Defence Budgets in the Post-Cold War Era: A Spatial Econometrics Approach

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Abstract

This paper examines the determinants of national defence budgets in the post-Cold War era using a spatial econometric framework. Using data for 124 countries over a 16 year time period, I examine spatial relationships in defence spending to investigate how countries account for the military spending of other countries when setting their budgets. Using specially developed weighting matrices, the regression results indicate that defence budgets are positively spatially correlated. These results provide support for the use of "external" factors when examining defence budgets over this time period. The importance of a country's spatial location when setting its budget is further examined through the identification of regions of high and low defence spending.

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1 Introduction

In this paper, spatial econometric techniques are used to access the extent to which, in the post-Cold War era, the defence spending of countries is positively spatially correlated with the defence spending of other countries. This is accomplished through the analysis of defence spending data of 124 countries over a 16 year time period.

The results obtained here diverge from those obtained by some authors studying defence spending during the Cold War. Both the end of the Cold War and strong economic growth in parts of the developing world have complicated the issue of budget setting. The polarization of countries into one of two camps is no longer observed. Regional powers such as Brazil, India, and Saudi Arabia have developed strong militaries, complicating the world's power structure. With this paradigm shift, countries may find it necessary, and prudent, to factor in the defence spending of other countries when setting their own defence budgets.

During the Cold War economists wrote many papers examining how military budgets were set. In light of the arms race between the US and the Soviet Union, the obvious first choice was to develop models where the defence budget of a country was a function of the defence budget of its rivals, the so called "external approach". Other authors instead focused on the political economy aspects of defence budget setting, known as the "internal approach."

The modeling of defence budgets as action-reaction processes is traced back to the 1960 book *Arms and Insecurity* by Lewis Richardson.[2] There he develops a model where the defence spending in country A is a function of the defence spending in country B, and vice versa. Under this external approach, the primary determinants of a country's military budget are factors originating from outside the country's borders. These factors can include the spending of potential enemies, the spending of allies, and the occurrence of war. It is clear why, in the 1960s, one would approach the problem in this manner. Only a few years earlier, in 1954, US Secretary of State John Foster Dulles announced a policy of "massive retaliation." This led both the US and Soviet Union to invest heavily in a stockpile of atomic weapons in order to ensure they would be able to enact this policy.

Thus, examining the correlation of defence budgets is necessary to provide support for the external factors approach. I postulate that a further refinement is needed based on the relative location of the countries in question. Not only will countries respond to the budgets of potential rivals, but it is important to factor in how feasible it would

[2]Richardson (1960)

be for a country to launch an attack on another. This information is captured by the relative location of the countries. For this reason, spatial econometric techniques are used, as they easily facilitate this addition.

Many authors have examined whether defence budget data during the Cold War fits the Richardson model, but their focus on single countries or small regions overlooks important determinants of defence spending. For instance, Lambelet (1971) looks at the Middle East. Similarly, Strauss (1978) tries to fit the model to the spending of the two Cold War Super Powers. Finally, Smith (1980) adapts the Richardson model into a neo-classical framework and estimates it for the UK. These papers all find that the defence spending of each of these countries is correlated with the defence spending of certain other countries. They do not, however, estimate any immediate in-year feedback effects of changes in spending, and they do not allow for spending from countries not in the study to impact budgets. By excluding the spending of countries outside the sample, they assume that a weight of zero is given to the spending of these countries. In some cases even immediate neighbours receive a zero weight. Thus, although they do provide support for the external approach to modeling defence budgets, there is room to pursue the question further. Here, I focus on the potential interactions amongst a large sample of countries and, furthermore, I factor in a more realistic interaction profile based on countries' capacity to engage one another militarily.

The internal approach to analyzing defence spending arose shortly after Richardson's work. It postulated that spending levels were based on the incentives faced by bureaucrats and politicians rather than the defence budgets of other nations. Nincic and Cusack (1979) examined the impact that election cycles have on spending, and found that upcoming elections are correlated with increased defence spending. Griffin, Wallace, and Devine (1982) showed that regressions which include internal factors, such as the size of the government, GDP, inflation, and unemployment, outperform regressions which focus solely on external factors. Cusack and Ward (1981) also finds that internal factors, such as elections, aggregate demand fluctuations, and general economic performance, outperform external factors as determinants of defence budgets, in the US, USSR, and China. Ostrom (1977) compares an external with an internal model and concludes that both perform rather poorly.

Although there is strong evidence to support the primacy of internal factors in explaining Cold War spending, it seems unreasonable to believe that the budgets of potential enemies play no role in the determination of defence budgets. In fact, I hypothesize that as a result of the uncertainty that exists in the post-Cold War period, external factors may play a more significant role. International relations have become more fluid as countries no longer fall into one of two opposing camps. Economic growth has led to the emergence of regional powers. These are countries who have a strong

influence over their closest neighbours. The militaries of other countries become a greater threat when one is no longer certain who ones allies are. For that reason, this paper focuses primarily on external factors, while controlling for internal factors.

Recently, a number of other papers have also studied post-Cold War defence spending. Nikolaidou (2008) examines the demand for defence spending in the European Union from 1961 to 2005, Solomon (2005) examines Canadian defence spending from 1952 to 2001, Looney and Frederiksen (2000) examines defence spending in Latin America from the 1970s through to the mid 1990s, and Douch and Solomon (2014) examines defence spending for Middle Powers between 1955 and 2007. My focus here is solely on the post-Cold War period, as the end of that conflict was the beginning of a new paradigm in global relations. Additionally, some of the data series for the years prior to 1993 are incomplete, making analyzing the transition from the Cold War era to the post-Cold War era difficult.

As already mentioned, this paper focuses on the importance of a country's relative location on its spending level. Murdoch and Sandler (1984) were amongst the earliest authors to address this point. An important result that emerges from their study is the effect that location has on the spending levels of NATO nations, specifically Germany and Italy as "flanking nations." Intriligator and Brito (2000) also raises the issue of geography. They argue that with the end of the Cold War, the behaviour of regional powers, such as Saudi Arabia and Egypt, have become more important to the study of defence spending patterns. The impact of a country's spatial location on its spending levels will be thoroughly examined. This will enable me to identify regions with relatively high and relatively low spending patterns.

In contrast to the more regional studies, this paper examines a large sample of 124 countries over 16 years. Thus, a spatial panel data model is used. It is only recently that techniques to perform this type of analysis have been developed. Few authors have made use of these techniques and none have examined military spending using a panel data spatial approach.

Spatial econometrics relies on a matrix that captures how a country factors in the defence spending of every other country. Three such weighting matrices are developed here, using the capacity of a country to project its military power beyond its immediate neighbours as the key component. These weighting matrices can be used by authors in the future to better examine interactions between countries.

The only other author who also uses a spatial approach in examining defence budgets is Goldsmith (2007). He examines 120 countries for 1991 only. Two weighting matrices are used: contiguity and inverted distances. He finds there is a positive and significant

spatial correlation measure, which supports the notion that countries respond in a positive manner to spending in neighbouring countries.

I extend this approach in two significant ways. First, the analysis is expanded to a 16 year period. This provides a more robust estimate of spending patterns in the post-Cold War era. Goldsmith limited his study to a single year, a year that had a relatively large conflict (the Gulf War), which could bias the results. The use of panel data also allows me to control for unobserved factors that are unique to each country. The longer time horizon also allows for an examination of any cyclical patterns and allows time for countries to respond to the observed changes in defence spending of neighbouring countries. As the results will show, controlling for these factors provides a better understanding of defence budgets. Second, and more importantly, weighting matrices are developed that more accurately reflect which countries each other country considers as a potential adversary. These changes result in a clearer account of how defence budgets are set. My results indicate that, given the qualitative structure I impose on the data, there is strong evidence of positive correlation in defence budgets, providing evidence of the importance of a country's relative location and the defence budgets of its neighbours in the determination of its own defence budget.

An interesting result that emerges from using the spatial approach is the identification of different behaviours between geographic regions. As expected, we see that regions such as the Middle East and North West Africa engage in high spending behaviour due to the spillover effect. These results match what casual observers may have predicted. Perhaps more importantly, however, regions that exhibit the opposite behaviour are identified. Such zones are found in Central America, Sub-Saharan Africa and parts of Europe and Asia. Additionally, one can examine the spatial nature of the spillover effects by examining counterfactual situations. By changing an independent variable, one can use the estimated parameters to predict how changes in defence spending by one country spread throughout the system of countries.

The paper is structured as follows. Section 2 provides a brief overview of spatial econometrics. Section 3 discusses the data sources for the variables used in the regressions. Section 4 describes the development of a number of weighting matrices examined in this paper. Section 5 presents the regression results and some robustness checks. Section 6 discusses the geographical interpretations of the results. Section 7 concludes. All tables and figures can be found at the end of the paper.

2 Spatial Econometrics Overview

Spatial econometrics allows for the analysis of defence spending data in a way that easily and intuitively incorporates the relative geographic location of a country. It is natural to think that the threat a country's military poses is a function of how easy or difficult it is for that country to actually engage in combat operations against the home nation. If it is believed that countries respond to one another's defence budgets in the same period, and if it is believed that the weights placed on these countries are a function of their relative spatial location, then spatial econometrics is a useful tool, as it easily incorporates these beliefs.[3]

Spatial econometric techniques conveniently handle the problems that arise when the dependent variables in a geographic region is a function of the dependent variables of other regions. As the number of countries rise, simply adding these dependent variables to the right hand side of an OLS regression equation leads to too many parameters to be estimated. Spatial econometrics solves this problem by imposing structure on the parameters. Specifically, it imposes the restriction that all countries respond with the same magnitude to a given weighting of the dependent variables of other countries. Although this condition is restrictive, it allows for an examination of an overall tendency in the data.

The general spatial autoregressive model (SAR) takes the following form

$$y = \rho W y + X\beta + \epsilon \tag{1}$$

Here, y is the vector of dependent variables, X is a matrix of independent variables, ϵ is the error term, and β are coefficients to be estimated. The two changes from a standard regression are W, a matrix of spatial weights, and ρ the parameter estimate for the variable Wy. In this paper, y will be the defence burden, that is the military spending of a country as a proportion of total GDP.

The data to be estimated is in the form of an N countries by T years panel given by Equation 2. Here a spatial fixed effect term, μ_i has been included.

$$y_{it} = \rho \sum_{j=1}^{N} W_{ij} y_{jt} + X_{it}\beta + \mu_i + \epsilon_{it} \tag{2}$$

[3]For excellent references on the subject see Anselin (1988) and Anselin, Le Gallo, and Jayet (2008).

Solving Equation 2 for y reveals that the error terms will not be independent from the regressors due to the presence of the weight matrix. As such, OLS cannot be used to estimate spatial econometric models. Others have shown that maximum likelihood estimation can provide consistent and unbiased estimates.[4] As such, this paper makes use of the maximum likelihood estimation approached, proposed by Elhorst (2003).[5]

It must be emphasized that ρ is a single value that describes the nature of the spatial relationship present in the data. It is hypothesized that the value of ρ will be positive. This would indicate a positive spatial relationship, which implies that defence spending in a country is positively correlated with that of its neighbours, as defined by the weight matrix.

The weight matrix is a row-normalized square matrix of size N that describes exogenous factors which determine how we might expect countries in the world to interact with one another. A typical element (W_{ij}) provides the relative weight that country i places on country j's spending. Examining a row of matrix W provides the relative weights that a country places on all other countries' defence spending. If an element W_{ij} is zero, then the spending of country j is not directly factored into the spending decision of country i. A larger value indicates that more weight is assigned to that country's spending, relative to others.

Another difference between spatial econometrics and standard OLS is in the interpretation of the β coefficients. It is not correct to interpret them as partial derivatives, as one would with an OLS regression, as this would ignore the feedback effects that are present in the model. The ultimate effect will depend on factors such as the location of the country, especially in terms of the number of neighbours and how closely they are connected.

In order to properly interpret the effect of changing an observation one can estimate the direct, indirect, and total impact that changing an observation will have on the vector y. The direct effect is a measure of the impact that changing a single element in the matrix X, say x_{ir}, has on y_i, including feedback effects. The indirect effect is the effect that changing x_{ir} has on all other ys that results from the interaction through the weight matrix. The total effect is the sum of these two values.[6]

At this point it is helpful to reemphasize why a spatial approach is needed. As with any regression, if Wy is an explanatory variable in the true model and it is left out, the regression will suffer from an omitted variable bias. It is reasonable to believe

[4]See Anselin (1988) Chapter 6 for details.

[5]For further information on how the model is estimated see Elhorst (2010) and Elhorst (2012).

[6]See LeSage and Pace (2009) Chapter 2 for equations and further details.

that policy makers account for the budgets of other countries when they set their own budget. It is also reasonable to believe that different weights are assigned to different countries depending on the threat which they pose. Thus, there is sufficient reason to believe that omitting the weighted spending of other countries would lead to biased estimates.

3 Data

I focus on the post-Cold War period, specifically the 16 year period from 1993 through to 2008. There are 124 countries in the sample. Table 1 provides summary statistics for the data series used in this paper. Data on military spending is obtained from the Stockholm International Peace Research Institute (SIPRI). Spending as a percent of GDP is the variable of interest, which the literature refers to as the defence burden. This measure was chosen over a dollar value of spending as it more easily facilitates cross country comparisons, as it indicates what share of available resources is devoted to defence. Additionally, the defence burden also allows for a more appropriate comparison between countries of different sizes.[7]

Data on the population of each country was obtained from version 7.0 of the Penn World Tables. A measure of civil liberties is used to identify countries which are more autocratic than others. The source of this data was Freedom House's Freedom in the World index. Their ranking runs from 1 to 7, where lower numbers indicate more civil liberties and higher numbers indicate a more authoritarian country. They assign the value based on factors such as freedoms of expression, assembly, and religion, as well as factors such as the rule of law and economic freedoms.

A dummy variable for whether or not a country was engaged in a war in a particular year is another explanatory variable. This was taken from the Correlates of War project.[8] A value of 1 is assigned if a country was engaged in an Inter-State War, an Intra-State War, or an Extra-State War. These measures include wars between states, wars within a state, and wars between a state and a non-state entity. The lag of this variable was used in regressions to mitigate potential endogeneity problems. Since wars are often planned in advance, increased spending could proceed a war.

Some internal factors were also examined in the paper. The first is a measure of

[7] As a robustness check, defence spending per capita is used as the dependent variable, with very little difference in the results.

[8] Sarkees and Wayman (2010)

GDP per capita, taken from version 7.0 of the Penn World Tables. Since military spending is included in GDP, the defence spending for each year was subtracted from this measure. This variable is in constant 2005 US dollars.

A second internal factor is economic growth. This is measured by real growth in the non-military component of GDP. This is computed from the adjusted GDP measure discussed previously.

A third internal factor found in other papers is the relative size of the government sector. To calculate this, military spending was subtracted from the dollar value of government consumption. This was then divided by adjusted GDP. The result was the fraction of the non-military economy that the non-military government sectors comprised. The source of government consumption is version 7.0 of the Penn World Tables.

The final variable considered is a dummy variable for whether an election occurs in the following year. After determining which elected official or officials are in charge of setting defence budgets, elections over the time period were documented. If the budget setter was to be elected in year t, then a value of 1 was assigned to the variable in year $t-1$.

These four internal factors were selected as they were frequently used in the literature and reliable and complete datasets were available. It was hoped that unemployment rates could have been used as a fifth variable, however data were not available for all countries in the study. I made the choice to omit this variable in order to maintain the maximum number of countries available for the regressions.

4 Weighting Matrices

The appropriate choice of weighting matrix is key for spatial regressions. This matrix must describe the relative weights that a country places on the spending of other countries when deciding at what level to set its budget. This paper will examine a variety of different candidate weighting matrices, which are outlined below. The first two are used extensively in the cross-country spatial literature. The latter three are constructed specifically for this paper.

The first matrix considered is the inverse distance between capital pairs of all countries. This is at one extreme of the spectrum of weighting matrices, as it states that

all countries factor in the spending of all other countries, however a higher weight is placed on countries whose capitals are nearer to their own. This type of matrix would be most appropriate if all countries were major powers in the world. It is conceivable that countries such as Russia, the US, and China do take into account the budgets of all other countries to some degree. However, it is difficult to believe that this method describes the thinking of smaller countries. It is unlikely that a small landlocked country such as Bhutan would react to changes in the military spending of a nearby small landlocked country, such as Kyrgyzstan.

The second weighting matrix is at the other extreme of the spectrum. To overcome the problems associated with the previous matrix, this matrix looks solely at countries which are immediate neighbours. It is a binary matrix where a value of 1 is assigned if two countries share a border, otherwise a weight of 0 is assigned. For the purpose of this matrix, maritime borders are included, as are dependencies. This matrix does a better job at describing which countries smaller nations factor in when setting their budget. On the other hand, it also implies that the US would not factor in the budgets of China or Russia, a difficult assumption to accept.

To find a more plausible weighting matrix, countries are classified into two groups. The first group includes countries that have the ability to project their military power worldwide. These countries are typically classified as middle powers, regional powers, or super powers. They are denoted as Type P countries. The second group includes those countries which do not fit into the first category. These are labeled Type Q countries.

In order to determine which countries fall into the former category, the military equipment of countries in 2010 is examined. This data is obtained from The Military Balance, a publication which lists the military assets of every country in the world.[9] This data will be used to determine which countries have the ability to project their power beyond their immediate neighbours. There are four criteria which are examined. A measure of the projection power of the navy, a measure of the size of the air transport capabilities, a measure of air combat capabilities, and a measure of mobility of the army.

The first measure examined is the size of the navy. Modern navies have many different vessels, which specialize in a number of different capabilities. A satisfactory measure of the navy is not simply the number of ships, as this number can easily be inflated with the purchase of smaller patrol or coastal vessels. The desired measure is the number of oceangoing ships, sometimes referred to as the size of the Blue Water navy. We wish to know the number of ships each country has that are classified as one of the following: Submarine (both tactical or strategic, but not midget), aircraft carrier

[9]International Institute for Strategic Studies (2010)

(including helicopter carriers), cruisers, destroyers, frigates, and amphibious ships (but not amphibious craft), as these are the classes of ships that can be used to project sea power around the globe.

Out of the 124 countries considered, 59 countries in the dataset have at least 1 ship of the types listed above. Countries which have 10 or more of these ships are classified as being able to project power with their navy. I find that 32 countries meet this criteria.

Next the size of the air force is examined. There are two measures of interest. The first is a measure of the air lift capabilities of the countries. If countries do not border one another, and do not have permission to travel through neutral countries to engage potential enemies, then they must either travel by ship or by air. Thus, a measure of the number of transport aircraft per country is needed.

The data shows 115 of the countries have at least 1 fixed wing transport aircraft. A cutoff point of 50 planes is used to determine which countries had the ability to project their military power worldwide. This cutoff resulted in 33 countries which satisfy the criteria.

The second component of the air force is the number of fixed-wing combat aircraft. In 2010, 93 of the countries examined have at least 1 combat aircraft. A cutoff of 100 combat aircraft is used to identify power projection capability in this dimension. This leaves 34 countries who meet this criteria.

Finally, the mobility of the armies is examined. In modern warfare, there is a need for military vehicles. Speed and maneuverability have been shown to be essential to engaging in combat operations. As such, countries which have a large number of military vehicles are able to engage in combat operations abroad. There are many different classifications of military vehicles, but only the following types are included: Main battle tanks, light tanks, reconnaissance vehicles, armoured infantry fighting vehicles, armoured personnel carriers, and armoured assault vehicles.

All but 5 countries in the data set have at least 1 vehicle of any of these types. The measure of 1000 vehicles is the chosen cutoff point. This leaves 47 countries which satisfy this criteria. Table 2 summarizes the above information.

There are 58 countries which satisfy at least one of these four criteria. Of these, 18 satisfy all four, 29 satisfy three or more, 41 satisfy two or more, and 58 satisfy only one. Countries which satisfy at least 3 of these criteria, are identified as countries with the ability to project their power globally. Table 3 lists these Type P countries and how many of the four criteria they satisfy.

Now that countries that can project their power have been identified, the next step is to determine how these countries interact with the other countries of the world. There are three hypotheses that are all examined in this paper.

The first, is that two groups ignore one another. In this W matrix, countries that are type P, assign a value of 1 to other type P countries, and a value of 0 to type Q countries, except if they share a border with that country, then they get a 1. Type Qs assign a value of 1 to countries with which they share a border, regardless of type. This matrix assumes that all countries care about what their immediate neighbours are doing, whether they are type P or type Q. Additionally, type Q countries believe that they could not compete militarily with type P countries, so they do not even bother to try. They simply ignore the actions of these countries. Meanwhile, type P countries view other type P countries as potential threats. This matrix is given the label, "Two Groups."

The second method, has type P countries interacting with all other countries, and type Q interacting with only their neighbours. This can be viewed as a world policing story. By acquiring the equipment to intervene anywhere in the world it is possible that type P countries have shown their desire to act as a global police force. Thus, these countries would be interested in the choices of all other countries, so that they can maintain the necessary equipment to intervene in any country. Again, type Q countries care only about their immediate neighbours, as they have determined that they cannot compete with the level of spending of these type P countries. This matrix is entitled, "World Police."

The final method, is to have all countries give a positive weight to type P countries. In this case, countries care about those countries that can threaten them, that is their immediate neighbours and all countries who possess the military capability to project their power. So, type P countries care about the actions of all type P countries, and their immediate neighbours. The difference now though, is that type Q countries factor in the spending of type P countries. It is logical to assume that countries would be interested in responding to the actions of those countries who could pose a threat. This matrix is entitled, "Who Can Get Me?"

These three matrices are further augmented by replacing the pairs assigned a value of 1 with the inverted distance between the two countries' capitals. This helps to capture the importance of regional powers.

A second change that is made, in this case to all five weighting matrices, is to control for alliances. A few issues arise in this regard. The first issue is in identifying what qualifies as an alliance. Certain countries work closely with one another, without

formalizing their relationship with a treaty. Others are in larger alliances, including some countries with which they are not on good terms. Other treaties, such as the African Union, contain provisions for mutual security that in practice are not binding. Thus, only formal alliances which have proven records or are, up to now, untested are included. Table 4 lists the alliances factored into the weighting matrices.

The second issue is that alliances change over the examined time period. Some alliances grow, while others contract. Since it is not possible to allow the weighting matrix to change over time, a decision as to which countries should be included in the alliance must be made. If the country was in the alliance for more than half the period, it is included. The justification is that the process of entering into an alliance often takes a few years, so for most of the period the countries already in the alliance would not view the potential new entrant as a threat.

The final issue involves what weight an ally should receive in the matrix. It was decided that if two countries are allied, that a zero weight will be applied.

One final augmentation is that the matrices are row normalized. That is each, element of the matrix is divided by the sum of the elements in its row. This is a standard practice in spatial econometrics. The result is that the sum of the weights placed on all other countries by a single country, sum to one. If a row is all zeroes, then no change is made.

Therefore, there are five weighting matrices that serve as potential candidates for describing the true state of the world. Testing will be conducted using all five of the matrices. Table 5 summarizes the matrices. It should be noted, that my preferred specifications are the "Two Groups" and "World Police" matrices. The inverse distance and contiguous matrices have problems that have been addressed above. The "Who Can Get Me?" matrix is an improvement over these two, and is rather intuitive, however I believe that it is not the best representation of the behaviour of smaller nations, as it assumes they react to the actions of all Type P countries, which is difficult to believe.

5 Results

Since there are five weighting matrices that serve as potential candidates to describe the true state of the world, there are a number of regression results to examine. Table 6 presents the regression results across the five weighting matrices using logged population, a dummy variable for war in the previous period, and a measure of civil liberties as

regressors. The key result obtained here is that the coefficient on the weighted defence spending of other nations is positive and significant across all five weight matrices, as hypothesized.

Comparing the two extremes, the estimates of ρ fall between 0.6265 in the case where all non-allied countries receive a positive weight, to a low of 0.1951 where only non-allied bordering countries receive a positive weight. The estimate of ρ in the other three cases fall between these two values. In the case of the "Who can get me" matrix, the estimate of ρ is higher than in the other two power projection matrices. This is not unexpected as this matrix is closer in nature to the inverse distance matrix, as there are more non-zero values. It is believed that the value for ρ is higher in the two cases where there are more non-zero elements in the weighting matrix as the regression is measuring a spurious relationship rather than countries actually responding to one another.

Although ρ is not a correlation coefficient, it does still hold that larger values imply increased correlation. This provides strong evidence that the defence spending of countries is indeed positively correlated with that of its neighbours in the post-Cold War era. The value of 0.6265 indicates that if all other countries independently raised their defence burden by 1% of GDP, then there would be an expected immediate rise in defence spending of 0.6265% of GDP in the remaining country. The ultimate rise in spending would be greater as all countries would wish to react to each other's spending change.

The regression results indicate that increases in population are correlated with increased defence burdens, albeit at a small rate. Being in a war in the previous period is also correlated with higher spending levels. Finally, a reduction in civil liberties is also associated with a higher defence burden. In order to measure the magnitudes of these correlations, one must account for the feedback effects associated with a spatial model. Table 7 provides estimates of the direct, indirect, and total effect of a change in these variables.

Examining population first, one observes that the total effect of an increase in population ranges from 0.0577 to 0.0118. The main difference between the estimates coming from the indirect effects of a change, that is the change in spending in other countries. Focusing on the "Two Groups" case, an increase in population of 10% in country i would lead to an increase in defence burden in that country of less than one tenth of one percent. If country i's defence burden was 2.5% prior to the change, its new defence burden would be 2.502%. The indirect effect is even smaller. Population thus does not appear to be a significant determinant of defence burden.

The effect of being in a war has a much larger impact on the defence burden, as

might be expected. Countries that engage in war are expected to devote more resources to defence for three reasons. First, there is a cost from expending munitions and from increased maintenance on weapon systems. Second, a country that was in a war in the previous period may still be in a war this period. Lastly, a country that was in a war that has now ended, must spend resources to demobilize, and may wish to keep some assets in a heightened state of alert in case the conflict begins again.

The direct effect is relatively constant across the five matrices, with an average of approximate 0.115. This implies that if country i were to be in a war, the expected effect on its defence spending would be an increase of 12%. So if country i had a defence burden of 2.5% prior to the war, the increase would bring it to 2.80%. This value may seem small, but one must realize that the size of the war has not been controlled for. Larger wars are expected to be correlated with larger increases in the defence burden. Of note is the predicted impact that country i's action has on the spending of its neighbours. Depending on the weight matrix used, the indirect effect is larger than the direct effect. In fact it is possible to map out the spending effects as it moves through the neighbouring countries. The closer the relationship is between another country and country i, the larger the expected change in defence burden for that country.

Finally, note the impact that a reduction in civil liberties has on the defence burden. An increase in the measure of civil liberties is associated with a decline in freedom, or in other words a movement towards a more authoritarian regime. Table 7 indicates that this is correlated with an increase in the defence burden. In fact a one point decrease in freedom has only a slightly smaller impact on the defence burden as going to war has.

5.1 Robustness Checks

The first robustness check involves including various internal factors that may act as determinants of the defence burden. The results of these regressions can be found in Tables 8 and 9. The variables included here have all been used in other studies to test if internal factors play a role in the determination of defence budgets. Adjusted GDP per capita, that is GDP with the defence budget removed, provides a measure of the available resources of the economy. Others have shown that during the Cold War higher GDPs have been correlated with larger dollar values of military expenditures.[10] First, higher GDPs indicate that there are more assets to defend, and second that with more resources available, budget setters may be able to acquire a larger share. It is not clear

[10]Murdoch and Sandler (1984), Looney (1989).

if the effect will be the same as on the Defence Burden, as increases in GDP, holding military spending constant, would cause the defence burden to fall.[11]

Similarly, GDP growth is included to see if the budget setters can claim a larger share of new resources available.[12] The Upcoming Election variable measures whether defence burdens rise in years before an election is held. It has been hypothesized that budget setters can use the defence budget to reduce unemployment by hiring soldiers or increasing procurement.[13] Finally, the government size variable is a ratio of the non-defence component of government spending as a percentage of non-defence GDP. Several authors have suggested that countries with larger government expenditures represent an increased ability to finance the defence departments.[14] Thus, larger government sizes are hypothesized to be positively correlated with increased defence burdens.

The results do not support the hypotheses presented by the internal factor literature. First, GDP per capita is negatively correlated with the defence burden. This might be the result of increasing returns to scale in military spending. The size of government is also negatively correlated with the defence burden. This can be explained by the fact that countries with large government sectors, are most often countries with a large welfare state. Health and education may be crowding out defence expenditures. Finally, growth and elections appear completely uncorrelated with the defence burden. The parameter ρ, remains positive and significant when these internal factors are included, suggesting that external factors are more important determinants of defence burdens.

It is not known with certainty why the internal factors fail to perform the same way as in previous studies. One possibility is that with the use of spatial econometrics, it is possible to handle defence budgets of neighbouring countries in a more appropriate manner. Accounting for the spatial location of countries may go a long way in explaining defence budgets. The evidence suggests that spending is positively spatially correlated, and that internal factors provide little assistance in explaining the defence burden when these external factors are properly accounted for. A second explanation might be in the time frame of the data. The post-Cold War time period may be fundamentally different than the Cold War. During the Cold War, the world was in some ways simpler. There were two main adversaries, and most countries aligned with one or the other. This made it clear who's ones allies and enemies were, simplifying spending decisions. With increased economic growth in the developing world, regional powers have sprung up in various regions. The world is no longer polarized, and this may lead to countries no longer seeing clear battle lines. The result may be to rely more on external factors

[11] Goldsmith (2003) shows a positive correlation between GDP per capita and Defence Burdens.
[12] Goldsmith (2003).
[13] Nincic and Cusack (1979), Griffin, Wallace, and Devine (1982).
[14] Maizels and Nissanke (1986).

when setting budgets.

As an additional robustness check, the regressions were run on a year by year basis under the same specification as in Table 6. The estimated value of rho for each year is presented in Table 10. Of course, as these regressions are cross-sectional, no location fixed effect was included. Instead, a constant was included. For this reason the estimated values of rho in the year by year case are not centered on the estimated rho for the full data set. The important thing to notice from this table however, is the relative constant nature of rho for each weight matrix. Although some yearly variation exists, the estimates of rho are fairly constant across time. The estimated values of the Betas on a year by year basis are consistent with the results in Table 6.[15] These results indicate that by using panel data as opposed to a simple cross-section, I am able to account for a potential upward bias in the measure of ρ by controlling for time-invariant variables within each country.

Another robustness check was to examine the data for certain regions only. This presents two challenges. First, with fewer observations for each regression, the efficiency of the estimates will be reduced. Second, by only examining certain countries, the implicit assumption is that the defence spending of countries outside these regions do not impact the spending levels of the countries within each region. Table 11 presents the regression results for four regions: Latin America, Europe, The Middle East, and the rest of Asia. Overall, the results are fairly robust to this analysis. The value of rho is positive and significant for most regions, indicating the continued presence of positive spatial correlation. The estimates of rho vary from those found in Table 6, but this is likely the result of omission of the other countries' defence spending.

One final robustness check was to re-run the regressions with a different dependent variable. Instead of the defence burden, defence spending per capita in constant 2005 US dollars was used. The results are presented in Table 12. Again, we immediately see that the estimate of rho is both positive and significant, indicating the presence of positive spatial correlation in the data. The estimates of rho are similar to those found in Table 6 for four of the five matrices examined, thus providing more support to the results found there.

[15] Full regression results available upon request

6 Geographic Analysis

With the regression results in hand, it is now possible to examine the data from a geographic perspective. The local Moran Is provided an indication of what regions showed strong evidence of positive spatial autocorrelation. These were the Middle East and Central America. One method to further study the geographic nature of the results is to examine the residuals from the regressions. The residuals are given by:

$$Residual = y - \hat{\rho}Wy - \hat{\beta}X \tag{3}$$

Notice that the residual include the fixed effects. Since the interest is in comparing the results of the model between countries, leaving the fixed effect estimate in the residual term allows us to more accurately observe how countries differ from one another. A second variable is created by multiplying the vector of residuals by the weighting matrix used in the regression.

Thus, for each regression there is a vector of residuals paired with a vector of values which weights the residuals of all the neighbours of the country, where neighbour is defined by the weighting matrix used in the regression. For each regression there are 16 pairs for each of the 124 countries.

These pairs can be interpreted as follows. The residual indicates how much more or less a country is spending on the military than is explained by the model. If the model is correct, the countries which have positive residuals are countries which tend to spend more than what would otherwise be expected. On the other hand, countries with negative residuals are spending less than what otherwise would be expected. If the value of the matrix weighted residuals for a country is positive this indicates that its neighbours are spending more than what otherwise would be expected. On the other hand, if this value is negative its neighbours are spending less than what otherwise would be expected.

Consequently, a country can be described by one of four characterizations. If both values are positive, this country could be described as being in an arms race. It is spending more than predicted, and so too are its neighbours. If both of the values are negative, then the opposite event is occurring. The country and its neighbours are both spending less than expected. This anti-arms race could be the result of a mutual agreement to keep spending low. If the country's residual is positive but the weighted residuals is negative then the country can be seen as one that is spending more on the military while its neighbours are spending less. Finally, if the residual is negative but

the weighted residual is positive, we observe that a country is underspending according to the model whilst its neighbours are overspending.

In each year, a country can be classified as one of these four types. It is often the case that a country is the same type in all 16 years. It is impractical to present the results for each year and each weighting matrix. Thus, these data are presented for only three of the five weighting matrices. Additionally, instead of looking at each of the sixteen years, the average residual and weighted residual were calculated for each country. By using this method any chance of observing a country changing its type over the period of the data is abandoned. For most countries this is not an issue.

To analyze the results, only the regression results from Table 6 will be presented. The three chosen matrices were "Contiguous," "Two Groups," and "World Police." The latter two were chosen as they are the preferred matrices of the three that were created for this paper. The "Contiguous" results are presented as a reference.

These data are best understood through use of the maps presented in Figures 1 and 2. In both cases there is clearly certain areas that display clustering. If the regressions fully supported the hypothesis, clustering of Colour A countries, which indicates positive clustering at high levels, and clustering of Colour B countries, which indicate positive spatial clustering at low levels, would be large and separated. Between these would be countries of Colour B and Colour C. Colour B countries are those who spend more whilst their neighbours spend less, and countries who are Colour C spend less whist their neighbours spend more.

In both cases, there is clearly a swath of high spending through the Middle East and surrounding area, including the Balkans and Northern Africa. Smaller regions of high spending clusters include parts of Southern Asia and Northwest and Southwest Africa. This certainly aligns with the traditional views of these areas. The Middle East is obviously a high spending area due to the numerous conflicts in its recent history. The India-Pakistan rivalry also causes spending in that area to be higher. The region of Northwest Africa has also had conflicts, specifically over the territory of Western Sahara.

Clustering of low spending countries in various regions is also observed. These include Central America, parts of Europe, Eastern Asia, and parts of Africa. The Americas have generally been peaceful thanks to the Monroe Doctrine. The existence of NATO has allowed some European countries to mutually lower their spending. The African regions may come as a surprise, until one realizes that most of the conflicts in the region are within state conflicts. Wars between neighbours are rarer.

The identification of these low spending zones is useful in a number of ways. If the goal of some countries is to move away from a high spending equilibrium to a low spending equilibrium, it is necessary to identify zones that are low spending so that one can understand how they reached this point. Additionally, these low spending zones may identify regions where more formal cooperation is possible. If a group of countries have existed in a relatively low spending equilibrium for a number of years, they may wish to move towards more formal mutual defence agreements. Finally, for investors it serves to identify countries where investment may be less likely to be destroyed in an international conflict.

So, although the data may not fit the hypothesis perfectly, as the clustering is not entirely clean, there is strong evidence to support the notion that there are clusters of high spending and low spending countries.

7 Conclusions

This paper uses spatial econometric techniques to analyze defence spending patterns of 124 countries during the post-Cold war period. In this period, the analysis indicates that there was significant evidence of positive spatial correlation in the data, given the qualitative structure imposed by the weight matrices. These results stand up to a number of robust checks, including focusing on fewer years, smaller regions, and differing sets of explanatory variables.

An important component of this paper was the development of weighting matrices that specifically factored in the ability of countries to project their power abroad. Three potential weighting matrices were crafted that took account of this factor. Although it is not possible to say with certainty which weighting matrix represents the true state of the world, the results from all three are consistent and lend support to the model. Future work in defence budget research can use this classification and associated weighting matrices to better understand how countries interact with one another.

The results also point to the benefit of using a panel data set. By using country fixed effects, I am able to control for the time-invariant unobserved variables that influence defence spending. As the robustness check that examines the year by year variable shows, the spatial correlation is fairly constant, but is biased upwards by the omission of the fixed effects.[16] Identifying what these unknown time-invariant country specific

[16]In regression results not presented here, a similar upward bias is found when the complete panel data set was analyzed without country fixed effects.

characteristics could be an interesting future area of research.

Overall, positive spatial correlation was found in the data, under the imposed neighbourhood structure. That is the spending in a country was positively correlated to the value set by neighbouring countries, as defined by the weighting matrices. Changes in population were found to have a small impact on the defence burden. Additionally, two societal measures of civil liberties and whether the country was at war in the previous year, are both positively correlated with the defence burden.

Analyzing the regression results allowed us to identify regions of the world that display different spending trends. The Middle East, Southern Asia, and parts of Africa all displayed positive spatial correlation at high levels. That is to say that countries in that area spent more than the model predicted. These regions can be classified as areas where arms racing is occurring. There are also regions that have countries spend less than the model predicts. These areas include Central America, parts of Europe Europe, parts of Asia, and Sub-Saharan Western Africa. These can be described as zones of peace, or areas of anti-arms racing.

The results were subjected to a number of robustness checks, including the addition of a number of internal factors that other authors have had success using, as well as yearly and regional analysis of the data. The results were robust to these additions. Though internal factors may also play a potential role, the analysis here clearly showed that in the post-Cold War era, external factors were significant. With the removal of the Soviet Union, there is no longer a polarization of the world. This has allowed for regional powers to develop. The result is that there are no longer clear battle lines, so countries must take into account the spending of more countries than they otherwise would have.

My findings emphasize the need to factor in spatial location when examining defence budgets. Although advanced weapon systems allow countries to launch limited strikes anywhere in the world, the threat of invasion is highest from those countries who have the opportunity and ability to move large number of forces to a given country. A realistic assessment of this ability was included in this paper. By adhering to this approach, the regression results provide a clearer picturer of the co-movement of defence burdens.

Overall, the results presented here make a few things clear. First, external factors are significant determinants of defence budgets. Authors who omit the budgets of other countries in their regressions could suffer from an omitted variable bias. Second, spatial econometrics, and the weighting matrices presented here, allow us to more thoroughly examine and understand the interaction of defence spending between countries. Finally, different areas of the world exhibit different spending patterns. The approach

of looking for common trends is helpful at identifying regions that could be examined independently in the future. An important caveat however, is that regions of the world do not exist in a vacuum. Though the countries of Central America may spend less collectively because of mutual cooperation, it is likely they still factor in the decisions of countries outside of this region when making their decisions. Thus, it is recommended that further use be made of the spatial econometric techniques. It allows for a formal and convenient way to account for the action-reaction nature of defence spending.

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8 Tables

Table 1: Summary Statistics

Variable	**Mean**	**Median**	**St. Dev**	**Min**	**Max**
Defence Spending (Percent of GDP)	2.44	1.80	2.05	0.2	17.5
Population (Thousands)	46,167	10,306	149,253	73	1,317,066
Civil Liberties (1 to 7)	3.3	3.0	1.7	1.0	7.0
Adjusted GDP per Capita (2005 $US)	11,719	6,491	12,682	314	85,480
Adjusted GDP Growth (%)	4.29	4.13	5.41	-54.93	44.79
Size of Government (% of GDP)	9.45	7.43	7.01	0.10	39.68
	Count				
War (Dummy)	263				
Election (Dummy)	532				

Description: Information on the mean, median, standard deviation, min, and max of the variables used in the regressions.

Table 2: Candidates for Type P Countries

Naval Ships (> 10)	Air Transport (> 50)	Air Combat (> 100)	Army Vehicles (> 1000)
China(236)	USA(1296)	USA(3609)	Russia(54459)
USA(214)	Russia(423)	China(2026)	USA(37005)
Russia(130)	China(386)	Russia(1909)	China(13752)
Japan(71)	India(278)	India(829)	Turkey(9666)
India(47)	Turkey(189)	Japan(653)	Syria(9490)
Taiwan(45)	Brazil(186)	Israel(640)	Israel(9015)
Indonesia(44)	Mexico(150)	Egypt(589)	Egypt(8834)
France(41)	Iran(135)	South Korea(588)	Ukraine(8058)
South Korea(41)	Colombia(129)	Taiwan(500)	Saudi Arabia(7617)
Turkey(37)	Japan(124)	France(489)	France(7140)
United Kingdom(36)	Venezuela(123)	Pakistan(449)	India(6234)
Iran(32)	United Kingdom(109)	United Kingdom(377)	South Korea(6025)
Greece(27)	Thailand(108)	Syria(365)	Pakistan(4046)
Italy(27)	Spain(101)	Iran(339)	Italy(4042)
Brazil(25)	Germany(95)	Turkey(338)	Greece(3962)
Germany(22)	Italy(92)	Saudi Arabia(296)	United Kingdom(3678)
Australia(20)	Bolivia(87)	Greece(288)	Kazakhstan(3192)
Canada(19)	Argentina(84)	Ukraine(267)	Algeria(3110)
Pakistan(19)	Greece(75)	Italy(263)	Poland(3060)
Peru(19)	Saudi Arabia(73)	Brazil(247)	Iran(3028)
Thailand(19)	Indonesia(73)	Spain(209)	Germany(2937)
Chile(17)	Ukraine(66)	Thailand(186)	Spain(2932)
Spain(17)	Australia(62)	Germany(182)	Taiwan(2845)
Egypt(15)	Egypt(60)	Kazakhstan(162)	Singapore(2615)
Singapore(15)	Canada(60)	Australia(147)	South Africa(2353)
Argentina(14)	Israel(58)	Argentina(143)	Jordan(2308)
Malaysia(12)	Ecuador(57)	Singapore(134)	Romania(2060)
Netherlands(12)	South Africa(55)	Belarus(128)	Morocco(2001)
Venezuela(12)	Philippines(55)	Algeria(125)	Yemen(1914)
Norway(11)	Chile(53)	Jordan(115)	Belarus(1890)
Algeria(10)	Algeria(51)	Sweden(115)	Switzerland(1883)
Mexico(10)	Morocco(51)	Poland(112)	Thailand(1808)
	Angola(50)	Finland(109)	Japan(1780)
		Venezuela(102)	Brazil(1722)
			Australia(1653)
			Lebanon(1636)
			Canada(1546)
			Bulgaria(1545)
			Malaysia(1466)
			Nigeria(1369)
			Indonesia(1324)
			Angola(1320)
			Sudan(1239)
			Argentina(1228)
			Kuwait(1188)
			Sweden(1123)
			Azerbaijan(1001)

Description: A list of countries that satisfy each of the four criteria used to identify a type P country. These criteria are having 10 or more Blue Water naval vessels, 50 or more transport aircraft, 100 or more combat aircraft, and 1000 or more army vehicles.

Table 3: Type P Countries

Algeria(4)	Germany(4)	Pakistan(3)	Turkey(4)
Argentina(4)	Greece(4)	Russia(4)	Ukraine(3)
Australia(4)	India(4)	Saudi Arabia(3)	United Kingdom(4)
Brazil(4)	Indonesia(3)	Singapore(3)	United States(4)
Canada(3)	Iran(4)	South Korea(3)	Venezuela(3)
China(4)	Israel(3)	Spain(4)	
Egypt(4)	Italy(4)	Taiwan(3)	
France(3)	Japan(4)	Thailand(4)	

Description: The 29 countries who satisfy three or more of the criteria identified in Table 2. The number in brackets indicates how many of the criteria each country satisfied.

Table 4: Alliances

European Union	**NATO**	**CSTO**
Austria	Belgium	Armenia
Belgium	Canada	Belarus
Denmark	Czech Republic	Kazakhstan
Finland	Denmark	Kyrgyzstan
France	France	Russia
Germany	Germany	Tajikistan
Greece	Greece	
Ireland	Hungary	**Pairwise Alliances**
Italy	Iceland	South Korea
Luxembourg	Italy	United States
Netherlands	Luxembourg	
Portugal	Netherlands	Philippines
Spain	Norway	United States
Sweden	Poland	
United Kingdom	Portugal	Australia
	Spain	New Zealand
SCO	Turkey	
China	United Kingdom	Australia
Kazakhstan	United States	United States
Kyrgyzstan		
Russia		
Tajikistan		

Description: Alliances that were factored into the weighting matrices.

Table 5: Summary of Weighting Matrices

Matrix	**Description**
1. Inverse Distances	Values are inverted capital pair distances. All non-allied countries receive a positive weight.
2. Contiguous	Values are binary. Only non-allied contiguous countries receive a weight of 1.
3. Two Groups	Values are inverted capital pair distances. Type Ps give a positive weight to non-allied Type Ps and non-allied contiguous countries. Type Qs give a positive weight to non-allied contiguous countries.
4. World Police	Values are inverted capital pair distances. Type Ps give a positive weight to all non-allied countries. Type Qs give a positive weight to non-allied contiguous countries.
5. Who can get me?	Values are inverted capital pair distances. Type Ps give a positive weight to all non-allied Type Ps and non-allied contiguous countries. Type Qs give a positive weight to all non-allied Type Ps and non-allied contiguous countries.

Description: A summary of the five weighting matrices used in the paper. Note the numbers associated with each name, as they will be used in the presentation of the regression results.

Table 6: Baseline Case

Defence Burden (Logged)	1	2	3	4	5
Rho	0.6265***	0.1951***	0.1990***	0.2047***	0.3763***
	(0.0480)	(0.0271)	(0.0263)	(0.0276)	(0.0413)
Population (Logged)	0.0212***	0.0097***	0.0097***	0.0097***	0.0145***
	(0.0037)	(0.0037)	(0.0037)	(0.0037)	(0.0037)
Lagged War	0.1179***	0.1133***	0.1133***	0.1127***	0.1166***
	(0.0214)	(0.0218)	(0.0218)	(0.0218)	(0.0216)
Civil Liberties	0.0628***	0.0960***	0.0956***	0.0958***	0.0809***
	(0.0099)	(0.0101)	(0.0101)	(0.0100)	(0.0100)
R-Squared	0.8879	0.8833	0.8837	0.8838	0.8856
Correlation Squared	0.1437	0.1609	0.1607	0.1603	0.1689
Log Likelihood	44.6499	7.6096	10.0045	12.0956	23.4897

Description: Standard Errors in Brackets. 1984 Observations. Country Fixed Effects. * 10% Significance. ** 5% Significance. *** 1% Significance.

Table 7: Baseline Case: Effects Breakdown

Defence Burden (Logged)		1	2	3	4	5
	Direct	0.0215***	0.0097**	0.0099**	0.0096**	0.0148***
	SE	(0.0037)	(0.0037)	(0.0039)	(0.0038)	(0.0037)
Population (Logged)	Indirect	0.0362***	0.0021**	0.0022**	0.0022**	0.0088***
	SE	(0.0100)	(0.0009)	(0.0009)	(0.0009)	(0.0028)
	Total	0.0577***	0.0118**	0.0121**	0.0118**	0.0236***
	SE	(0.0127)	(0.0046)	(0.0048)	(0.0047)	(0.0062)
	Direct	0.1197***	0.1142***	0.1136***	0.1158***	0.1188***
	SE	(0.0215)	(0.0216)	(0.0223)	(0.0224)	(0.0213)
Lagged War	Indirect	0.2014***	0.0250***	0.0252***	0.0270***	0.0700***
	SE	(0.0563)	(0.0062)	(0.0064)	(0.0067)	(0.0177)
	Total	0.3211***	0.1392***	0.1387***	0.1427***	0.1888***
	SE	(0.0720)	(0.0264)	(0.0275)	(0.0278)	(0.0362)
	Direct	0.0639***	0.0966***	0.0962***	0.0967***	0.0817***
	SE	(0.0100)	(0.0098)	(0.0105)	(0.0101)	(0.0103)
Civil Liberties	Indirect	0.1073***	0.0211***	0.0213***	0.0225***	0.0480***
	SE	(0.0275)	(0.0040)	(0.0040)	(0.0042)	(0.0098)
	Total	0.1711***	0.1178***	0.1175***	0.1192***	0.1297***
	SE	(0.0343)	(0.0122)	(0.0131)	(0.0128)	(0.0176)

Description: Standard Errors in Brackets. 1984 Observations. Country Fixed Effects. * 10% Significance. ** 5% Significance. *** 1% Significance.

Table 8: Internal Factors Included

Defence Burden (Logged)	1	2	3	4	5
Rho	0.6245***	0.2022***	0.2000***	0.2116***	0.3793***
	(0.0486)	(0.0267)	(0.0261)	(0.0272)	(0.0410)
Population (Logged)	0.0812***	0.0917***	0.0937***	0.0932***	0.0926***
	(0.0137)	(0.0139)	(0.0139)	(0.0139)	(0.0138)
Lagged War	0.1141***	0.1079***	0.1080***	0.1071***	0.1118***
	(0.0210)	(0.0214)	(0.0214)	(0.0213)	(0.0212)
Civil Liberties	0.0461***	0.0720***	0.0714***	0.0714***	0.0585***
	(0.0103)	(0.0105)	(0.0105)	(0.0105)	(0.0105)
GDP per Capita (Logged)	-0.0716***	-0.1142***	-0.1186***	-0.1175***	-0.1069***
	(0.0245)	(0.0250)	(0.0249)	(0.0249)	(0.0248)
Upcoming Election	-0.0017	-0.0024	-0.0019	-0.0021	-0.0011
	(0.0125)	(0.0128)	(0.0127)	(0.0127)	(0.0126)
GDP Growth	-0.0012	-0.0019*	-0.0020*	-0.0020*	-0.0016
	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
Government Size (Logged)	-0.1752***	-0.1610***	-0.1590***	-0.1594***	-0.1637***
	(0.0221)	(0.0225)	(0.0225)	(0.0224)	(0.0223)
R-Squared	0.8923	0.8881	0.8886	0.8887	0.8903
Correlation Squared	0.1804	0.1945	0.1947	0.1948	0.2038
Log Likelihood	84.2057	49.3116	52.3019	54.3808	65.0036

Description: Standard Errors in Brackets. 1984 Observations. Country Fixed Effects.
* 10% Significance. ** 5% Significance. *** 1% Significance.

Table 9: Internal Factors Included: Effects Breakdown

Defence Burden (Logged)		1	2	3	4	5
	Direct	0.0823***	0.0921***	0.0940***	0.0941***	0.0931***
	SE	(0.0136)	(0.0134)	(0.0138)	(0.0137)	(0.0146)
Population (Logged)	Indirect	0.1372***	0.0208***	0.0209***	0.0229***	0.0558***
	SE	(0.0366)	(0.0046)	(0.0044)	(0.0049)	(0.0134)
	Total	0.2195***	0.1129***	0.1149***	0.1170***	0.1489***
	SE	(0.0460)	(0.0169)	(0.0171)	(0.0175)	(0.0259)
	Direct	0.1148***	0.1101***	0.1095***	0.1084***	0.1128***
	SE	(0.0210)	(0.0213)	(0.0216)	(0.0208)	(0.0220)
Lagged War	Indirect	0.1916***	0.0248***	0.0244***	0.0264***	0.0675***
	SE	(0.0539)	(0.0062)	(0.0060)	(0.0065)	(0.0176)
	Total	0.3063***	0.1349***	0.1339***	0.1347***	0.1803***
	SE	(0.0694)	(0.0264)	(0.0265)	(0.0262)	(0.0370)
	Direct	0.0468***	0.0729***	0.0727***	0.0722***	0.0597***
	SE	(0.0104)	(0.0104)	(0.0105)	(0.0103)	(0.0113)
Civil Liberties	Indirect	0.0779***	0.0164***	0.0162***	0.0175***	0.0356***
	SE	(0.0235)	(0.0033)	(0.0033)	(0.0035)	(0.0086)
	Total	0.1247***	0.0893***	0.0889***	0.0898***	0.0952***
	SE	(0.0317)	(0.0127)	(0.0129)	(0.0129)	(0.0184)
	Direct	-0.0726***	-0.1146***	-0.1191***	-0.1184***	-0.1071***
	SE	(0.0243)	(0.0244)	(0.0248)	(0.0245)	(0.0257)
GDP per Capita (Logged)	Indirect	-0.1207**	-0.0258***	-0.0265***	-0.0288***	-0.0641***
	SE	(0.0478)	(0.0069)	(0.0068)	(0.0076)	(0.0193)
	Total	-0.1933***	-0.1404***	-0.1456***	-0.1472***	-0.1712***
	SE	(0.0692)	(0.0301)	(0.0304)	(0.0309)	(0.0429)
	Direct	-0.0017	-0.0026	-0.0018	-0.0022	-0.0010
	SE	(0.0129)	(0.0129)	(0.0129)	(0.0125)	(0.0126)
Upcoming Election	Indirect	-0.0025	-0.0006	-0.0004	-0.0005	-0.0006
	SE	(0.0221)	(0.0029)	(0.0030)	(0.0028)	(0.0077)
	Total	-0.0042	-0.0032	-0.0021	-0.0028	-0.0016
	SE	(0.0348)	(0.0158)	(0.0152)	(0.0158)	(0.0203)
	Direct	-0.0012	-0.0019*	-0.0020*	-0.0019*	-0.0017
	SE	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
GDP Growth	Indirect	-0.0019	-0.0004*	-0.0004*	-0.0005*	-0.0010
	SE	(0.0019)	(0.0002)	(0.0002)	(0.0003)	(0.0007)
	Total	-0.0031	-0.0024*	-0.0025*	-0.0024*	-0.0028
	SE	(0.0030)	(0.0014)	(0.0014)	(0.0014)	(0.0018)
	Direct	-0.1770***	-0.1618***	-0.1600***	-0.1615***	-0.1662***
	SE	(0.0228)	(0.0225)	(0.0213)	(0.0224)	(0.0231)
Government Size (Logged)	Indirect	-0.2956***	-0.0365***	-0.0356***	-0.0392***	-0.0997***
	SE	(0.0749)	(0.0080)	(0.0072)	(0.0081)	(0.0229)
	Total	-0.4725***	-0.1983***	-0.1956***	-0.2007***	-0.2659***
	SE	(0.0891)	(0.0286)	(0.0266)	(0.0284)	(0.0422)

Description: Standard Errors in Brackets. 1984 Observations. Country Fixed Effects.
* 10% Significance. ** 5% Significance. *** 1% Significance.

Table 10: Yearly Rhos

Defence Burden (Logged)	1	2	3	4	5
1993	0.8375***	0.3711***	0.4460***	0.4547***	0.6394***
	(0.1048)	(0.0874)	(0.0817)	(0.0853)	(0.1202)
1994	0.8804***	0.4112***	0.4670***	0.4856***	0.6624***
	(0.0794)	(0.0890)	(0.0819)	(0.0850)	(0.1213)
1995	0.8515***	0.3362***	0.4200***	0.4407***	0.6284***
	(0.0975)	(0.0923)	(0.0844)	(0.0876)	(0.1265)
1996	0.8805***	0.4032***	0.4930***	0.5056***	0.6964***
	(0.0792)	(0.0907)	(0.0812)	(0.0844)	(0.1147)
1997	0.8565***	0.4012***	0.4590***	0.4697***	0.5863***
	(0.0945)	(0.0921)	(0.0858)	(0.0894)	(0.1379)
1998	0.8515***	0.3881***	0.4610***	0.4756***	0.5733***
	(0.0972)	(0.0930)	(0.0854)	(0.0888)	(0.1374)
1999	0.8516***	0.4032***	0.4800***	0.4977***	0.5964***
	(0.0972)	(0.0914)	(0.0831)	(0.0860)	(0.1343)
2000	0.8555***	0.3952***	0.4360***	0.4427***	0.5564***
	(0.0947)	(0.0907)	(0.0857)	(0.0894)	(0.1390)
2001	0.8285***	0.4031***	0.4410***	0.4357***	0.5634***
	(0.1111)	(0.0902)	(0.0852)	(0.0898)	(0.1394)
2002	0.8555***	0.4172***	0.4681***	0.4796***	0.5934***
	(0.0949)	(0.0911)	(0.0852)	(0.0887)	(0.1359)
2003	0.8225***	0.4161***	0.4550***	0.4657***	0.5803***
	(0.1146)	(0.0897)	(0.0853)	(0.0888)	(0.1366)
2004	0.8595***	0.3901***	0.4280***	0.4286***	0.5854***
	(0.0923)	(0.0921)	(0.0878)	(0.0922)	(0.1364)
2005	0.8585***	0.3722***	0.4070***	0.4076***	0.5624***
	(0.0930)	(0.0943)	(0.0902)	(0.0950)	(0.1405)
2006	0.8575***	0.3691***	0.4170***	0.4017***	0.5864***
	(0.0937)	(0.0948)	(0.0899)	(0.0958)	(0.1374)
2007	0.8495***	0.3452***	0.3940***	0.3947***	0.5464***
	(0.0988)	(0.0965)	(0.0918)	(0.0963)	(0.1447)
2008	0.7845***	0.2402**	0.3410***	0.3357***	0.4814***
	(0.1375)	(0.1033)	(0.0956)	(0.1005)	(0.1549)

Description: Standard Errors in Brackets. 124 observations per regression.
* 10% Significance. ** 5% Significance. *** 1% Significance.

Table 11: Regional Analysis

	Defence Burden (Logged)	1	2	3	4	5
	Rho	0.4572***	0.2120***	0.2196***	0.2203***	0.3075***
		(0.0790)	(0.0740)	(0.0699)	(0.0737)	(0.0752)
	Population (Logged)	0.0379***	0.0209*	0.0198*	0.0200*	0.0238**
		(0.0106)	(0.0110)	(0.0110)	(0.0110)	(0.0108)
Middle East	Lagged War	0.0622	0.0543	0.0533	0.0540	0.0574
		(0.0450)	(0.0469)	(0.0467)	(0.0468)	(0.0460)
	Civil Liberties	0.1189***	0.1619***	0.1603***	0.1598***	0.1487***
		(0.0282)	(0.0295)	(0.0293)	(0.0294)	(0.0290)
	Log Likelihood	41.1330	34.6120	35.1800	35.0600	37.4320
	R-Squared	0.8776	0.8677	0.8686	0.8682	0.8722
	Correlation Squared	0.3528	0.3849	0.3879	0.3847	0.3999
	Rho	0.5221	0.3916	0.3958	0.4379	0.4537
		(0.0717)***	(0.0569)***	(0.0536)***	(0.0543)***	(0.0575)***
	Population (Logged)	-0.0054	-0.0057	-0.0042	-0.0039	-0.0029
		(0.0110)	(0.0112)	(0.0108)	(0.0106)	(0.0108)
Latin America	Lagged War	0.0767	0.0789	0.0793	0.0784	0.0774
		(0.0579)	(0.0584)	(0.0568)	(0.0558)	(0.0564)
	Civil Liberties	0.0724***	0.0920***	0.0791***	0.0824***	0.0734***
		(0.0214)	(0.0216)	(0.0209)	(0.0206)	(0.0208)
	Log Likelihood	86.5260	83.0360	89.4890	93.7400	90.7560
	R-Squared	0.9103	0.9086	0.9137	0.9167	0.9149
	Correlation Squared	0.1751	0.1767	0.1619	0.1701	0.1646
	Rho	0.3745	0.1234	0.0680	0.1301	0.0566
		(0.0821)***	(0.0581)**	(0.0549)	(0.0603)**	(0.0591)
	Population (Logged)	0.0058	0.0003	-0.0002	0.0000	-0.0003
		(0.0063)	(0.0064)	(0.0065)	(0.0064)	(0.0065)
Europe	Lagged War	0.1523***	0.1525***	0.1528***	0.1529***	0.1532***
		(0.0421)	(0.0427)	(0.0429)	(0.0427)	(0.0429)
	Civil Liberties	0.0688***	0.0843***	0.0896***	0.0852***	0.0913***
		(0.0193)	(0.0195)	(0.0196)	(0.0195)	(0.0196)
	Log Likelihood	46.3100	39.5280	38.4160	39.9580	38.1240
	R-Squared	0.8154	0.8096	0.8084	0.8099	0.8081
	Correlation Squared	0.0852	0.0962	0.0925	0.0965	0.0891
	Rho	0.4970***	0.2210***	0.3320***	0.3480***	0.4975***
		(0.0802)	(0.0532)	(0.0522)	(0.0570)	(0.0632)
	Population (Logged)	-0.0095	-0.0213**	-0.0176*	-0.0148	-0.0116
		(0.0103)	(0.0107)	(0.0104)	(0.0104)	(0.0104)
Asia	Lagged War	0.1705***	0.1363**	0.1288**	0.1245**	0.1569***
		(0.0556)	(0.0574)	(0.0559)	(0.0560)	(0.0554)
	Civil Liberties	0.0903***	0.1254***	0.1189***	0.1109***	0.1034***
		(0.0280)	(0.0289)	(0.0282)	(0.0282)	(0.0280)
	Log Likelihood	-32.4740	-43.1100	-36.0470	-36.0590	-32.6180
	R-Squared	0.8097	0.7974	0.8079	0.8068	0.8113
	Correlation Squared	0.1116	0.1025	0.1057	0.1012	0.1371

Description: Standard Errors in Brackets.
* 10% Significance. ** 5% Significance. *** 1% Significance.

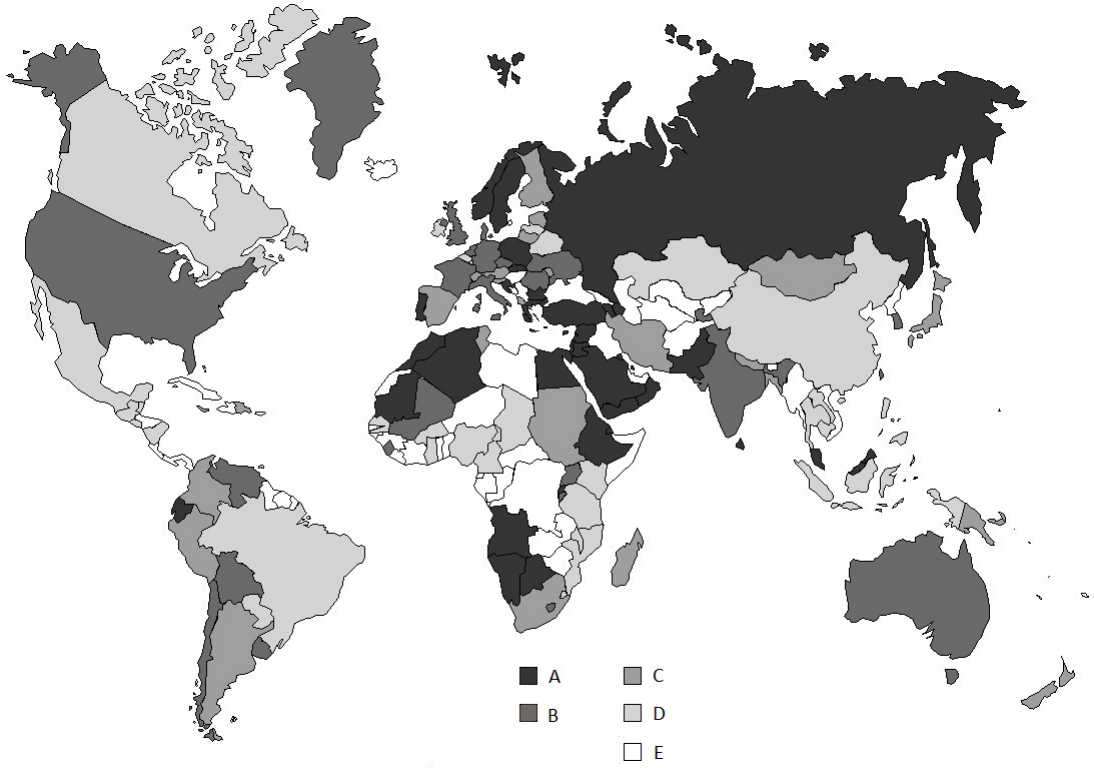
Table 12: Defence Spending per Capita

Defence Spending per Capita (Logged)	1	2	3	4	5
Rho	0.2685***	0.2122***	0.2200***	0.2247***	0.3294***
	(0.0407)	(0.0211)	(0.0211)	(0.0216)	(0.0322)
Population (Logged)	0.2102***	0.2114***	0.2104***	0.2095***	0.2083***
	(0.0053)	(0.0050)	(0.0050)	(0.0050)	(0.0051)
Lagged War	0.0923***	0.0847***	0.0845***	0.0852***	0.0885***
	(0.0289)	(0.0284)	(0.0282)	(0.0283)	(0.0283)
Civil Liberties	-0.0695***	-0.0812***	-0.0800***	-0.0770***	-0.0708***
	(0.0139)	(0.0132)	(0.0131)	(0.0131)	(0.0133)
Log Likelihood	-540.4000	-518.4100	-507.5800	-508.1900	-508.8100
R-Squared	0.9699	0.9708	0.9712	0.9711	0.9711
Correlation Squared	0.6244	0.6251	0.6278	0.6272	0.6305

Description: Standard Errors in Brackets. 1984 Observations. Country Fixed Effects.
* 10% Significance. ** 5% Significance. *** 1% Significance.

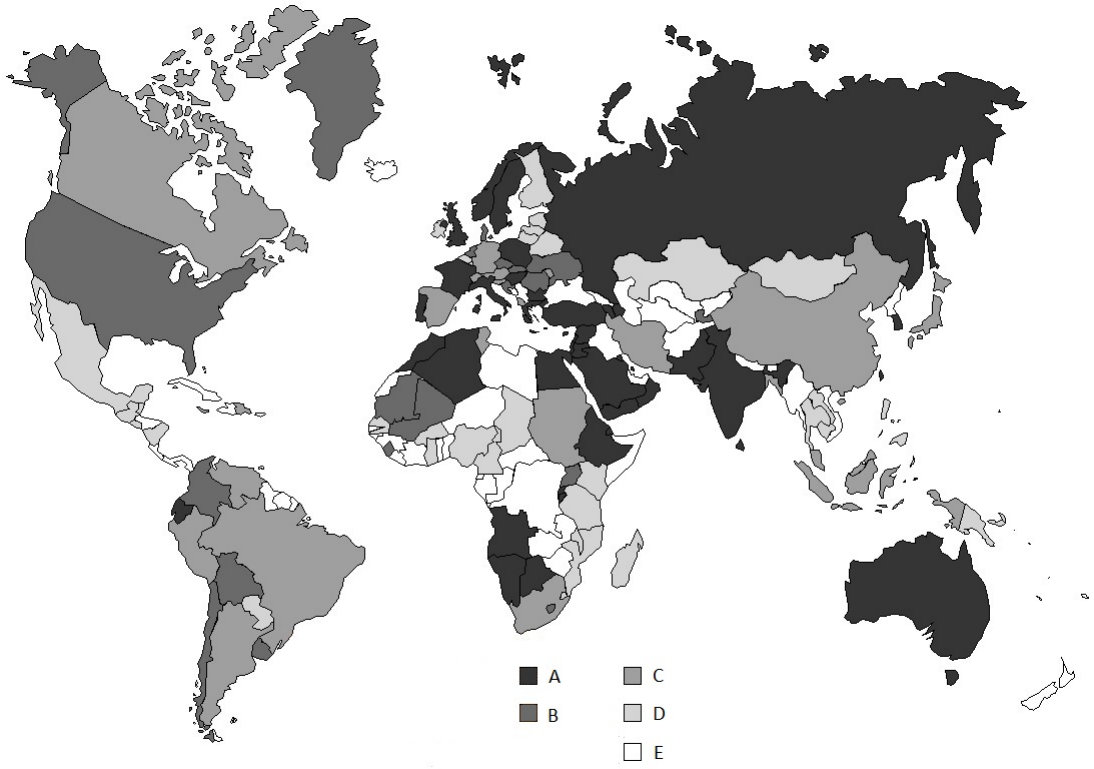
9 Figures

Figure 1: Residuals and Weighted Residuals (Contiguous)



Description: A map of the 124 countries in the sample, where the colour indicates the defence spending behaviour relative to that of its neighbours, as defined by the weight matrix. Colour A: High spending country with high spending neighbours. Colour B: High spending country with low spending neighbours. Colour C: Low spending country with high spending neighbours. Colour D: Low spending country with low spending neighbours. Colour E: No data. Note the grouping of Colour A countries in the Middle East and parts of Africa and the grouping of Colour D countries in Central America, parts of Africa, and parts of Asia.

Figure 2: Residuals and Weighted Residuals (Two Groups)



Description: A map of the 124 countries in the sample, where the colour indicates the defence spending behaviour relative to that of its neighbours, as defined by the weight matrix. Colour A: High spending country with high spending neighbours. Colour B: High spending country with low spending neighbours. Colour C: Low spending country with high spending neighbours. Colour D: Low spending country with low spending neighbours. Colour E: No data. Note the grouping of Colour A countries in the Middle East, and parts of Africa, Europe, and Asia. Also, note the grouping of Colour D countries in Central America, and parts of Africa and Asia.