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## DETERMINANTS OF THE DEMAND FOR DEFENCE EXPENDI- TURE IN THE NATO COUNTRIES\*

This paper analyses the determinants of the demand for defence expenditure in the NATO countries during the period 1996-2006. The study has been approached through three different sets of variables, related to economic aspects, strategic and military factors and political issues. The empirical analysis has employed dynamic panel data and the results highlight the important role played by inertia in the nations' defence budgets over time, the unequal effect of income, the effect of relative prices and the existence of a spill-in effect (replacement of own expenditure by expenditure of allied nations).

Defence expenditure, demand, panel data, economic determinants, NATO

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## I. INTRODUCTION

From the late 80's through to the present, momentous changes have taken place in the geopolitical and economic environment. The fall of the Berlin Wall gave rise to a period promising greater international stability, which would in turn lead to a major reduction in the resources devoted to defence in western countries. Indeed, this fact is backed up by the figures relating to defence expenditure. However, regional conflicts with a capacity for destabilisation in “economically sensitive” regions - above and beyond other factors, such as religion, politics, etc. - have led to a reorientation of military power, but which does not appear to be matched with an increase in the defence budgets of western countries.

The question that begs to be asked is: What are the determining factors behind the evolution of such expenditure? Studies carried out on this issue reveal the existence of three major groups that explain defence spending: economic, military and geostrategic factors. Their combined effect should provide an explanation as to the main arguments that drive countries' defence expenditure - for instance, NATO.

This paper attempts to address the subject through the estimation of a demand function for the defence expenditure of those countries that make up the Atlantic Alliance. One novel aspect is the use of dynamic panels in the aforementioned estimation, which have been used on very few occasions to address this subject.

The following point thus analyses certain theoretical aspects of the explanatory factors for defence expenditure. We then analyse its evolution from 1996 to 2006, followed by an estimation of the explanatory factors thereof and, finally, a review of the key conclusions.

## II. SOME THEORETICAL CONSIDERATIONS

Ever since the earliest pioneering work concerning the determinant factors behind the defence expenditure of nations, the existence of a demand function has been considered, derived from a social - or, in some cases, individual - utility function allowing us to observe the relevance of the different explanatory factors employed. Within this context, various concepts of the “defence good” have been used, defined as a public good in most cases, whereby the demand for military spending is an indication as to how a country assigns its resources between the defence good and other goods, in relation to a set of explanatory variables – Hartley and Sandler, 2001.

A large proportion of the studies have focused on the analysis of Atlantic Alliance (NATO) member States due to the characteristics revealed by the behaviour of such countries through their pertaining to a club, in terms of contributions to its budget, the distribution thereof (*burden sharing*), additionality or substitution of defence expenditure, etc.

There have traditionally been two approaches most commonly employed for addressing the analysis of defence expenditure: the Pure Public Goods model and the Joint Product or Joint Production model<sup>1</sup>. The first such approach holds that the defence of member States is a pure public good since it is linked to the strategy of mutually assured destruction, which began with the creation of NATO and lasted till the mid-60's. In this scenario, nuclear armament gave rise to a situation of non-exclusive defence consumption among the allies. Indeed, this had a perverse effect since the poorer nations, who possessed no nuclear weapons, benefitted from those who did and thus had higher defence expenditure, which came to be known as the “*exploitation hypothesis*”, whereby the poorer NATO States exploited the wealthier States - Sandler and Murdoch, 2000.

The second approach focuses its analysis on the effects that a country's membership to a military alliance has on defence spending, whereby a *spill-in* effect exists among the allied nations (Olson and Zeckhauser, 1966) and a certain degree of *free rider* behaviour among lower-income nations resulting from their chance to use the defence expenditure of richer nations for their own benefit – Murdoch and Sandler, 1984. This approach implies the existence of multiple outputs ranging from deterrence to damage limitation – linked to conventional armament – or protection. In this respect, it should be noted that the Joint Product perspective is linked to different NATO strategies, ranging from the Flexible Response - 1967 to 1990 - with all its various stages, to the current Crisis Management strategy, wherein the level of public good is increasing - Sandler and Murdoch, 2000.

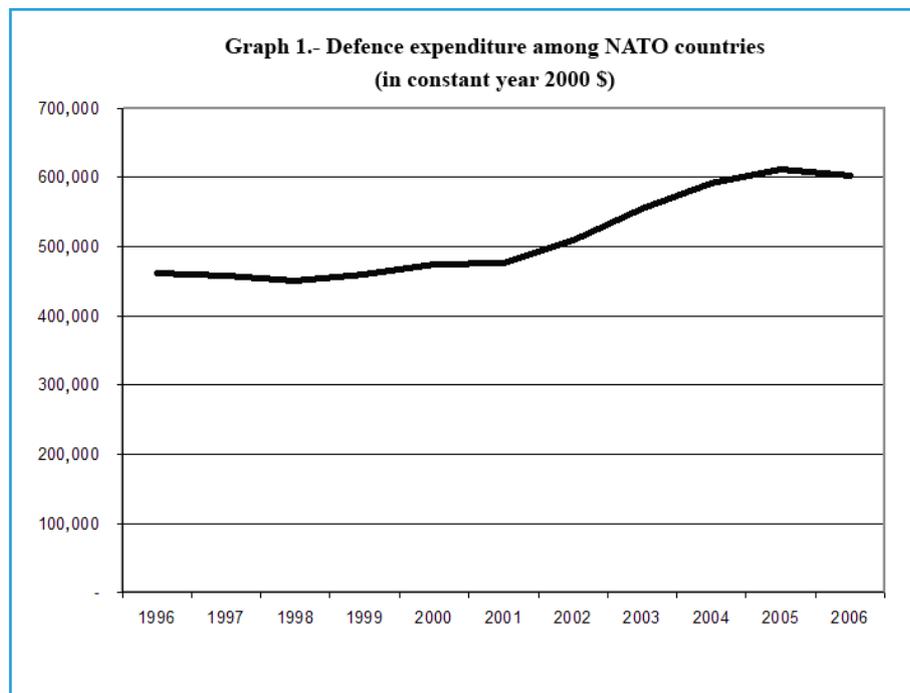
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<sup>1</sup> Indeed, these are not the only approaches. Historically, other perspectives have arisen, such as the arms race, which was used greatly during the Cold War, or that of organisational policies and bureaucracy - see Mayer, 1986 for the first approach and Kamlet and Mowery, 1987, as regards the second.

Consequently, the demand for defence expenditure would be reduced on a scale that would be related to the volume of defence spending made by the allies of the country in question, which implies *free rider* behaviour. For this very reason, together with the major changes in international scenarios that have been occurring since the 1980's, the overall tendency of the countries is oriented towards reducing defence expenditure, at least up until the early 21st century, when it began to rise once more.

Thus, during the Cold War, an initial reduction in defence budgets took place among western countries, when we moved towards NATO's so-called Flexible Response strategy in reply to the Warsaw Pact. Subsequently, the dissolution of the latter led to a new reduction in expenditure which lasted until the late 1990s (see Graph 1), when it began to rise again in response to regional terrorism-related threats<sup>2</sup>.

Nevertheless, as well as purely strategic aspects such as those mentioned above, due to responses to changes in the international scenarios the demand for defence spending has been affected by shifts in the preferences of developed societies which do not allow for major increases therein. Obviously, institutions, essentially political parties, must respond to the demands of the median voter as a means of obtaining votes, which leads them not to make significant increases in defence spending – Dudley and Montmarquette, 1981.



Source: National budgets, NATO and the author

<sup>2</sup> Note that the percentage of defence expenditure in terms of the world's GDP was 2.5% in 2005.

However, as explained by Fritz-Aßmus and Zimmerman, 1990, the factors that define the demand for defence spending are basically of three types: economic, political and military. Such diversity of aspects makes this type of analysis very difficult as, on the one hand, the heterogeneity of situations multiplies, whereby contradictory behaviour can be observed among the three aspects within a single country and, on the other, such contradictions can be compounded when we analyse groups of countries, as in the case of NATO. Table 1 contains some of the literature that has studied the explanatory factors of the demand for defence spending along with some of their main characteristics.

Table 1.- Determinants of the demand for defence expenditure

Author	Approach	Time frame	Countries addressed	Included variables	Type of analysis
Benoit (1978)	-----	1950-1965	44 developing countries	Relationship between defence spending and economic growth (both ways)	OLS
Dudley and Montmarquette (1981)	Public choice – median voter	1960; 1970; 1975	38 developed and developing countries	Spill-in; relative income; tax-price elasticity; economies of scale in security consumption	Simultaneous equations
Murdoch and Sandler (1984)	Joint Production model	1961-1979	9 NATO countries	GDP; Spill-in; Considers structural change	SURE
Smith (1989)	-----	1949-1987	United Kingdom and France	GDP; Spill-in; Considers structural change; USSR defence spending	Log-linear
Byers and Peel (1989)	-----	1954-1984	NATO-Warsaw Pact	NATO and Warsaw Pact lagged defence expenditure	OLS

Okamura (1991)	Alliance theory	1972-1985	USA and Japan	Types of goods (military-civil); subsistence income; threat level	Linear Logarithmic Expenditure System (LLES) and (LES)
Sandler and Murdoch (2000)	Alliance theory	1988-1999	15 NATO countries	GDP, GDP per capita, exposed border, benefit	Non-parametric correlations
Throsby and Withers (2001)	Public choice-median voter	1992	Australia	Income; individual and collective benefits; individual characteristics	OLS in surveys
Pérez-Forniés, Gadea and Pardos (2004)	Alliance theory	1960-2002	15 NATO countries	Income	SURE
Bernauer, Koubi and Ernst (2006)	Public choice	1975-2001	Switzerland	GDP; unemployment rate; public deficit; external threat; bureaucratic inertia	OLS
Alonso and Martínez (2007)	Comprehensive demand model	1975-2005	13 NATO countries	Income, prices, public spending, trade liberalisation, population, political system, joint military spending, nuclear powers, size of Armed Forces	PANEL DATA

*Source: Author*

As regards the factors used for explaining defence spending, the various theoretical and empirical approaches have highlighted different aspects, depending on the time frame of the analysis. Thus, the aforementioned arms race approach focused on studying the action-reaction between two rivals, who act as rational agents and hold differing regional or international power. In this regard, the amount of resources dedicated to defence made them dependant on the expenditure of the rival country (reaction ef-

fect), on the intensity of grievances of one country against the other (grievance effect) and on the past cost of defence expenditure decisions (fatigue effect), as described by Richardson, 1960 and Bernauer, Koubi and Ernst, 2006.

On the other hand, the organisational policies approach (bureaucratic approach) focuses on the behaviour of the public sector over time, whereby due to the complexity of the decision-making process in relation to defence spending, this process leads to a significant level of “incrementalism” in expenditure; i.e. there is a certain degree of predictability thereof linked to its past history, whereby the spending of the previous year becomes the main explanatory factor behind the current year's expenditure – Rattinger, 1975. Moreover, due to the fact that defence programmes are multiannual, previously-committed expenditure is recorded for subsequent periods, which means that a large proportion of the budget for future periods is already assigned. Therefore, expenditure in previous periods becomes an important estimator of defence expenditure – Dunne and Perlo-Freeman, 2003. Thus, Byers and Peel, 1989, conclude from their analysis that the bureaucratic perspective is the most relevant for explaining defence expenditure, though they do not exclude external effects on a secondary level.

However, most studies are neoclassical, whereby a country behaves as a rational agent that maximises a utility function in which two types of goods are recorded: civil and military. The fundamental part of the model includes a security function that determines defence spending in relation to the country's armed forces and those of its allies<sup>3</sup>.

Within this set of analyses, income is the most widely-used variable in explaining the demand for defence spending, which shows a positive relationship with regard to military spending. Some authors say that security is a luxury good, since its demand increases more quickly than income – Dudley and Montmarquette, 1981. Moreover, it has been observed that larger countries spend a proportionally greater amount on defence (Murdoch and Sandler, 1984), although this is only true when developed countries are compared. Yet subsequent studies have revealed that the explanatory capacity of this variable is lower in more highly-developed countries – Pérez-Fornies, Gadea and Pardos, 2004. Such results imply that the greater a country's income (more assets both within and beyond its borders - in terms of, for instance, direct investment - and, therefore, it has more to defend), the lower its defence expenditure. This apparent contradiction can be explained through internal factors of the country (a situation of political stability) and the absence of nearby threats to its security, which would mean that, as there is an opportunity cost between defence spending and other public spending, the first has a higher cost than the latter and the assigning of resources is oriented towards other spending not related to defence.

A further argument in the explanation of defence spending is not the size of the country, but rather its volume or density of population, revealing contradictory results as far as its effect on defence expenditure. Thus, Dudley and Montmarquette,

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<sup>3</sup> In cases involving countries that do not pertain to an alliance, such as Switzerland, this aspect is rarely taken into consideration, although it has been shown that their defence spending follows a very similar pattern to that displayed by most NATO countries - Bernauer, Koubi and Ernst, 2006.

1981, reach the conclusion that proportionality exists between both variables, whereas Markowski and Tani, 2005, observe a negative relationship which they attribute to the fact that more densely populated countries tend to have a lower level of income, which prohibits high military spending. However, one criticism of this result arises from the proposal that a country will spend more on defence - depending on internal factors as well as its international involvement and commitment, not only in military terms but also economic and political - on the basis of its desire to maintain a specific position on the international stage, whether leadership or other. Thus, both strategic and international influences or conditioning factors determine a major proportion of defence spending, regardless of population volume – Smith, 1989.

Similarly, external threats would have to be incorporated into the model, as they affect not only an individual country, but also alter burden sharing among allied nations, leading to *free rider* behaviour arising from a response in which a country's own expenditure is replaced by that of its allies – McGuire, 1982 and Okamura, 1991. Some literature based on individual countries shows that both the proximity of neighbouring countries with which it has disputes - as in the case of Greece and Turkey, as described by Kollias, 2004 - and the geopolitical situation within a context of regional conflict tend to increase defence spending - Sandler and Murdoch, 2000. The clearest example of this is the Cold War and how, as tensions decreased during the 1990s, defence spending also decreased.

The main difficulty in regard to this aspect is the gauging of threats. In some cases, the defence spending of the other party has been used to gauge the threat level (Smith, 1989), while in others it is the proportion of borders shared with friendly or unfriendly neighbouring countries – Sandler and Forbes, 1980. Obviously, neither approach is completely satisfactory, but they address an issue which is extremely hard to quantify.

Thus, the existence of ongoing conflicts is clearly a major factor in explaining defence expenditure - Kamlet and Mowery, 1987. However, due to regional conflicts in which NATO forces are implicated, countries are increasingly adding to their budgets the expected spending on international operations, both peace-keeping and other types of interventions, thereby increasing overall expenditure. A different approach has also been employed, linked to armament stockpiling rather than increased spending, in the face of threats or conflicts in which a country is implicated<sup>4</sup> – Richardson, 1960.

Yet the political stability generally afforded by democratic systems acts as an insurance policy in their relationships, whereby conflicts are resolved peacefully. This tends not to occur, however, in countries with non-democratic governments, especially in the case of military regimes, inducing such countries to maintain high levels of defence spending. Yet empirical studies that encompass this kind of political affect produce ambiguous results, as described by Alonso and Martínez, 2007, since it depends on the methodology employed to address the political aspect, on the sources and on the definition of military regime. In general terms, most literature reveals either the inexistence of a relationship or a weak relationship - West, 1992.

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4 This was especially so during the Cold War and was analysed within the Arms Race model.

Finally, certain approaches to so-called “military inflation” have been employed, but generally these have been unfeasible due to the complexity of its calculation and the fact that, in most cases, there is no deflator linked to defence spending, thereby reducing the possibility of its use. Moreover, the results of some studies concerning the USA and the UK reveal that, because they have similar technology, the price differential should also be very similar, but this is not the case due to the way in which the deflators are constructed (Smith, 1989), thus reducing their credibility. Nevertheless, Solomon, 2005, shows that in the case of Canada an important inflation differential does exist between civil and military goods and criticises the fact that most studies omit this variable, with the specification error issues that this situation generally entails.

Generally speaking, the model which has been used to address the analysis of the explanatory factors behind defence spending is based on what Smith calls the “extremely rational behaviour of an actor” (Smith, 1989), which attempts to maximise a welfare function with two goods: the defence good,  $M$ , and all remaining goods,  $C$ , which are chosen on the basis of a non-observable variable; namely, the defence or “security” output,  $S$ . This function is:

$$W = W ( S, C, PI ) \quad (1)$$

Where  $PI$  represents the political influences that provoke movements of the objective function. This function is presumed subject to a budgetary restriction:

$$Y = PM * M + PC * C \quad (2)$$

Where  $Y$  is real aggregate income and  $PM$  and  $PC$  are the relative prices of  $M$  and  $C$  respectively. The other restriction that is included is a production function that determines the degree of security,  $S$ , in relation to defence spending and other security-related variables, such as the defence spending of other allied countries or opponents; i.e. the threat level,  $SI$ :

$$S = S ( M, SI ) \quad (3)$$

By maximising (1) subject to (2) and (3), we obtain the demand function:

$$M = D ( Y, PM, PC, PI, SI ) \quad (4)$$

A further analysis method is based on the Median Voter model which shows a somewhat different perspective by maximising an individual utility function and including the spending propensity of voters, which may differ between voter  $i$  and  $j$ , as shown by Throsby and Withers, 2001, and where the scale of public sector spending is the fundamental factor. The main problem for these authors in terms of the model described above is how to determine the *trade-off* that exists between military and civil goods, which they attempt to address through the demand from the individual consumer.

However, the sum of demands would produce an aggregate demand such as that described and the problem would not be how, but rather who decides the amount of security output produced, since in the case of democratic States, the governments make the decision based on a combination of at least three factors: the interests of

oligarchies (defence industry, stakeholders, etc.), the government's behaviour, which may be a benevolent dictatorship - particularly in the case of absolute majorities - and, finally, interpreting the aggregate preferences of society.

This paper follows the first of the described approaches, as we are primarily concerned with gaining insight into the factors affecting defence expenditure as opposed to the distribution of public spending among different expenditure options (health care, education, defence, etc.).

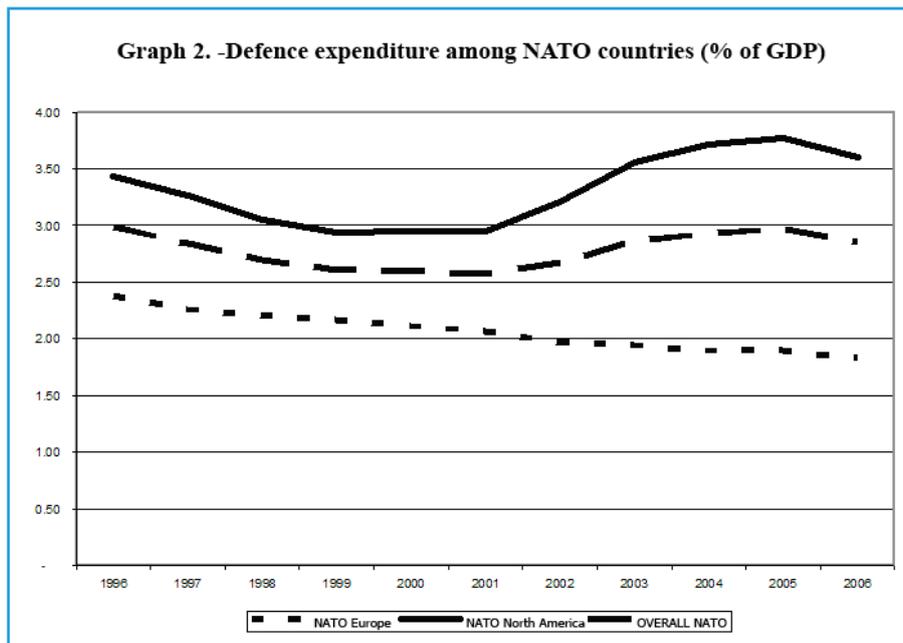
### III. EVOLUTION OF DEFENCE EXPENDITURE IN NATO COUNTRIES

The indicators most employed to address nations' defence expenditure are usually the percentage of GDP involved and the total volume of expenditure (see Graph 1), though other indicators often help us to understand the overall situation, whereby it seems appropriate to employ more than one indicator in a supplementary manner. Moreover, a proper approach to analysing defence spending should take into account that no "correct number" exists in terms of how much a nation should spend, since this depends on national priorities as well as both national and international issues, known or unexpected.

Furthermore, it is not appropriate to deduce that the proportion of defence spending has to rise in line with GDP, since even in the case of nations showing strong economic growth, when defence spending is increased it does not generally exceed the rise in product, whereby the ratio tends to decrease when both aspects display growth.

Between 1996 and 2006, the evolution of defence spending among current members of the Atlantic Alliance showed a downward trend through to 2001, when, in the wake of 9/11, defence budgets tended to rise. This is the profile shown by NATO as a whole, but especially the US. Yet this variable has maintained a slow but steady downward trend in the case of European NATO States (see Graph 2).

This ever-increasing gap between European and North American NATO countries reflects the differing conceptions as regards security and defence on either side of the Atlantic. Thus, from the North American viewpoint, the instruments used are based upon their comparative edge; i.e. military, or *hard power*, whereas in Europe, the instruments are of a civil nature (Lindstrom, 2005), or *soft power*, which entails a different burden, both on the budget of NATO as a whole and in terms of the importance that defence spending has on the GDP in each of the countries.

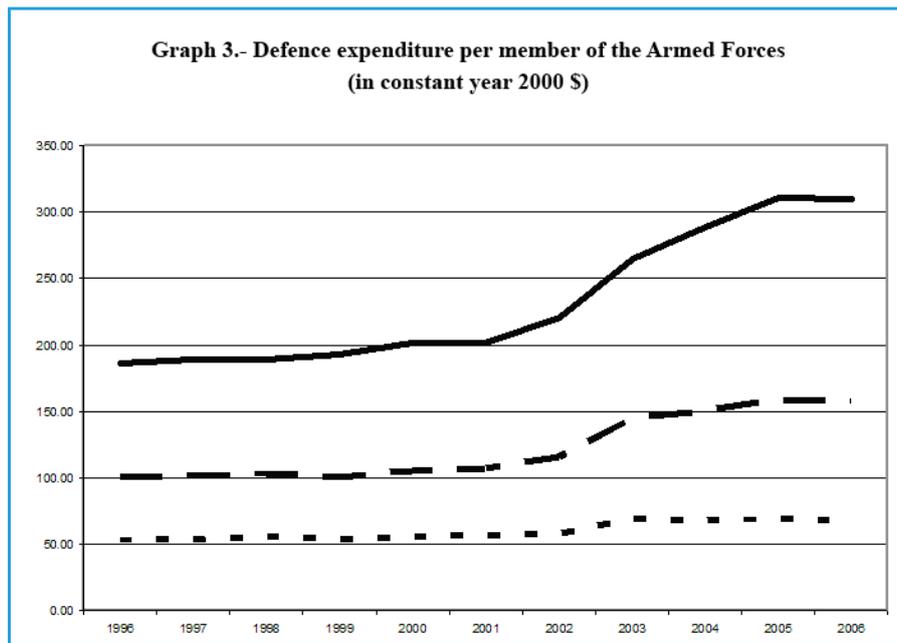


Source: National budgets, NATO and the author

In this sense, the defence spending of the different countries reflects not only a way to satisfy voters, as a means of capturing votes, but also a national strategy, both internal and external. In the case of Europe, the Petersberg tasks are a clear example of this, the main objectives of which are based on *peace keeping* and humanitarian operations, crisis management tasks, etc., and whose purely military or intervention component is fairly minor - compared to the type of interventions carried out by the US - which satisfies both the demands of the voters and the strategy set out within the EU.

Yet this is not an optimum situation for Europe for two reasons. Firstly, the huge difference in military capacity that exists between the two zones of the Alliance, which implies high military dependency on the US – Lindstrom, 2005. The second reason is geostrategic in nature. It refers to the location of Europe in terms of its proximity to areas of conflict, which should result in a major commitment of resources dedicated to defence. Such resource dedication is reflected in the ratio of defence spending per member of the armed forces, as illustrated in Graph 3.

The lesser defence endowment of Europe is brought into stark contrast when we analyse the increasing gap that exists between Europe and North America, particularly from 2001 onwards, when the US made substantial increases to its defence budget. In this regard, the incorporation of seven new countries into the Alliance in 2004 has had little effect on this indicator, which has remained virtually unchanged in Europe since 2003.



Source: National budgets, NATO and the author

On the other hand, as has already been mentioned, the level of income is one of the factors most frequently associated with defence spending. Thus, the relationship between defence expenditure and income level - as shown in Graphs 4 and 5 for 1996 and 2006 respectively - is positive but minimal. Indeed, the correlations between both variables are very low and insignificant. This result falls in line with those of other studies; Solomon, 2005, in the case of Canada, for instance. In a different study, Pérez-Forniés, Gadea and Pardos, 2004, observe that the importance of the relationship between income and defence spending has lessened over time and depends largely on the strategy of the NATO countries. Cappelen, Gleditsch and Bjerkholt, 1984, also find a minimal relationship at best between the two variables. From this perspective, the “peace dividend” argument gains strength, whereby the assigning of resources for purposes other than defence would be a way of stimulating economic growth<sup>5</sup>. However, when we look at the growth, as opposed to the levels, of both variables the correlation becomes significant (0.78 with a significance level of 95%), which undermines the validity of the opposing argument.

Finally, if we look at the level of defence spending, over previous years and now, and compare it against economic growth the situation changes drastically, since there is a significant yet negative correlation<sup>6</sup>, once again implying that the peace dividend is a relevant argument for a more appropriate assignation of resources. Ultimately, this

<sup>5</sup> However, we should also take into consideration the direction of the causality between income and defence spending since, as claimed by some authors, many cases reveal a significant endogenous effect, whereby the directionality of the relationship is unclear – Solomon, 2005.

<sup>6</sup> The correlation between the level of defence expenditure in terms of GDP in 1996 compared to GDP growth between 1996 and 2006 is -0.49, whereas the correlation between the level of defence expenditure in terms of GDP in 2006 compared to GDP growth between 1996 and 2006 is -0.21. Both correlations have a significance level of 95%.

relationship is not without its problems, as pointed out by Dunne, Smith and Willenbockel, 2005, since defence spending has a positive effect on output when there is an elevated level of threat, and a negative effect otherwise. This affords us an insight into the difficulty of quantifying this type of relationship in terms of the direction of the effects as well as their intensity and hallmark. Indeed, Kollias, Mylonidis and Paleologou, 2007, describe the existence of a feedback effect between both variables, revealing differences between the short and the long term as regards their temporal effects.

#### IV. DETERMINANTS OF THE DEMAND FOR DEFENCE EXPENDITURE AMONG NATO COUNTRIES: ANALYSIS USING DYNAMIC PANEL DATA

The study of the determinants of defence expenditure has been approached through the use of different statistical and econometric tools. In a large proportion of cases, time series analysis has been employed by means of various techniques<sup>7</sup>, such as those of Smith, 1980, who studies a demand function for the UK and compares it to another for France, or Solomon, 2005, who analyses the Canadian case. In other cases, simultaneous equations or systems of equations have been applied for studying a large group of countries (Dudley and Montmarquette, 1981), or for comparing pairs of countries, such as the US and Japan (Okamura, 1991). Panel data techniques have been used for a few years now, as in the case of Dunne and Perlo-Freeman, 2003, who study the determinants of the demand for defence spending in developing countries through the use of dynamic panels, or Alonso and Martínez, 2007, who analyse the case of European countries from the 1970s onwards.

This paper estimates a dynamic data panel model that has the following specification:

$$GD_{it} = \alpha GD_{i,t-1} X_i^\beta e^{\eta_i} e^{\gamma_t} \quad (5)$$

Where the sub-index  $i=1,2,\dots,N$  represents the unit of analysis, which in this case are the NATO member States, and the sub-index  $t=1,2,\dots,T$  represents a given moment in time.  $GD_{it}$  is the defence expenditure of country  $i$  at moment  $t$ .

Assuming that defence spending is an ongoing process and subject to inertia, investment in defence will depend on investment made over the previous year ( $GD_{i,t-1}$ ). Likewise,  $\eta_i$  encompasses the time-invariant variables that influence said investment, whereas  $\gamma_t$  show time variations and  $X_{it}$  represents a set of additional explanatory variables. Taking logarithms in the equation (5) gives us the following formulation:

$$\ln GD_{it} = \alpha \ln GD_{i,t-1} + \beta X_{it} + \eta_i + \gamma_t + v_i \quad (6)$$

Given the dynamic specification of the model, it becomes necessary to take a number of questions into account. Firstly, the explanatory variables ( $X_{it}$ ) must be strictly exogenous. However, they may display endogeneity or be predetermined due to the inclusion of such variables as *spill-in* and the size of armed forces. Such explana-

<sup>7</sup> See Table 1 for a description of certain studies and the techniques employed therein.

tory variables could be determined at the same time as the decisions on defence spending. In that case,  $X_{it}$  would be correlated with  $v_{it}$  and previous disturbances, though no correlation would exist with  $v_{i,t+1}$  and subsequent disturbances. Secondly, there is an autocorrelation problem arising from the introduction of the lagged dependant variable. This variable is predetermined as it depends on past disturbances. Therefore, even though  $GD_{i,t-1}$  would not be correlated with  $v_{it}$ , it would be correlated with  $v_{i,t-1}$  and with previous disturbances. Finally, it is essential to taken into account that a non-observable heterogeneity may exist at country level; i.e. there may be individual effects deriving from the characteristics of each country<sup>8</sup>.

In this context, Arellano and Bond, 1991, propose an estimation using the Generalized Method of Moments (GMM) in first-differences for dynamic panel data. This transformation eliminates the individual effects ( $\eta_i$ ), thus controlling the unobservable heterogeneity. Likewise, the endogeneity issue would be solved by including as instruments all possible regressor lags in order to eliminate possible correlations. Applying the transformation in the equation (6) gives us the following formulation:

$$\Delta GD_{it} = \alpha \Delta GD_{i,t-1} + \beta \Delta X_{it} + \Delta v_{it} \quad (7)$$

Yet this transformation yields unsatisfactory results due to the fact that, on many occasions, the series are highly autoregressive (Blundell, Bond and Weidmeijer, 2000 and Bond, 2002). Therefore, Arellano and Bover, 1995 and Blundell and Bond, 1998, propose extending the GMM estimator by combining the equation in differences with the original equation in levels (GMM estimation system). In these equations, both the predetermined variables and the endogenous variables in levels are implemented with lagged first-differences. Therefore, the instruments employed in the regression in levels are the lagged differences of the explanatory variables, and the instruments employed in the equation in differences are the variables in levels. This allows the specific effects (unobservable heterogeneity) to be controlled, along with the problems of correlation between the explanatory variables, both predetermined and endogenous.

Because of the advantages afforded by this method compared to the GMM estimator in differences, regressions are estimated by way of the GMM system. To evaluate the validity of the model defined in this paper, various tests shall be conducted on each estimation<sup>9</sup>.

As regards the variable to be explained, the most common is the absolute value of military spending (Kollias, 2004, Solomon, 2005, Alonso and Martínez, 2007), which approximates a nation's level of military activity. On other occasions, spending is ex-

8 For all of the above reasons, the OLS-based estimation presents a significant bias due to the correlation of the independent variables with the specific individual effects, whereby a biased estimator is obtained regardless of whether the individual effects are set or random.

9 Firstly, the Arellano-Bond test is obtained for the first and second-order residual autocorrelations (AR(1), AR(2)). If no autocorrelation problem exists in any of the series, the residuals should be characterised by a first-order negative correlation and absence of a second-order correlation. Secondly, the Hansen test is conducted to verify the validity of the instruments; i.e. to check whether excessive restrictions are being imposed. Non-rejection of the null hypothesis would indicate that the instruments are valid and, consequently, the specification of the model is also valid. Finally, the estimation is performed in two stages as it offers robust and efficient estimators.

plained in per capita terms, though this tends to be more common in Median Voter models, as described by Murdoch and Sandler, 1984. Likewise, defence expenditure relativised by the size of the economy, i.e. as a percentage of GDP, has also been used – Kollias, Mylonidis and Paleologou, 2007. Ultimately, there is no unanimity as to the variable that suitably approximates a nation's defence demand. For that reason, two different estimations will be performed, employing both the absolute value of military spending and its percentage in relation to product.

The explanatory variables included in the estimations are<sup>10</sup>:

1.- The lagged defence expenditure, which reveals the relevance of the existing *incrementalism* for determining the expenditure between periods and, therefore, the level of bureaucratic inertia in the countries. This variable is expected to have a positive sign.

2.- The per capita product of the countries. The inclusion of this variable is an attempt to provide new evidence as to its explanatory capacity in regards to defence spending, which has been called into question in numerous works as explained above, and to establish whether the defence good is normal with regard to income. In this case, while the coefficient is not expected to be very high, it is expected to be both significant and positive.

3.- Relative price levels or indicator of military inflation. In this case, the ratio between the nations' output prices in industry and their consumer price index has been employed. It has been deemed more appropriate to use industrial prices as opposed to GDP, as the latter includes consumer goods far removed from military demand, whereas an ever-increasing proportion of this demand requires industry and, especially, high technology sectors in order to maintain its operational capacity. On the other hand, the inclusion of relative prices allows us to approximate the price elasticity of defence demand. Obviously, this variable is expected to have a negative sign.

4.- The first of the contemplated strategic variables is the absolute value of armed forces, whereby having sizeable armed forces implies higher defence spending, so the expected sign should be positive.

5.- The *spill-in* effect shows the countries' likelihood of *free rider* behaviour. This variable has been defined as the defence expenditure of all countries except that of each *i* country, with regard to the total spending of NATO countries. If *free rider* behaviour is observed, the sign would be negative, whereby the country in question would be moving in the opposite direction to the allied nations as a whole.

6.- The variable relating to the geostrategic position of the countries shows the *risk* associated therewith. To that end, the kilometres of border shared with non-NATO States has been used. In this case, the expected sign is positive, since the greater the proportion of border not shared with allied countries, the greater the risk of conflict, which would in turn lead to higher defence spending.

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<sup>10</sup> The quantification of the variables employed is as follows: The GDP and defence spending are expressed in millions of US\$ at constant 2000 prices and exchange rate; the population in thousands; members of the Armed Forces in thousands. The data has been obtained from the World Bank, NATO and national statistics.

7.- The last included variable refers to purely institutional aspects. It has been decided to contemplate data from the institutional indicators available at the World Bank and produced by Kaufmann et al (2006). More specifically, of the six indicators that make up the six measures of governance<sup>11</sup>, the Voice and Accountability indicator has been included in the study. This indicator measures the extent to which a country's citizens are able to participate in selecting their government, freedom of expression, freedom of association, and media independence.

The results of the estimations shown in Table 2 reveal that the estimated models, both the model referring to the absolute value of defence expenditure and the one that explains expenditure in relation to GDP, meet the requirements of the Hansen test as well as the tests of Arellano and Bond for first and second-order residual autocorrelations (AR(1), AR(2)), indicating that the instruments used are valid and there are no autocorrelation problems.

Table 2.- Estimations of the demand for defence expenditure

	GD/GDP		GD (Defence Expenditure)	
GD <sub>t-1</sub>	0.789	(0.031)***	1.041	(0.018)***
PCGDP	0.005	(0.001)***	0.002	(0.013)
PRICES	-0.007	(0.003)**	-0.008	(0.003)**
ARMED FORCES	0.014	(0.008)*	0.077	(0.024)***
SPIII	-0.102	(0.018)***	-0.121	(0.034)***
RISK	0.018	(0.015)	0.003	(0.007)
DEMOCRACY	-0.106	(0.012)***	-0.112	(0.038)***
CONSTANT	1.389	(0.292)***	1.748	(0.493)***
<i>Hansen Test</i>	21.77	(0.029)	17.49	(0.045)
<i>Arellano-Bond Test for AR(1)</i>	-2.28	(0.023)**	-2.02	(0.042)**
<i>Arellano-Bond Test for AR(2)</i>	-0.03	(0.976)	-0.59	(0.553)
<i>Number of observations</i>	250		250	
<i>Number of groups</i>	25		25	

Standard errors in parenthesis. \*\*\* significant to 1%, \*\* significant to 5% and \* significant to 10%

In line with the arguments put forth by Byers and Peel, 1989, the best estimator of defence demand is the expenditure realised during previous periods. Thus, in the two estimations performed, this variable shows the highest coefficient and is highly

<sup>11</sup> The value of this indicator ranges between -2.5 and +2.5 and the top positions represent the highest values. These data are available at: <http://info.worldbank.org/governance/wgi2007/home.htm>.

significant, overcoming the unitary elasticity when referring to the explanation of the absolute expenditure value. The degree of inertia of defence spending policies is therefore very high and with no likelihood of major shifts in short periods of time.

On the other hand, the only variable that shows clearly different results in both estimations is the PCGDP. Although the coefficients are reduced, Si bien los coeficientes son reducidos, no significance is obtained in the estimation of the expenditure in levels<sup>12</sup>. This result is hardly surprising given that various studies have reached conclusions which confer a high degree of ambiguity on the role of income in determining defence expenditure, from behaving as a luxury good in the 1970s (Dudley and Montmarquette, 1981) to losing much of its relevance during the 1990s (Pérez-Fornies, Gadea and Pardos, 2004), confined to specific countries, usually developed.

The behaviour of relative prices is fully coherent with the expected results. The sign of the coefficient is thus negative and is shown to be significant, with an effect size that is reduced and very similar in both estimations. This result is in line with that obtained by Solomon, 2005, which shows the existence of price differentials between civil and military goods. However, since the indicator used is an approximation of military inflation, the results must be viewed with caution. Therefore, it becomes necessary to estimate price indices which encompass the goods and services most closely related to the ambit of defence.

As regards the size of armed forces, the coefficient is positive and significant in both estimations, though larger in the case of the absolute value of expenditure. This is because the absolute value of the armed forces has also been taken in the estimation. The result obtained by Alonso and Martínez, 2007, in relation to this variable is also of reduced size compared to the importance of other variables. This concept of national defence budget expenditure can be largely considered as a given due to two factors: the size of the force does not vary significantly except in the long term and the cost thereof rises slowly, at least in the case of European countries, as shown in Graph 3.

The behaviour of the countries as a whole in relation to their defence spending is shown through the *spill-in* variable. As we can see, it is a highly significant variable and shows a negative sign. In accordance with this result, each country attempts to rely on the expenditure of the other members of the Alliance, revealing a *free rider* effect. Consequently, there exists an effect of replacing the defence spending of country *i* with that of the whole. This fact is especially evident in the spending made by European countries compared to that of North American countries, particularly the US, as shown in Graph 2. The results obtained by Murdoch and Sandler, 1984, reveal such behaviour in certain European NATO countries. Other studies obtain different results, such as Alonso and Martínez, 2007, which reveal a certain degree of complementarity in the expenditure of European NATO countries and the US. However, the contemplation of a very broad time period in the latter study (1975-2005), without taking into consideration NATO's strategic shifts over the period which entail chang-

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<sup>12</sup> Although per capita GDP has ultimately been the variable employed, estimations using the GDP in levels have also been performed and the results are virtually identical.

es in the nations' defence spending (Sandler y Murdoch, 2000), means there may be bias in the results, thus overestimating this effect.

The variable that approximates the risk derived from a country's location and the borders it shares with the Allies is not significant in either of the estimations. The aforementioned difficulty in approximating this aspect may explain this result<sup>13</sup>. Nevertheless, we must take into consideration that many NATO countries share borders with their partners, thus reducing the role of this variable, to which must be added the reduced border pressure during the 1990s due to the fall of the Berlin Wall and the dissolution of the Warsaw Pact.

The final aspect that has been contemplated relates to institutional factors. The results clearly show that the more consolidated a democracy and the greater the capacity of its society to influence political and social decisions, the lower its defence spending – Yildirim y Sezgin, 2005. This aspect is especially relevant in the case of Europe, where there is a clear social standpoint that does not allow for increased defence spending.

## V. CONCLUSIONS

As we have been able to observe throughout this paper, the explanatory factors of the demand for defence expenditure in NATO countries are multiple and, in some cases, of complex approximation. Moreover, there are many information-related issues to be addressed and the reliability of the information is often unsatisfactory. However, it is possible to draw some important conclusions from the analysis undertaken. Thus, in order to reinforce the results thereof, it was decided to estimate both the defence expenditure in absolute terms and the spending relative to the countries gross domestic product. The key results can be summarised as follows:

Firstly, the partners on either side of the Atlantic have a different concept of defence, which can be clearly seen in the evolution of their defence expenditure and their policies on international intervention.

Secondly, the economic aspects linked to the demand for defence expenditure shows, on the one hand, that the countries afford a significant degree of inertia to defence spending, deriving from its social unpopularity and the long-term commitments which they have acquired and, on the other, that the relative prices of defence are a major determinant of its demand, though they are a factor that has been rarely used in studies of this kind due to the complexity in their empiric approximation.

In addition, income has been shown to be a relatively minor factor in the explanation of defence spending, particularly in the case of the explanation of its absolute value, which involves the divergent upward curve that exists between both variables.

<sup>13</sup> Furthermore, this is the only variable that does not include temporal variation, which may affect its low significance.

As regards the military and strategic aspects, the size of the nations' armed forces explains part of the demand, though this is reduced due partly to the existence of an effect of replacing the defence spending of some countries with that of others (*spill-in*).

Finally, the political factor has significant weight in the explanation of the demand for defence expenditure, which reveals the need for economic studies to include institutional variables that enable the contextualisation of aspects that are difficult to explain in economic terms if abstracted from their specific political ambit.

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