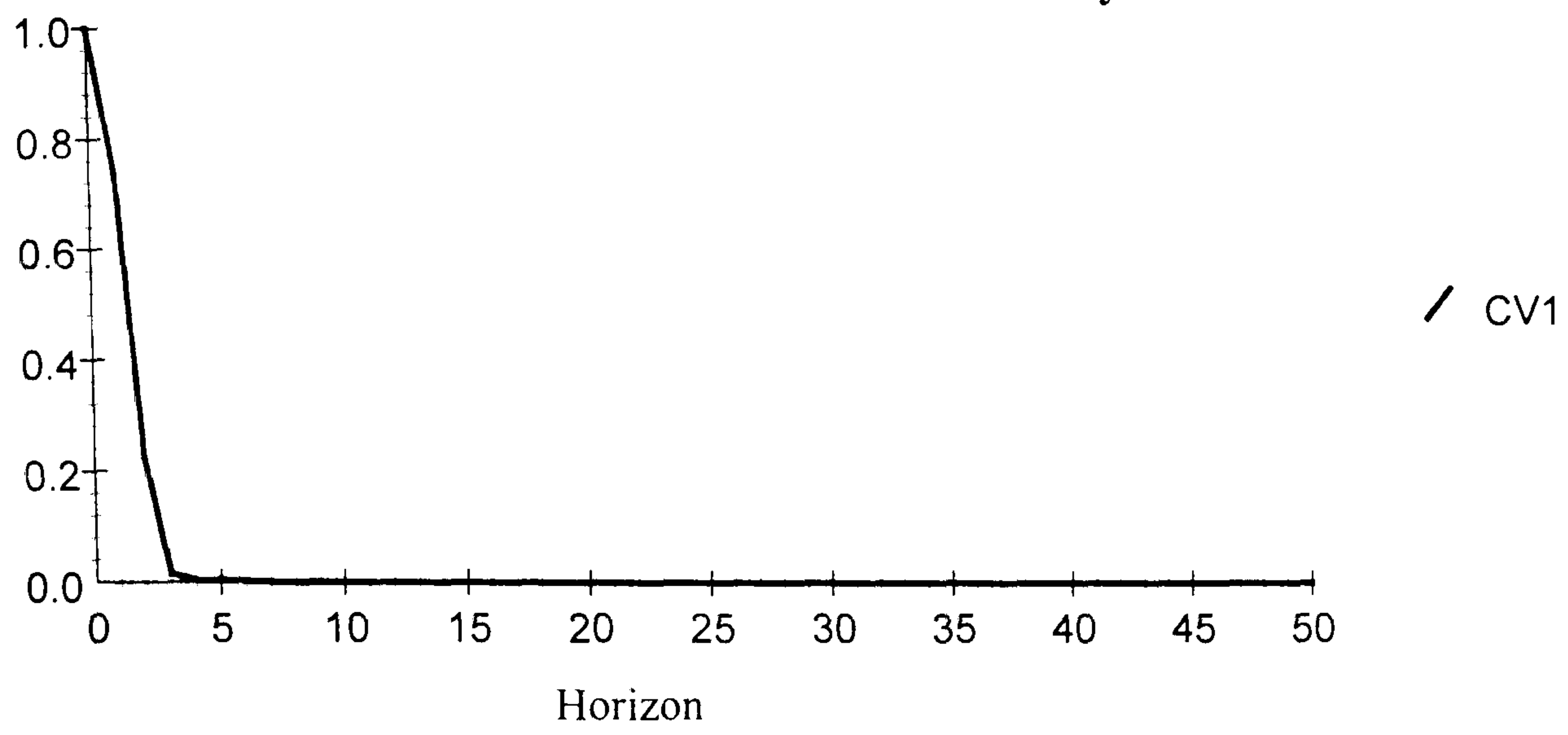


Table C1. DF and ADF tests for Greek GDP and Military Burden

The Dickey-Fuller regressions with an intercept					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable Y_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-6.1440	78.5373	76.5373	75.0408	76.0338
ADF(1)	-4.2924	78.5425	75.5425	73.2978	74.7872
ADF(2)	-4.1798	78.8932	74.8932	71.9002	73.8862
ADF(3)	-3.3270	79.0174	74.0174	70.2761	72.7585
Unit root tests for variable SM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.8475	128.6736	126.6736	125.1771	126.1701
ADF(1)	-1.8618	128.7559	125.7559	123.5112	125.0007
ADF(2)	-1.6754	128.9879	124.9879	121.9949	123.9809
ADF(3)	-1.8951	129.7788	124.7785	121.0372	123.5197

95% critical value for the ADF statistic= -2.9528

Table C2. DF and ADF tests for Greek GDP and Military burden

The Dickey-Fuller regressions with an intercept and a linear trend					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable Y_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.7747	78.5540	75.5540	73.3092	74.7987
ADF(1)	-1.7486	78.5645	74.5645	71.5715	73.5575
ADF(2)	-1.6676	79.0296	74.0296	70.2883	72.7708
ADF(3)	-1.6397	79.0882	73.0882	68.5987	71.5776
Unit root tests for variable SM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.5007	128.6762	125.6762	123.4315	124.9209
ADF(1)	-1.5376	128.7817	124.7817	121.7887	123.7747
ADF(2)	-1.1960	128.9879	123.9879	120.2467	122.7291
ADF(3)	-1.5541	129.8568	123.8568	119.3673	122.3462

95% critical value for the ADF statistic= -3.5514

Table C3. DF and ADF tests for Greek GDP and Military burden (differenced)

The Dickey-Fuller regressions with an intercept					
32 observations used in the estimation of all ADF regressions (1965-1996)					
Unit root tests for variable ΔY_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-3.3006	68.1697	66.1697	64.7040	65.6838
ADF(1)	-2.3934	68.8647	65.8647	63.6661	65.1359
ADF(2)	-1.4795	70.8430	66.8430	63.9115	65.8713
ADF(3)	-1.2713	70.9933	65.9933	62.3290	64.7787
Unit root tests for variable ΔSM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-5.4916	122.9183	120.9183	119.4526	120.4325
ADF(1)	-4.6316	123.4909	120.4909	118.2923	119.7621
ADF(2)	-3.1333	123.6937	119.6937	116.7622	118.7220
ADF(3)	-3.4694	124.8042	119.8042	116.1399	118.5896

95% critical value for the ADF statistic= -2.9558

Table C4. Determination of the order of the VAR model for Greece

1965-96. Order of VAR=5, Variables included: Y, SM Exogenous: Constant						
Order	LL	AIC	SBC	LR	LR Adjusted	
5	207.95	185.95	169.83	-----	-----	
4	202.23	184.23	171.04	X ² (4)= 11.44 [.022]	7.51	[.111]
3	201.29	187.29	177.03	X ² (8)= 13.31 [.101]	8.74	[.365]
2	199.76	189.76	182.44	X ² (12)=16.38 [.175]	10.75	[.551]
1	194.39	188.39	183.99	X ² (16)=27.12 [.040]	17.80	[.336]
0	101.00	99.00	97.54	X ² (20)=213.90[.000]	140.37	[.000]

DERIVATION OF THE FEDER-TYPE MODEL

The form of the model used here assumes the economy consists of four sectors mutually exclusive and exhaustive: the civilian sector (C), the non-military government sector (G), the export sector (X) and the military sector (M) so that total output of the economy is the sum of the civilian output, the non-military government output, the export output and the military output. That is:

$$Y = C + G + X + M \quad (1)$$

Capital and labour are allocated among the four sectors at each point in time. So, that:

$$K = K_C + K_G + K_X + K_M \quad \text{and} \quad L = L_C + L_G + L_X + L_M \quad (2 \text{ a, b})$$

where uppercase subscripts denote the civilian sector (C), the non-military government sector (G), the export sector (X), and the defence sector (M).

Each of the M, G and X sectors has an externality effect on the civilian (C) sector.

For this approach the production functions for the four sectors are:

$$G = G (K_G , L_G)$$

$$M = M (K_M , L_M)$$

(3 a, b, c, d)

$$X = X (K_X, L_X)$$

$$C = C (K_C , L_C , G, X, M)$$

where subscripts C, M, G, X denote sectoral inputs.

Allowing for relative productivity differences between the “base” sector (civilian) and the other three sectors, ie by $(1+\delta)$, the ratios of the marginal productivities for the sectors are:

$$M_L /C_L = M_K / C_K = (1 + \delta_m)$$

$$G_L /C_L = G_K / C_K = (1 + \delta_g)$$

(4 a, b, c)

$$X_L /C_L = X_K /C_K = (1+ \delta_x)$$

where the uppercase subscripts on M, G, X, C denote partial derivatives (or marginal products) of labour and capital (ie. $M_L = \theta M / \theta L_m$ and $M_K = \theta M / \theta K_m$). Also, the size of M, G, X may act as “externality” factors for the civilian sector (C). In other words, the model also identifies marginal externality effects of each of the three sectors (M, G, X) on the civilian sector (C). So, we will have:

$$G_K = (1 + \delta_g) C_K \quad \text{and} \quad G_L = (1 + \delta_g) C_L$$

$$X_K = (1 + \delta_x) C_K \quad \text{and} \quad X_L = (1 + \delta_x) C_L \quad (5 \text{ a, b, c})$$

$$M_K = (1 + \delta_m) C_K \quad \text{and} \quad M_L = (1 + \delta_m) C_L$$

where \boxtimes_i is the relative factor productivity between the “base” sector and the other three sectors. If for example the productivity index for defence δ_m is positive then the defence sector is more productive than the civilian sector. A zero value for δ_m would indicate the absence of a productivity difference while a negative value for δ_m would indicate that the civilian sector is more productive.

Due to unavailability of sectoral input data the model is reformulated in terms of aggregate inputs.

Differentiating with respect to time (indicated by a prime) equation 1 becomes:

$$Y' = M' + G' + X' + C' \Rightarrow$$

$$Y' = M_K I_m + M_L L'_m + G_K I_g + G_L L'_g + X_K I_x + X_L L'_x + C_K I_c + C_L L'_c + \\ + C_M M' + C_G G' + C_X X'$$

where $I_i = K'_i$, investment in sector I (i=m, g, x, c)

Using the fact that productivities may vary across sectors (5a,b,c), it follows:

$$Y' = (1+\delta_m) C_K I_m + (1+\delta_m) C_L L'_m + (1+\delta_g) C_K I_g + (1+\delta_g) C_K I_x + (1+\delta_x) C_K I_x + \\ (1+\delta_x) C_L L'_x + C_K I_c + C_L L'_c + C_M M' + C_G G' + C_X X' \Rightarrow$$

$$C_K (I_m + I_g + I_x + I_c) + C_L (L'_m + L'_g + L'_x + L'_c) + \delta_m (C_K I_m + C_L L'_m) + \\ \delta_g (C_K I_g + C_L L'_g) + \delta_x (C_K I_x + C_L L'_x) + C_M M' + C_G G' + C_X X'$$

Using (2a,b) and (5a,b,c):

$$Y' = C_K I + C_L L' + \frac{\delta_m}{1+\delta_m} (M_K I_m + M_L L'_m) + \frac{\delta_g}{1+\delta_g} (G_K I_g + G_L L'_g) + \\ \frac{\delta_x}{1+\delta_x} (X_K I_x + X_L L'_x) + C_M M' + C_G G' + C_X X' \Rightarrow$$

$$Y' = C_K I + C_L L' + \left(\frac{\delta_m}{1+\delta_m} + C_M \right) M' + \left(\frac{\delta_g}{1+\delta_g} + C_G \right) G' + \left(\frac{\delta_x}{1+\delta_x} + C_X \right) X'$$

Dividing by Y, gives:

$$\frac{Y'}{Y} = C_K \left(\frac{I}{Y} \right) + C_L \left(\frac{L'}{L} \right) \left(\frac{L}{Y} \right) + \left(\frac{\delta_m}{1+\delta_m} + C_M \right) \frac{M'}{M} \times \frac{M}{Y} + \left(\frac{\delta_g}{1+\delta_g} + C_G \right) \frac{G'}{G} \times \frac{G}{Y} +$$

$$\left(\frac{\delta_x}{1+\delta_x} + C_X \right) \frac{X'}{X} \times \frac{X}{Y}$$

and using (8a,b,c), it becomes:

$$\frac{Y'}{Y} = C_K \left(\frac{I}{Y} \right) + \beta \left(\frac{L'}{L} \right) + \left(\frac{\delta_m}{1 + \delta_m} + \theta_m \frac{C}{M} \right) \frac{M'}{M} \times \frac{M}{Y} + \left(\frac{\delta_g}{1 + \delta_g} + \theta_g \frac{C}{G} \right) \frac{G'}{G} \times \frac{G}{Y} +$$

$$\left(\frac{\delta_x}{1 + \delta_x} + \theta_x \frac{C}{X} \right) \frac{X'}{X} \times \frac{X}{Y}$$

This is equation 7 in the text.

Table E1. Dickey-Fuller tests for unit roots

Variable	Test Statistics			
	Levels		First Differences	
	Intercept	Intercept & trend	Intercept	Intercept & trend
Y	-1.57	-1.00	-4.09	-4.73
M	-1.69	-1.60	-4.67	-4.73
S	-1.50	-2.30	-4.06	-4.01
TB	1.05	0.08	-4.08	-4.57
L	-2.42	-3.08	-6.11	-6.00
INFL	-1.71	-1.39	-4.91	-5.21
EX	1.60	-1.03	-2.84	-3.82
TSM	-3.32	-3.35	-4.88	-4.80
NATO	-1.09	-2.26	-4.43	-4.40
NG	-0.78	-1.85	-4.29	-4.40
GDPC	-2.58	-0.42	-3.19	-4.73
	Critical	Critical value(5%)	Critical	Critical value(5%)
	-2.95	-3.54	-2.95	-3.55

For all the estimations Microfit 4.0 (Pesaran & Pesaran) and Eviews 1.0 (Micro TSP) were used

Table F1. Disaggregated Military Expenditure for Greece, Portugal and Spain*

	Personnel Expenditure			Equipment Expenditure		
	Greece	Portugal	Spain	Greece	Portugal	Spain
1987	3116	1370	5223	868	211	2597
1988	3108	1538	5354	1244	244	2034
1989	3076	1739	5824	1095	290	1860
1990	3243	1830	5901	1083	258	1209
1991	3089	1924	5968	974	218	1190
1992	3062	2125	5928	1167	58	930
1993	3027	2032	5778	1202	183	1252
1994	3119	1955	5526	1208	104	1018
1995	3201	2077	5684	1001	158	1177
1996	3280	2076	5687	1131	162	1132
1997	3547	2094	5606	1106	411	1151

* in constant 1990 mn US \$

Source: SIPRI

Table F2. Disaggregated Military Expenditure for Greece and Turkey*

	Personnel Expenditure		Equipment Expenditure	
	Greece	Turkey	Greece	Turkey
1987	3116	1550	868	943
1988	3108	1401	1244	886
1989	3076	2098	1095	783
1990	3243	2657	1083	1100
1991	3089	2743	974	1284
1992	3062	2897	1167	1475
1993	3027	3585	1202	1506
1994	3119	3280	1208	1884
1995	3201	3363	1001	1962
1996	3280	3417	1131	2278
1997	3547	3260	1106	2432

* in constant 1990 mn US \$

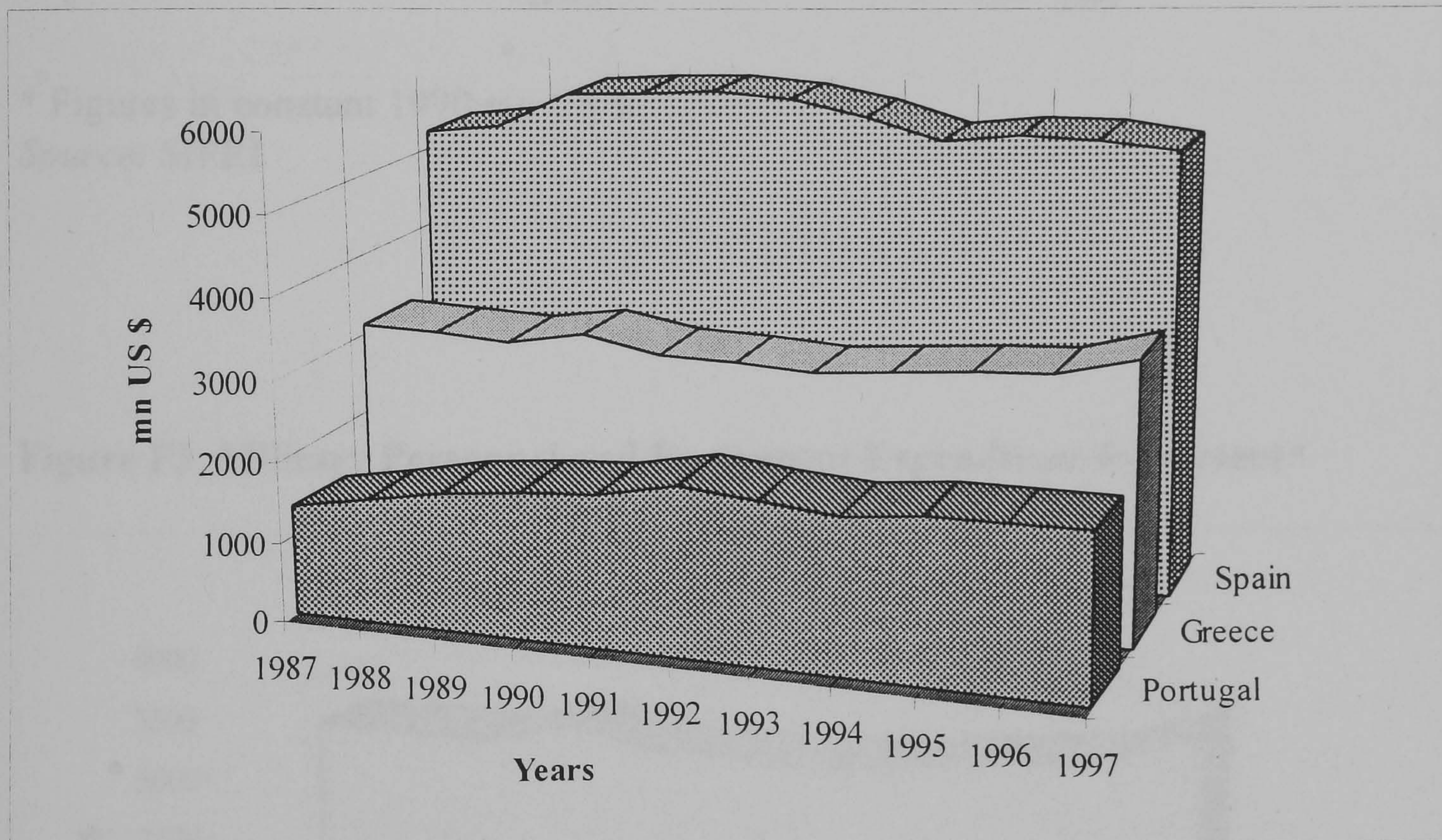
Source: SIPRI

Table F3. Imports of Major Conventional Weapons in 1990 mn US \$*

	1988-92	1991	1992	1993	1994	1995	1991-95
Turkey	6167	954	1640	2288	2089	1125	8096
Greece	6197	559	2632	891	1185	489	5756
Spain	3747	126	261	580	863	359	2189
Portugal	1374	1062	3	300	500	5	1870

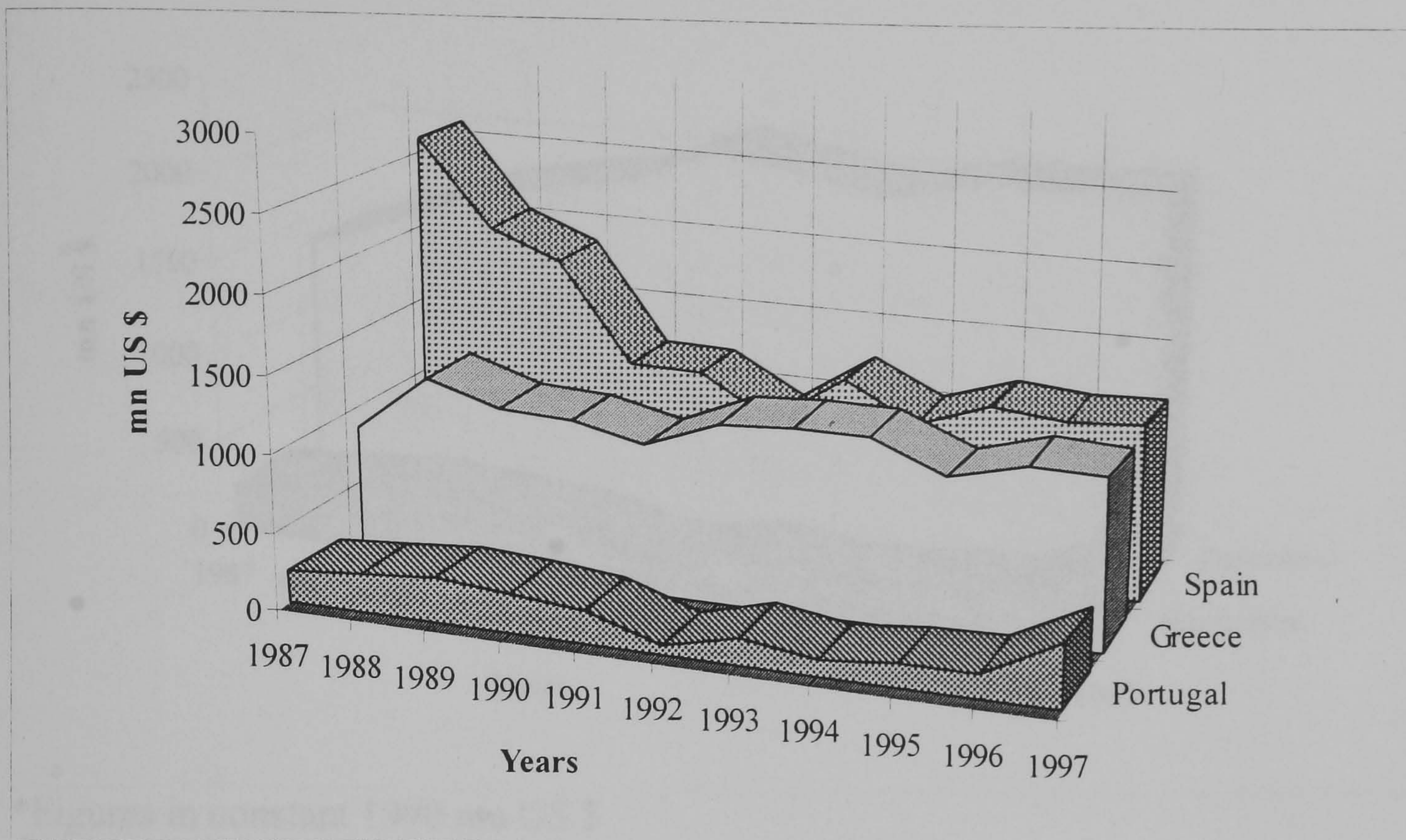
* For the years 1991-95, Turkey was ranked first among the major recipients for conventional weapons, Greece fifth, Spain twentieth and Portugal twentythird
 Source: SIPRI

Figure F1. Military Personnel Expenditure for Greece, Portugal and Spain*



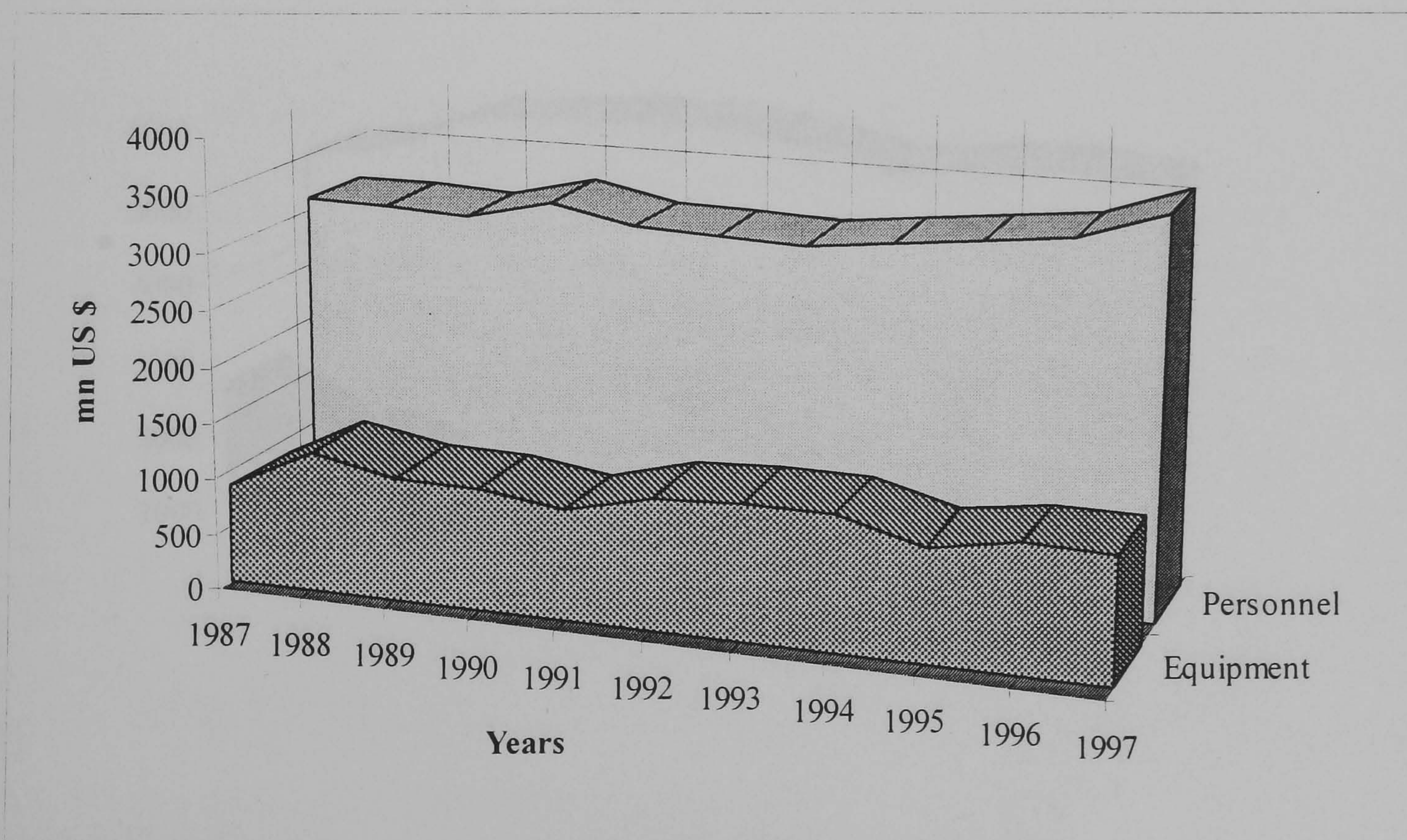
*Figures in constant 1990 mn US \$
 Source: SIPRI

Figure F2. Military Equipment Expenditure for Greece, Spain and Portugal *



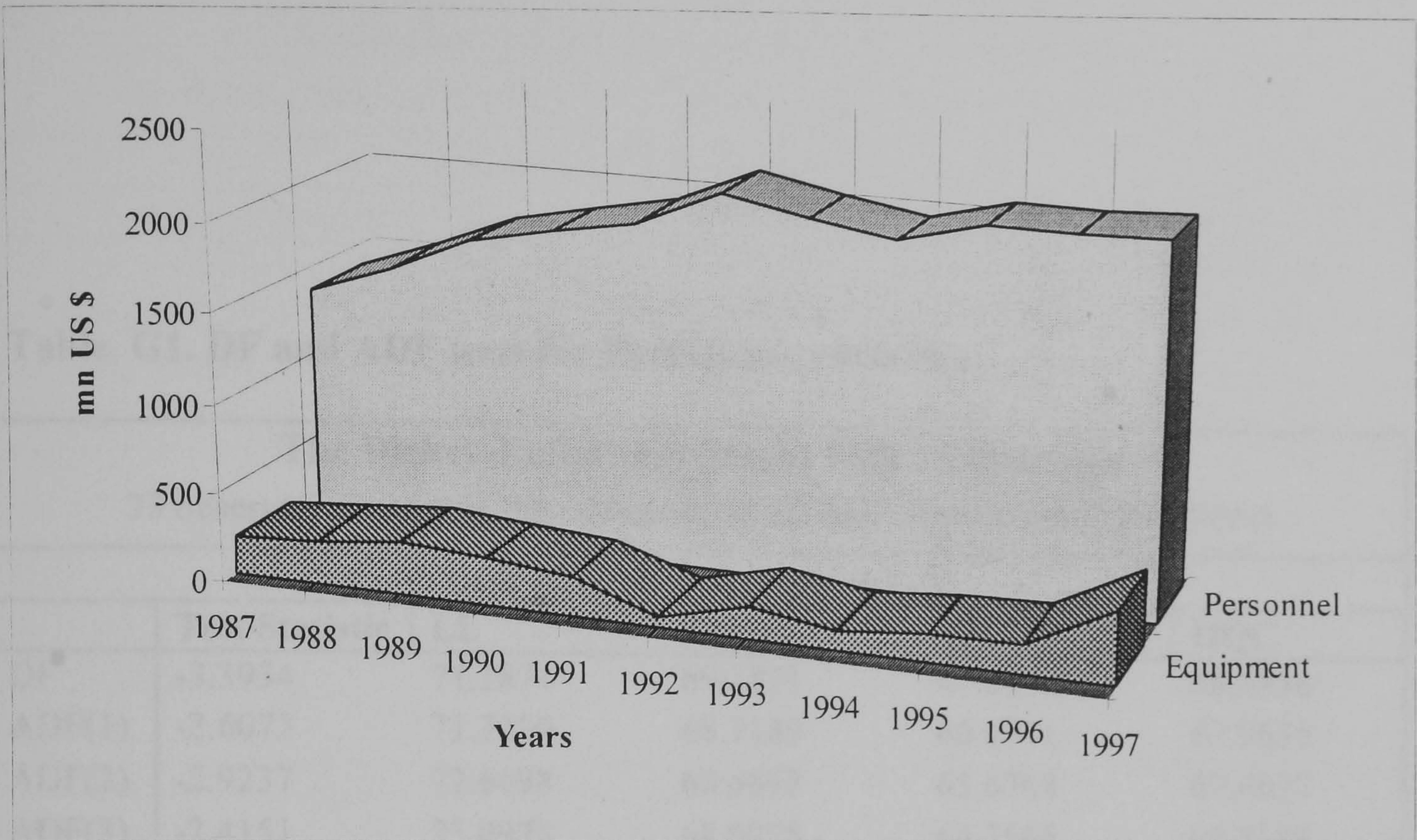
* Figures in constant 1990 mn US \$
 Source: SIPRI

Figure F3. Military Personnel and Equipment Expenditure for Greece*



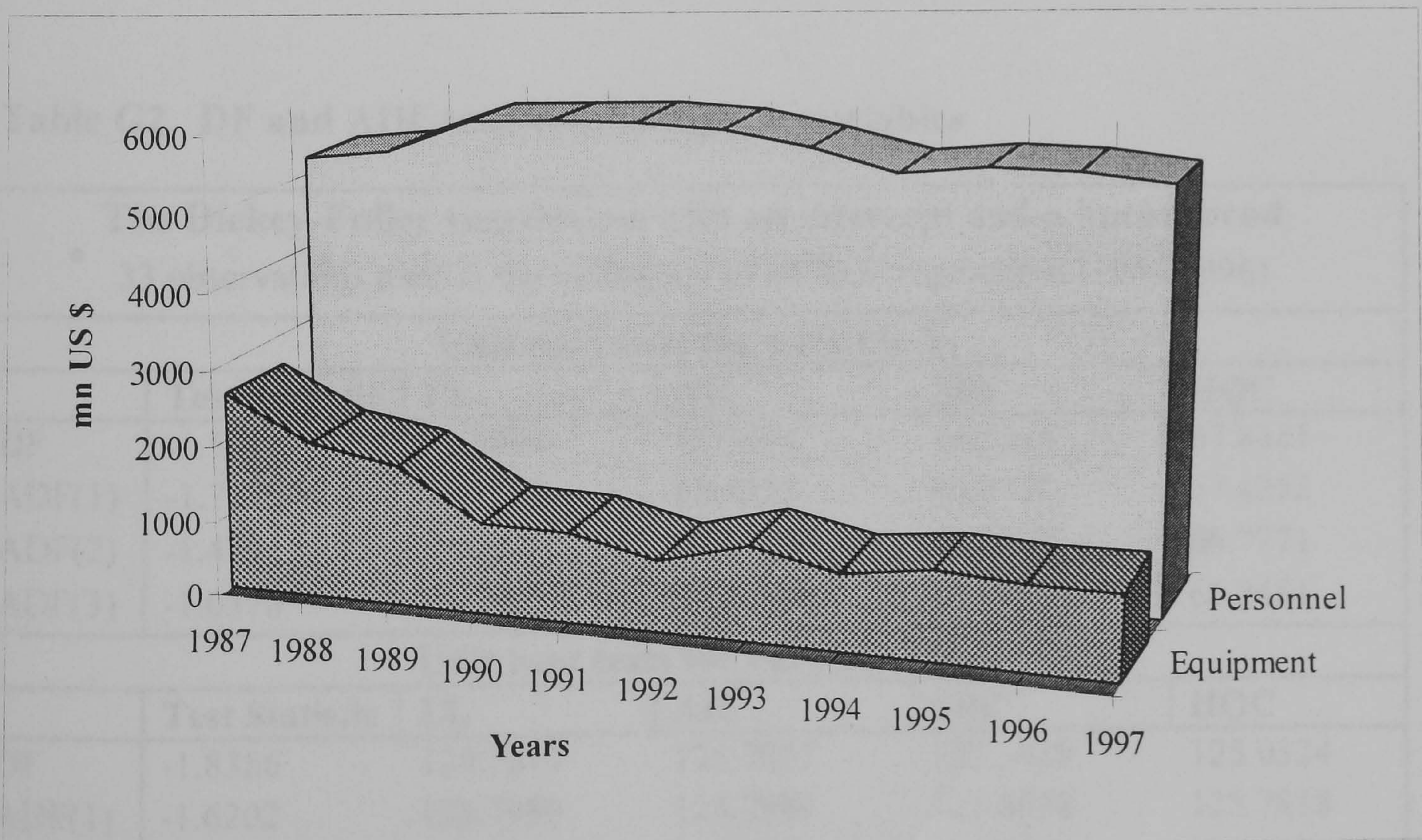
* Figures in constant 1990 mn US \$
 Source: SIPRI

Figure F4. Military Personnel and Equipment Expenditure for Portugal*



*Figures in constant 1990 mn US \$
 Source: SIPRI

Figure F5. Military Personnel and Equipment Expenditure for Spain*



*Figures in constant 1990 mn US \$
 Source: SIPRI

Table G1. DF and ADF tests for Portuguese variables

The Dickey-Fuller regressions with an intercept					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable Y_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-3.3954	71.1871	69.1871	67.6906	68.6836
ADF(1)	-2.6072	71.7189	68.7189	66.4741	67.9636
ADF(2)	-2.9237	72.6698	68.6698	65.6768	67.6627
ADF(3)	-2.4151	73.0978	68.0978	64.3565	66.8389
Unit root tests for variable SM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.1033	127.6275	125.6275	124.1310	125.1240
ADF(1)	-0.99999	127.8603	124.8603	122.6155	124.1050
ADF(2)	-0.90726	127.9598	123.9598	120.9667	122.9527
ADF(3)	-1.1534	128.7527	123.7527	120.0114	122.4938

95% critical value for the ADF statistic= -2.9528

Table G2. DF and ADF tests for Portuguese variables

The Dickey-Fuller regressions with an intercept and a linear trend					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable Y_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.5712	71.5994	68.5994	66.3546	67.8441
ADF(1)	-1.7173	72.4323	68.4323	65.4392	67.4252
ADF(2)	-1.4791	73.0359	68.0359	64.2947	66.7771
ADF(3)	-1.6378	73.7557	67.7557	63.2662	66.2451
Unit root tests for variable SM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-1.8386	128.7877	125.7877	123.5429	125.0324
ADF(1)	-1.6202	128.7989	124.7989	121.8058	123.7918
ADF(2)	-1.4891	128.8023	123.8023	120.0610	122.5434
ADF(3)	-1.6655	129.7255	123.7255	119.2360	122.2150

95% critical value for the ADF statistic= -3.5514

Table G3. DF and ADF tests for Portuguese variables

The Dickey-Fuller regressions with an intercept					
32 observations used in the estimation of all ADF regressions (1965-1996)					
Unit root tests for variable ΔY_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-3.7778	65.9746	63.9746	62.5089	63.4888
ADF(1)	-3.2928	66.0555	63.0555	60.8569	62.3267
ADF(2)	-2.0135	67.5752	63.5752	60.6437	62.6035
ADF(3)	-2.6488	69.4159	64.4159	60.7516	63.2013
Unit root tests for variable ΔSM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-6.2443	123.0944	121.0944	119.6286	120.6085
ADF(1)	-4.5549	123.3420	120.3420	118.1434	119.6132
ADF(2)	-2.9931	123.6223	119.6223	116.6908	118.6506
ADF(3)	-2.6633	123.6381	118.6381	114.9738	117.4235

95% critical value for the ADF statistic= -2.9558

Table G4. Determining the order of the VAR model for Portugal

1965-96. Order of VAR=5, Variables included:Y, SM Exogenous: Constant					
Order	LL	AIC	SBC	LR	LR Adjusted
5	207.95	185.95	169.83	-----	-----
4	202.23	184.23	171.04	X ² (4)= 11.44 [.022]	7.51 [.111]
3	201.29	187.29	177.03	X ² (8)= 13.31 [.101]	8.74 [.365]
2	199.76	189.76	182.44	X ² (12)=16.38 [.175]	10.75 [.551]
1	194.39	188.39	183.99	X ² (16)=27.12[.040]	17.80[.336]
0	101.00	99.00	97.54	X ² (20)=213.90[.000]	140.37[.000]

Table G5. DF and ADF tests for Spanish variables

The Dickey-Fuller regressions with an intercept					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable Y_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-4.1375	83.3399	81.3399	79.8434	80.8364
ADF(1)	-1.7906	87.4969	84.4969	82.2521	83.7416
ADF(2)	-1.9297	87.8147	83.8147	80.8217	82.8077
ADF(3)	-1.4945	88.0038	83.0038	79.2625	81.7450
Unit root tests for variable SM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-0.94351	175.7395	173.7395	172.2430	173.2360
ADF(1)	-0.98938	175.8056	172.8056	170.5609	172.0503
ADF(2)	-2.0475	181.1221	177.1221	174.1291	176.1150
ADF(3)	-1.8489	181.1227	176.1227	172.3814	174.8639

95% critical value for the ADF statistic= -2.9528

Table G6. DF and ADF tests for Spanish variables

The Dickey-Fuller regressions with an intercept and a linear trend					
33 observations used in the estimation of all ADF regressions (1964-1996)					
Unit root tests for variable Y_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.1541	84.0889	81.0889	78.8441	80.3336
ADF(1)	-1.8718	88.5514	84.5514	81.5584	83.5444
ADF(2)	-1.8579	88.7598	83.7598	80.0185	82.5010
ADF(3)	-1.7497	88.9909	82.9909	78.5013	81.4803
Unit root tests for variable SM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-0.68116	176.0889	173.0889	170.8441	172.3336
ADF(1)	-0.69436	176.1085	172.1085	169.1155	171.1014
ADF(2)	-1.8941	181.1291	176.1291	172.3878	174.8702
ADF(3)	-1.6998	181.1293	175.1293	170.6397	173.6187

95% critical value for the ADF statistic= -3.5514

Table G7. DF and ADF tests for Spanish variables

The Dickey-Fuller regressions with an intercept					
32 observations used in the estimation of all ADF regressions (1965-1996)					
Unit root tests for variable ΔY_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-2.4665	83.2731	81.2731	79.8073	80.7872
ADF(1)	-2.2422	83.2839	80.2839	78.0853	79.5551
ADF(2)	-1.7790	84.6578	80.6578	77.7263	79.6861
ADF(3)	-1.7451	84.6607	79.6607	75.9964	78.4461
Unit root tests for variable ΔSM_t					
	Test Statistic	LL	AIC	SBC	HQC
DF	-5.4253	169.5225	167.5225	166.0568	167.0366
ADF(1)	-2.3571	173.3084	170.3084	168.1098	169.5796
ADF(2)	-2.5327	173.8125	169.8125	166.8811	168.8408
ADF(3)	-2.0522	173.9910	168.9910	165.3266	167.7764

95% critical value for the ADF statistic= -2.9558

Table G8. Determining the order of the VAR model for Spain

1965-96. Order of VAR=5, Variables included: Y, SM Exogenous: Constant					
Order	LL	AIC	SBC	LR	LR Adjusted
5	269.53	247.53	231.40	-----	-----
4	266.43	248.43	235.23	$X^2(4) = 6.20 [.185]$	4.07 [.397]
3	265.72	251.72	241.46	$X^2(8) = 7.62 [.472]$	5.00 [.758]
2	260.92	250.92	243.59	$X^2(12) = 17.21 [.142]$	11.29 [.504]
1	253.63	247.63	243.23	$X^2(16) = 31.80 [.011]$	20.87 [.184]
0	138.26	136.26	134.79	$X^2(20) = 262.53 [.000]$	172.29 [.000]

Table G9. Cochrane-Orcutt Estimation Results (1961-1996) for Spain

AR(1) converged after 5 iterations			
Dependent GDP Growth			
Indep. Var.	Eq. 7	Eq. 7	Eq. 7
<i>Intercept</i>	-0.15 (3.13)***	-0.14 (2.98)***	-0.16 (3.49)***
I / Y_{-1}	0.79 (3.82)***	0.74 (3.50)***	0.75 (3.70)***
$\Delta L / L_{-1}$	0.29 (0.64)	0.25 (0.56)	0.13 (0.32)
$\Delta M / M_{-1}(M / Y_{-1})$	0.99 (0.56)	0.08 (0.04)	-0.36 (0.21)
$\Delta G / G_{-1}(G / Y_{-1})$	-----	1.10 (1.17)	2.27 (2.22)**
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	0.79 (2.21)**
R²	0.73	0.74	0.78
SE	0.02	0.02	0.01
DW	2.16	2.06	2.12
F-stat	F(4,30)=20.08***	F(5,29)=16.54***	F(6,28)=16.40***
Parameters of the Autoregressive Error Specification: $U = a * U(-1) + E$			
a	0.69 (7.51)***	0.69 (7.43)***	0.72 (8.42)***

T-ratios in parenthesis

Table G10. Cochrane-Orcutt Estimation Results (1961-1996) for Spain

AR(1) converged after 5 iterations			
Dependent GDP Growth			
Indep.Var.	Eq. 9	Eq. 9	Eq. 9
<i>Intercept</i>	-0.15 (3.11)***	-0.12 (2.65)**	-0.14 (3.00)***
I / Y_{-1}	0.80 (3.80)***	0.66 (3.07)***	0.64 (3.08)***
$\Delta L / L_{-1}$	0.24 (0.51)	0.32 (0.70)	0.37 (0.81)
$\Delta M / M_{-1}(M / Y_{-1})$	6.70 (0.58)	5.62 (0.45)	-6.88 (0.58)
$\Delta G / G_{-1}(\dot{G} / Y_{-1})$	-----	-6.53 (1.48)	-2.82 (0.78)
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	0.88 (1.35)
$\Delta M / M_{-1}(C / Y_{-1})$	-0.12 (0.50)	-0.11 (0.40)	0.21 (0.65)
$\Delta G / G_{-1}(C / Y_{-1})$	-----	1.18 (1.77)*	0.95 (1.58)
$\Delta X / X_{-1}(C / Y_{-1})$	-----	-----	-0.01 (0.10)
R²	0.73	0.77	0.81
SE	0.02	0.02	0.01
DW	2.11	1.99	2.06
F-stat	F(5,29)=15.72***	F(7,27)=12.73***	F(9,25)=12.05***
Parameters of the Autoregressive Error Specification: $U = a * U (-1) + E$			
a	0.70 (7.46)***	0.69 (7.04)***	0.68 (6.34)

Table G11. AR(1) Estimation Results (1963-1996) for Spain

Dependent GDP Growth			
Indep. Var.	Eq. 7	Eq. 7	Eq. 7
<i>Intercept</i>	-0.04 (1.42)	-0.04 (1.38)	-0.06 (1.71)*
I / Y_{-1}	0.25 (1.70)*	0.25 (1.67)	0.25 (1.65)
$\Delta L / L_{-1}$	0.65 (1.61)	0.66 (1.54)	0.50 (1.14)
$\Delta M / M_{-1}(M / Y_{-1})$	2.41 (0.92)	2.42 (0.90)	3.52 (1.26)
$\Delta G / G_{-1}(G / Y_{-1})$	-----	-0.02 (0.03)	0.86 (0.72)
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	0.63 (1.28)
$(Y / Y_{-1})_{-1}$	0.47 (3.40)***	0.47 (3.33)***	0.52 (3.59)***
R²	0.60	0.60	0.62
SE	0.02	0.02	0.02
DW	2.00	2.00	2.05
F-stat	F(4,29)=10.97***	F(5,28)=8.47***	F(6,27)=7.49***
Diagnostic Tests			
Serial Cor.	X ² (1)=0.28 [.598]	X ² (1)=0.32 [.572]	X ² (1)=0.38 [.539]
Funct. Form	X ² (1)=0.42 [.517]	X ² (1)=0.42 [.518]	X ² (1)=0.07 [.794]
Normality	X ² (2)=0.14 [.931]	X ² (2)=0.13 [.935]	X ² (2)=0.29 [.864]
Heterosc.	X ² (1)=0.62 [.431]	X ² (1)=0.62 [.433]	X ² (1)=1.12 [.290]

Table G12. Long Run AR(1) Estimation Results (1963-1996) for Spain

Dependent GDP Growth			
Indep. Var.	Eq. 11	Eq. 11	Eq. 11
<i>Intercept</i>	-0.08 (1.55)	-0.08 (1.50)	-0.12 (1.73)*
I / Y_{-1}	0.48 (1.97)*	0.48 (1.94)*	0.52 (1.90)*
$\Delta L / L_{-1}$	1.23 (1.71)*	1.24 (1.62)	1.05 (1.22)
$\Delta M / M_{-1}(M / Y_{-1})$	4.56 (0.88)	4.57 (0.86)	7.41 (1.12)
$\Delta G / G_{-1}(G / Y_{-1})$	-----	-0.05 (0.03)	1.80 (0.69)
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	1.33 (1.09)

Table G13. AR(1) Estimation Results (1963-1996) for Spain

Dependent GDP Growth			
Indep.Var.	Eq. 9	Eq. 9	Eq. 9
<i>Intercept</i>	-0.04 (1.29)	-0.04 (1.04)	-0.04 (1.27)
I / Y_{-1}	0.25 (1.59)	0.21 (1.31)	0.19 (1.24)
$\Delta L / L_{-1}$	0.68 (1.55)	0.89 (1.84)*	1.28 (3.04)***
$\Delta M / M_{-1}(M / Y_{-1})$	-1.20 (0.06)	1.50 (0.08)	-22.29 (1.30)
$\Delta G / G_{-1}(G / Y_{-1})$	-----	-3.47 (1.00)	-2.03 (0.69)
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	0.04 (0.07)
$\Delta M / M_{-1}(C / Y_{-1})$	0.07 (0.20)	-0.01 (0.03)	0.61 (1.23)
$\Delta G / G_{-1}(C / Y_{-1})$	-----	0.59 (1.07)	0.81 (1.65)
$\Delta X / X_{-1}(C / Y_{-1})$	-----	-----	0.16 (1.84)*
$(Y / Y_{-1})_{-1}$	0.46 (2.96)***	0.39 (2.33)**	-----
R²	0.60	0.62	0.67
SE	0.02	0.02	0.02
DW	2.01	1.88	1.34
F-stat	F(5,28)=8.49***	F(7,26)=6.08***	F(8,25)=6.24***
Diagnostic Tests			
Serial Cor.	X ² (1)=0.35 [.555]	X ² (1)=0.01 [.914]	X ² (1)=2.65 [.104]
Funct.Form	X ² (1)=0.50 [.477]	X ² (1)=0.38 [.538]	X ² (1)=0.54 [.463]
Normality	X ² (2)=0.10 [.950]	X ² (2)=0.23 [.893]	X ² (2)=0.20 [.906]
Heterosc.	X ² (1)=0.50 [.478]	X ² (1)=2.01 [.156]	X ² (1)=0.23 [.630]

The top columns give the coefficients estimates followed by the t-ratios (in parentheses) while the bottom columns give the X² tests for Serial Correlation, Functional Form, Normality and Heteroskedasticity followed by the probabilities (in brackets). ***: significant at 1% level of significance, **: significant at 5% level of significance, *: significant at 10% level of significance. For all estimations Microfit 4.0 was used.

Table G14. Long Run AR(1) Estimation Results (1963-1996) for Spain

Dependent GDP Growth			
Indep.Var.	Eq. 9	Eq. 9	Eq. 9
<i>Intercept</i>	-0.08 (1.31)	-0.06 (1.04)	-0.04 (1.27)
I / Y_{-1}	0.45 (1.70)*	0.34 (1.34)	0.19 (1.24)
$\Delta L / L_{-1}$	1.26 (1.73)*	1.46 (2.08)**	1.28 (3.04)***
$\Delta M / M_{-1}(M / Y_{-1})$	-2.21 (0.07)	2.46 (0.07)	-22.29 (1.30)
$\Delta G / G_{-1}(G / Y_{-1})$	-----	-5.68 (1.02)	-2.03 (0.69)
$\Delta X / X_{-1}(X / Y_{-1})$	-----	-----	0.04 (0.07)
$\Delta M / M_{-1}(C / Y_{-1})$	0.13 (0.20)	-0.02 (0.03)	0.61 (1.23)
$\Delta G / G_{-1}(C / Y_{-1})$	-----	0.97 (1.12)	0.81 (1.65)
$\Delta X / X_{-1}(C / Y_{-1})$	-----	-----	0.16 (1.84)*
δ_m	-0.675	-1.69	-0.95
δ_g	-----	-0.82	-0.55
δ_x	-----	-----	0.25

Table G15. ADF Tests for unit roots for Portugal

Variable	Intercept Critical -2.95	Intercept & trend Critical -3.54	1 st diff (no trend) Critical -2.95
INV	-2.58	-2.58	-4.55
EXCH	-0.60	-2.21	-3.62
GDPC	-0.74	-2.97	-4.11
INFL	-1.47	-0.71	-4.38
LAB	-3.21	-3.15	
NGSH	0.67	-2.60	-3.68
POP	-1.37	-2.27	-2.77
SAV	-4.23	-4.54	
TB	-2.34	-2.52	-4.66
NATOE	-1.37	-1.71	-4.70
GDP	-0.56	-3.53	-4.1
Y	-3.27	-4.44	
SM	-1.02	-2.02	-5.64

Table G16. ADF Tests for unit roots for Spain

Variable	Intercept Critical -2.95	Intercept & trend Critical -3.54	1st diff (no trend) Critical -2.95	2nd diff (no trend) Critical -2.95
INV	-2.26	-3.06	-3.77	
EXCH	-1.66	-2.95	-3.33	
GDPC	-0.48	-2.56	-2.94	
INFL	-1.40	-1.51	-3.97	
LAB	-3.40	-3.35		
NGSH	-0.21	-2.99	-3.43	
POP	-2.08	-0.91	-0.31	-3.25
SAV	-1.45	-2.18	-3.56	
TB	-3.19	-3.64		
NATOE	-1.46	-1.84	-4.57	
GDP	-0.34	-2.75	-3.05	
Y	-2.74	-2.92	-5.64	
SM	-0.96	-0.69	-2.43	-5.31

EXOGENEITY AND CAUSALITY

Definition of Exogeneity

Whether a variable is exogenous depends upon whether that variable can be taken as “given” without losing information for the purpose at hand. The distinct purposes of statistical inference, forecasting and policy analysis define the three concepts of weak, strong and super exogeneity (analysed later in this Appendix).

As Ericsson & Irons (1994) claim: “*Valid exogeneity assumptions may permit simpler modelling strategies, reduce computational expense and help isolate invariants of the economic mechanism. Invalid exogeneity assumptions may lead to inefficient or inconsistent inferences and result in misleading forecasts and policy simulations*”, (Ericsson & Irons, 1994, p.7).

Arguments about the division of a model’s variables into endogenous and exogenous can be summarised as follows:

The Cowles Foundation approach or the structural econometrics was developed during the late 1940s and early 1950s. According to this approach, the data are assumed to have been generated by a system of simultaneous equations. The classification of variables into “exogenous” and “endogenous” and the causal

structure of the model are both given a priori and are untestable. Generally, but not very precisely, the endogenous variables are those which are explained by the structure of the model and all the remaining variables are the exogenous variables. This approach, however, has been criticised in recent years on the following grounds:

- a) The classification of variables into endogenous and exogenous is sometimes arbitrary
- b) Sometimes variables that should be included in an equation, are excluded in order to achieve identification. This was the argument made by Liu in 1960 and is known as the *Liu critique*.
- c) Then, there is the argument put forward by Lucas in 1976 (known as the *Lucas critique*). According to the Lucas critique, the coefficients in the simultaneous equations models cannot be assumed to be independent of changes in the exogenous variables. One solution to the Lucas critique is to make the coefficient of the simultaneous equation system depend on the exogenous policy variables.
- d) Leamer (1985) suggests redefining the concept of exogeneity. He suggests defining the variable x as exogenous if the conditional distribution of y given x is invariant to modifications that alter the process generating x . Or, in other words, a variable is defined as exogenous if the Lucas critique does not apply to it. It has been claimed that it is not clear whether such a redefinition solves the problem raised by Lucas. There are two concepts of exogeneity that are usually distinguished:

- i) Predeterminedness: A variable is predetermined in a particular equation if it is independent of the contemporaneous and future errors in that equation and
 - ii) Strict exogeneity: A variable is strictly exogenous if it is independent of the contemporaneous future and past errors in the relevant equation.
- e) But Engle, Hendry and Richard (1983) are not satisfied with these two definitions of exogeneity and suggest the concepts of weak, strong and super exogeneity.
- i) Weak exogeneity: A variable x_t is said to be weakly exogenous for estimating a set of parameters λ if inference on λ conditional on x_t involves no loss of information. In other words, the concept of weak exogeneity is related to the problem of static inference in an econometric model.
 - ii) Super exogeneity: This concept is related to the Lucas critique. If x_t is weakly exogenous and the parameters in $f(y_t/x_t)$ remain invariant to changes in the marginal distribution of x_t , then x_t is said to be super exogenous. Leamer finds it unnecessary to require weak exogeneity as a condition for super exogeneity. He argues that this confounds the problem of efficient estimation with that of policy analysis. His definition of exogeneity is the same as the definition of super exogeneity by Engle, Hendry and Richard without the requirement for weak exogeneity.
 - iii) Strong exogeneity: This concept is linked to Granger causality. If x_t is weakly exogenous and x_t is not preceded by any of the endogenous variables, x_t is defined to be strongly exogenous. This definition is

according to Leamer. The definition by Engle, Hendry and Richard uses the concept of Granger causality. If x_t is weakly exogenous and x_t is not caused in the sense of Granger by any of the endogenous variables in the system, then x_t is defined to be strongly exogenous. In simple words, the term “Granger causality” means “precedence”.

Granger Causality and Exogeneity

So, according to the definition given by Engle, Hendry and Richard, Granger noncausality is necessary for strong exogeneity. However, as Cooley and LeRoy (1985) claim, Granger noncausality is neither necessary nor sufficient for exogeneity as understood in the simultaneous equations literature.

Thus, a test for Granger noncausality is not useful as a test for exogeneity. Despite that, some argue that it is still useful as a descriptive device for time-series data.