2006

Three essays on political regimes, military spending, and economic *growth

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Dissertation submitted to the
College of Business and Economics
at West Virginia University
in partial fulfillment of the requirements
for the degree of

Doctor of Philosophy
in
Economics

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Morgantown, West Virginia
2006

Keywords: Arms Trade, Conflict, Military Spending, Political Regimes, Economic Growth

Abstract

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This dissertation is a collection of essays on the issues in political and defense economics. Chapter 1 gives a brief introduction to the role that political and institutional arrangements play in affecting government policy and economic well-being. The second chapter examines how different political regimes and military manpower systems affect the value of life in military conflicts. The results in Chapter 2 show that democracies suffer lower battlefield casualties than dictatorships. Also noteworthy is that more volunteer based armies, per capita income, and economic freedom lead to lower battlefield deaths. Thus, political and economic liberties are found to increase the value of life in military conflicts. Chapter 3 investigates how arms trade and military spending affect economic growth. The results indicate that higher military spending and net arms exports lead, separately, to lower economic growth, but higher military spending appears to be less detrimental to growth when a country is a large net arms exporter. The fourth chapter examines the relationship between incumbency advantage and legislative shirking or ideology. The results indicate that the incumbency advantage leads to more legislative shirking as evidenced by the departure of politicians from the median voter's ideological preferences. Chapter 5 summarizes the findings of the dissertation, provides concluding remarks, and discusses opportunities for future research in the political economy of warfare.

Acknowledgements

My strongest appreciation is reserved for Russell Sobel, my dissertation advisor, and Mehmet Tosun, my colleague and mentor at the Bureau of Business and Economic Research (BBER). Throughout the last four years, Russ Sobel inspired many of my research ideas some of which made it into my dissertation. Russ also provided me with exceptional research and career guidance, while Mehmet was instrumental in nurturing in me a virtuous economist and experienced professional by fully involving me in many research projects. I really appreciate all of their help.

I am also deeply grateful to the remaining members of my dissertation committee, Alexei Egorov, Santiago Pinto, and Pete Leeson, for their constructive comments and advice. They were always supportive of my research ideas and greatly helped me to sharpen the quality of this dissertation. I would like to thank all other economics professors in our department who were always friendly and eager to help.

Many thanks go to all of my colleagues at the BBER for being a pleasure to work with during the last three years. I would especially like to thank Justin Ross and Claudia Williamson, who despite being the younger students in our graduate program, provided me with a great deal of research advice, moral support, and friendship.

And last but not least, I would like to extend a final note of thanks to my parents, Tatiana and Alexander Yakovlev, who tried their best to see that I become a compassionate, honest, and just individual despite all of my attempts to the contrary. My parents provided me with all the necessary resources and encouragement to pursue my quest for higher knowledge in the United States of America and deserve all the benefits of my achievements.

Any errors are the sole responsibility of the author.

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Chapter 1

An Introduction to the Political Economy of Conflict, Military Spending, and Legislative Shirking

1.1 Introduction

Political economy is a subfield of economics that analyzes the interactions between political institutions and economic policies. Political and economic processes have long been considered intertwined. Scholarly research shows that political and legal institutions are significantly correlated with economic development and well-being. For instance, Persson (2002) finds empirical evidence consistent with the theory that different political regimes have a significant influence on fiscal policy, welfare, and corruption. Mulligan, Gil, and Sala-i-Martin (2004) find that when economic and demographic variables are taken into account, democracies and non-democracies differ significantly in military spending, torture, execution, censorship, and religious regulation. Thus, the importance and relevance of academic research in the field of political economy is clear.

It is crucial to understand how economic and political forces interact together in order to make the world a better place via wise governance. In the following chapter, I extend the frontier of knowledge in the field of political economy by analyzing: (1) how different political regimes affect the value of life in military conflicts, (2) how military spending and arms trade affect economic growth, and (3) how elected officials deal with the tradeoff between their self-interest and reelection incentives when legislating constituents' preferences. In other words, my research examines how different political regimes and politicians' incentives affect government policy and, in turn, public well-being. The latter can be manifested in a variety of ways, ranging from higher standards of living to lower battlefield casualties.

1.2 Political Regimes and Military Conflicts

The humanitarian and economic costs of conflicts can be astronomical. For this reason, humanity remains engaged in a struggle to prevent conflicts from occurring. This undertaking warrants a better understanding of what causes conflicts and how to prevent them or to lessen their burdens. A few researchers have discovered that geopolitical and economic factors may affect conflict initiations, payoffs, and outcomes. Filson and Werner (2004), for instance, develop a formal model of conflict showing that democratic regimes are sensitive to the institutional constraints and costs of war. They argue that this sensitivity affects the propensity of democratic regimes to accept negotiated settlements over wars and leads to the often noted tendency for democracies to select to fight low-cost, short wars that they can win. Garfinkel (1994) arrives at a similar conclusion for democracies by showing that political party competition, in association with electoral uncertainty, can reduce military spending and the severity of conflict between nations. Gartzke (2005), on the other hand, finds that economic freedom is fifty times more potent than political freedom in promoting peace.

The works of the above scholars in political economy inspired me to study how political and economic factors may affect the level of casualties in a given conflict. Taking my own approach, I develop a theoretical model to analyze whether democracies and dictatorships, with volunteer or conscription armies, value life differently from one another when they are involved in military conflicts. My model yields formal theoretical insights into how economic and institutional factors may affect military capital intensity and subsequent combat casualties. The empirical evidence presented in this dissertation supports the model's prediction that more democratic nations with volunteer armies experience lower conflict casualties owing to their higher military capital intensity. I also find that higher reliance on conscription leads to lower military capital intensity, whereas higher real GDP per capita leads to higher military capital intensity. Moreover, I find that economic freedom is thirteen times more potent than political freedom in increasing military capital intensity and saving more lives. One of my intriguing findings suggests that political and economic freedoms converge in the strength of their respective impacts on military capital intensity.

1.3 "Guns vs. Butter" Debate Revisited

Given the findings cited above that democracies tend to have higher defense expenditure per soldier than non-democracies, it would be worthwhile to examine how political regimes influence military spending and arms trade, which could have significant implications for economic growth. There is a large literature on the relationship between economic growth and military spending, but its findings are mixed and largely inconclusive. Some researchers find that military spending is positively related to growth, while others find the opposite result. This disagreement on the effect of military spending could stem partly from the non-linear growth effects of military expenditure and incorrect model specifications. Addressing these problems and controlling for country differences in political regimes and arms trade could improve our understanding of the complex issues involved in this debate. The interplay of military spending and arms trade, for instance, could have a priori unpredictable effect on growth.

My research could bring new evidence to the debate on the growth effects of military spending, or the "butter vs. guns" tradeoff. In Chapter 3, I investigate the non-linear effects of military spending and arms trade on economic growth using the Solow and Barro growth models as recommended by Dunne et al. (2005). The empirical evidence indicates that military spending and arms exports have a significant negative effect on economic growth, but higher military spending is less detrimental to growth when a country is a large net arms exporter. I also find that democracy is inversely related to the size of military expenditure as a share of GDP, providing at least some explanation for why democratic regimes and per capita incomes appear to be correlated.

1.4 The Incumbency Advantage and Legislative Shirking

Economists identify two legitimate reasons to justify government intervention: (1) the enforcement of law and property rights and (2) the provision of public goods that a free market may fail to provide. Many governments around the world, however, take on more responsibilities than are considered legitimate by economists. In a representative democracy, elected officials are expected to act responsibly in enacting the preferences of their citizens. However, as is the case with the inefficient provision of public goods in a free market, the government itself may also be inefficient at providing these goods and services to its citizens. Think of voters as customers, and their elected officials as firms. This way, all of us can be thought of as operating in a market of some sort, the electoral market, in which our decisions are guided by self interest and some constraints. Voters, acting as customers, shop around for the best offers made by politicians, who are acting as competitive firms in this electoral market. Under the ideal conditions, this market would function efficiently; voters would elect the best politicians to enact the most preferred policies. If some of these ideal conditions are violated, then the efficient outcomes in the electoral markets may not be achieved. In a world of less than perfect competition, politicians may find it optimal to enact their own ideological preferences or to sell their votes to interest groups rather than to represent the interests of their constituents. Since information is costly, voters choose to be rationally ignorant, which makes it difficult for them to monitor and asses the performance of their elected representatives. This means that politicians do not have as much pressure to do their best, and they might find it possible to shirk on the job and still get reelected. Moreover, if incumbent politicians enjoy some kind of advantage over their challengers, then they are more likely to remain in office and to continue to shirk.

Does this kind of shirking really happen? Does the incumbency advantage really increase legislative shirking? These are the kind of questions I ask and try to answer in Chapter 4 of my dissertation. In this chapter, I develop and test the principal-agent model, in which political agents seeking reelection face a tradeoff between pursuing their own ideological preferences (i.e. shirking) and adhering to the preferences of their constituents. Using the aggregate elections data for the U.S. House of Representatives, I find evidence supporting the claim that the incumbency advantage reduces the tradeoff between shirking and reelection prospects for incumbents. My findings suggest that if voters expect their elected officials to enact the optimal policy, whether it is the size of military spending or something else, politicians may find it optimal to enact a policy that is closer to their own preferences instead of those of their voters.

Chapter 2

Do Democracies and Dictatorships Value Life Differently in Military Conflicts?

2.1 Introduction

There exists a rich literature devoted to studying conflict and related issues of imperative economic and humanitarian importance. In a survey of selected contributions to the economic analysis of conflict, Sandler (2000) points out the diversity and depth of issues that have been addressed by scholars. Yet, the contemporary economic literature seems to lack a rigorous theoretical and empirical analysis of how different political, institutional, and economic factors may affect the value of life and the size of combat casualties in military conflicts.

This paper develops a theoretical model of warfare that provides insights into how different political regimes and military manpower systems may affect the relative value (price) of military personnel, capital intensity of military forces, and total combat casualties. I argue that democracies should have more capital intensive militaries than dictatorships because of the re-election incentives to incur less combat casualties. As a result, more democratic nations suffer fewer battlefield deaths compared to less democratic nations. In light of the recent work by Gartzke (2005), who finds that economic freedom is fifty times more potent than democracy in promoting peace, I also analyze the effect of economic freedom (index developed by Gwartney and Lawson 2004) on battlefield deaths.

The empirical evidence presented in this paper supports the model's predictions that democracies value life more in military conflicts than dictatorships. A heavier reliance on conscription in acquiring military manpower leads to lower capital intensity, while higher real GDP per capita leads to higher capital intensity of military forces. I find that economic freedom is as much as thirteen times more potent than democracy in generating more capital intensive military forces, leading to lower total battlefield deaths. Thus, the empirical evidence shows that political regimes and military manpower systems are still the significant determinants of value of life even after controlling for economic factors.

2.2 Literature Review

Most of the contemporary research on conflict and peace has been focused on the rational approach to studying conflict. Rational conflict theory postulates that warfare becomes an attractive dispute instrument when property rights are poorly defined and poorly enforced. In his book, *Arms and Influence*, Schelling (1966) argues that nations with complete information should never go to war because a peaceful settlement is less costly than a conflict. What is puzzling about conflicts, however, is that they may occur despite the possibility of having complete information and mutually superior peaceful bargains. Hirschleifer (1995) contends that anarchy is especially susceptible to conflict unless there are strongly diminishing returns to fighting and incomes exceed the viability minimum. Fearon (1995) suggests that bargains may not occur because of commitment problems due to incentives to renege on the bargain terms, issue indivisibilities (such as to legalize or not to legalize abortion), private information about relative military capabilities or resolve, and incentives to misrepresent such information. Moreover, Garfinkel and Skaperdas (2000) demonstrate that conflict could be the rational equilibrium outcome if the long-run gains from defeating an opponent outweigh the short-run losses.

A number of researchers have also discovered that geographical, institutional, and economic factors may affect conflict initiations, payoffs, and outcomes. For instance, Filson and Werner (2004) develop a formal model of conflict showing that democratic regimes are sensitive to the institutional constraints and war costs. They argue that this sensitivity entices democratic regimes to accept negotiated settlements over wars and choose to fight only low cost and short wars that they can win. Garfinkel (1994) arrives at a similar conclusion for democracies by showing that political party competition associated with electoral uncertainty can reduce military spending and the severity of conflict between nations. Similarly, Mitchell et. al. (1999) find support for the propositions that democratization decreases the systemic amount of war in addition to having a pacifying effect on war that increases over time. Biddle and Long (2004) find that factors like superior human capital, harmonious civil-military relations, and Western cultural background are highly correlated with democracies and are largely responsible for democracy's apparent military effectiveness.

On the other hand, Hess and Orphanides (2001) show how economic recessions and president's desire for re-election can instigate an otherwise avoidable war in order to show off president's military prowess. Nafziger and Auvinen (2002), on the other hand, find that income inequality and pervasive rent-seeking by the ruling elites may lead to war and state violence. In his recent work, Gartzke (2005) shows that economic freedom is a much more potent determinant of peace than democracy. Gartzke (2005) finds that economic freedom is fifty times more potent in encouraging peace than democracy, which is a strong evidence for capitalism driven peace.

From a more general political economy perspective, there is still much to learn about how political regimes and institutions relate to economic development and well-being. For instance, Persson (2002) finds empirical evidence consistent with the theory that different political regimes have a significant influence on government size, welfare-state programs, and corruption. Mulligan, Gil, and Sala-i-Martin (2004) find that when economic and demographic variables are taken into account, democracies do not differ significantly from non-democracies in affecting economic or social policies, but they do differ significantly in military spending, torture, execution, censorship, and religious regulation.

Considering the above findings, one might expect political regimes and military manpower systems (volunteer vs. conscription) to be among the significant determinants of military capital intensity and corresponding conflict casualties. The theoretical and empirical search for determinants of conflict casualties is well warranted, which sets the stage for the construction of this paper.

2.3 Theoretical Model

Intuitively, an ill-equipped (labor intensive) army should have higher combat casualties when fighting against a well-equipped (capital intensive) army, everything else being equal. Warfare entails a production of some kind of fighting or military output that requires a constrained choice of labor, capital, and technology. This choice is tempted by conflict payoffs and constrained by conflict costs. Thus, a warfare profit function seems like a well suited theoretical foundation for analyzing the optimal choice of capital and labor needed for warfare. The tricky part is how to incorporate the possible influence of political regimes and military manpower systems on the optimal choice of military capital and labor. Incorporating this influence would allow us to examine the relative value of life and the size of combat casualties being driven by differences in military capital intensity (i.e. capital-labor ratio) under democracy and dictatorship.

Looking for theoretical elegance and simplicity, I try to model only how the essential differences between democracy and dictatorship, as well as conscription and volunteer armies, may affect military capital intensity and consequent combat casualties. I investigate how the relative value of labor (military personnel) varies between these four scenarios: (1) dictatorship with volunteer army, (2) dictatorship with conscription army, (3) democracy with volunteer army, and (4) democracy with conscription army. Each scenario works as if one would insert a given political regime and military manpower institution into the same hypothetical country to compare and contrast the resulting changes in the relative value of military personnel and military's capital to labor ratio.

I assume that dictators in this model are able to capture at least some rewards from a successful war so that their incentives are aligned with maximizing warfare profits for given labor and capital costs. Arguably, dictators or autocratic governments in general, may perceive warfare or military build up in itself as a means of self-enrichment or rent seeking (Sandler, 2000). Conversely, I assume that democratically elected leaders represent the preferences of the median voter and that the threat of being voted out of office keeps the elected officials in alignment with the vote maximizing political platform. In other words, democratically elected leaders maximize warfare profits on behalf of their constituents, who care about conflict benefits and costs.[1] Overall, the only differences that might exist in all four scenarios must come from political or military manpower systems.

Each decision maker in any of the four scenarios is assumed to be fighting separately some hypothetical enemy nation, rebel force, terrorist group, or a coalition of these. How successful the four decision makers are in capturing the disputed asset or conflict objective depends on their respective fighting effort Y compared to their enemy's fighting effort Y^E. The respective fighting efforts of both warring sides can be combined together into some general functional form $Q(Y, Y^E)$. This function could be thought of as the general functional form of the Contest Success Function (CSF) that is used extensively in the literature to specify how appropriative contest efforts lead to an appropriative contest outcome (Hirshleifer, 1995). If fighting an enemy coalition, the assumed general form CSF can be expressed as $Q(Y, Y_1^E, Y_2^E, \ldots, Y_n^E)$.

[1] Perhaps this dichotomous modeling of the differences between democracy and dictatorship is unrealistic since even dictatorships must have some public support (arguably much lower than in democracy) to avoid an uprising. However, this dichotomy allows for elegant theoretical conclusions without missing the main point that the two regimes differ in the extent to which they follow the preferences of their constituents.

Fighting effort Y is some production function with assumed constant returns to scale (CRS) in capital and labor. It can be written as $Y=F(A, K, L)$, where A is the exogenous productivity parameter or technological constant, K is capital, and L is labor or military personnel. To simplify the analysis, capital and labor are assumed to be homogenous in ability, effort, and preferences and can be substituted for each other continuously. The hypothetical enemy nation, rebel, or terrorist group has its own fighting effort function labeled as $Y^E=F^E(A^E, K^E, L^E)$ that is subject to the same properties. I assume that there is no uncertainty and that all decision makers have perfect information about each other's military capabilities or fighting efforts. That is, the enemy's combat output is known to the decision maker and is held constant when maximizing warfare profit.

The supply of labor (soldiers) and capital (weapons) is assumed to be perfectly elastic so that any amount of labor and capital can be hired at the given prices determined in perfectly competitive factor markets.[2] I assume that military volunteers can only be recruited by paying them the competitive market wage that fully reflects the risk and opportunity cost of this choice. Conscription is assumed to work as a random military draft that selects the necessary amount of conscripts. A conscription based army, by its principle, should pay its soldiers a conscription wage that is lower than the wage paid in a volunteer army. I assume that factor markets priced in all the risk preferences and private costs (except for externalities) for a given military conflict.

The value or size of the contested asset or conflict objective is assumed to be fixed throughout the war. Fighting or warfare in this model serves merely as a means of achieving or capturing some objective (asset) with a known and certain payoff for a given level of enemy resistance. The conflict objective can be virtually anything: from capturing natural resources and land to "establishing democracy" in the opponents' country. However, the necessary provision

[2] Wages could be made endogenous in military output, which would reinforce the exogenous-wage model's predictions, but make them unnecessarily complex as well.

for reaching the conflict objective might require the elimination of enemy resistance, say, measured in enemy combatants killed. Thus, if both parties' fighting efforts Y and Y^E are measured in the same units (say combat losses), then a more specific functional form, like the ratio-based Contest Success Function (CSF), could be used instead of the general $Q(Y, Y^E)$ warfare functional form. For example, in a two-party contest, fighting efforts by each side (F_1 and F_2) can be combined together in the following ratio form.

$$p_1 = \frac{F_1^m}{F_1^m + F_2^m} \qquad \text{and} \qquad p_2 = 1 - p_1 = \frac{F_2^m}{F_1^m + F_2^m}$$

Where p_1 and p_2 can be interpreted as the respective proportions of the prize won in a continuum, two-party conflict model. In this representation, military conflict is a continuous zero-sum game. In a two-party model of conflict, p_1 and p_2 can be interpreted as the respective probabilities of victory. According to Hirshleifer (1995), the parameter m in the CSF can be thought of as a decisiveness coefficient, which represents the degree to which greater fighting efforts translate into battlefield success. Setting $m=1$ makes this ratio based CSF concave with monotonically diminishing marginal returns throughout the entire [0, 1] continuum.

However, I shall use some general form contest function as to make the model flexible enough to address a variety of conflicts: from conventional interstate warfare to fighting asymmetric wars against terrorists who try to achieve some political or resource transfer objectives (Enders and Sandler 1995). This general contest function can always assume some specific functional form that is better suited for a given conflict. Hirshleifer (2000) provides a good description of various contest success functions. The advantage of using the profit function as a theoretical framework in this paper is that it allows us to derive the familiar first order conditions of profit maximization that can be used to infer how political and military manpower institutions can affect military capital intensity, which in turn can affect the total number of casualties in military conflicts.

2.4 Four Theoretical Scenarios

SCENARIO 1: DICTATORSHIP WITH VOLUNTEER ARMY

Consider the first scenario where the assumed hypothetical country is a dictatorship with a volunteer army. There are still countries like Cameroon, Rwanda, and Uganda, for example, with very low democracy scores and heavy reliance on volunteer armed forces. While this scenario is not the most common around the world, theoretically it is the simplest case to begin with. A dictator chooses the profit maximizing level of fighting effort or output in a given conflict with a given payoff p^{Dic}, enemy resistance effort Y^E, volunteer wage w^V, and capital rent r.

$$\underset{K,L}{Max}\ \pi_V^{Dic} = p^{Dic}Q(Y,Y^E) - rK - w^V L \tag{1.1}$$

Where $Q(Y,Y^E)$ is the general form CSF, $Y=F(A, K, L)$ and $Y^E=F^E(A^E, K^E, L^E)$ are the respective fighting effort or production functions of the two contesting parties, L and K are labor and capital. From now on forward assume that $F_L > 0, F_{LL} \leq 0, F_K > 0, F_{KK} \leq 0$.

It can be shown that taking the first order conditions for equation (1.1) yields the conventional microeconomic result where the ratio of the marginal product of labor and capital equals to the wage to rent ratio as shown in equation (1.2).

$$\frac{\mathrm{F_L}}{\mathrm{F_K}} = \frac{w^V}{r} \tag{1.2}$$

The wage to rent ratio shows how valuable is one input relative to another. If military volunteers are relatively more expensive compared to military capital (weapons), then this army would have fewer soldiers and more military capital than the army with less expensive volunteers, ceteris paribus. A country with relatively more abundant capital and relatively scarce labor force would value labor more and capital less, resulting in a more capital intensive military. Total combat casualties would then depend on the amount of labor input used in a given combat for a given level of capital, technology, and some constant exogenous casualty (depreciation) rate. Thus, a more labor intensive military would be expected to suffer more total combat casualties compared to a less labor intensive military, holding everything else equal. This is how the relative value of life in military conflicts is determined by military capital intensity, which is determined by the relative price of labor.

SCENARIO 2: DICTATORSHIP WITH CONSCRIPTION ARMY

Consider the second scenario where the same hypothetical country is still a dictatorship, but with a conscription army. This dictator chooses the profit maximizing level of fighting effort or output in a given conflict for a given payoff p^{Dic}, enemy resistance effort Y^E, conscription wage w^C, and capital rent r. All other variables defined as previously.

$$\underset{K,L}{Max}\ \pi_C^{Dic} = p^{Dic} Q(Y, Y^E) - rK - w^C L \tag{2.1}$$

Conscription places an indirect tax on draftees by forcing them to work for a lower wage than they would have chosen voluntarily. Hence, conscripts will be paid some wage that is less then the wage paid in a volunteer army in the first scenario by some constant $\varepsilon > 0$, such that $w^C = w^V - \varepsilon$. The dictator's objective, then, is to draft the warfare profit maximizing level of labor at the conscription wage w^C and to buy the optimal level of capital at the competitive market price r. The first order conditions for this scenario yield the marginal products ratio that equals to the ratio of factor prices as shown in equation (2.2).

$$\frac{\mathrm{F_L}}{\mathrm{F_K}} = \frac{w^C}{r} = \frac{w^V - \varepsilon}{r} \tag{2.2}$$

With the conscription wage being lower the volunteer wage, the dictator in this scenario finds it optimal to hire more military personnel or soldiers than he would in the first scenario with volunteer based army. The total level of combat casualties would then be higher in the second scenario than in the first. Therefore, the total level of casualties under a conscription army is expected to be higher than under a volunteer army, ceteris paribus. Thus, the wage to rental ratio in equation (2.2) tells us that dictatorship with volunteer army would value life more and suffer fewer casualties in a given conflict than its "twin" regime with conscription army.

SCENARIO 3: DEMOCRACY WITH VOLUNTEER ARMY

Consider the third case scenario where the same hypothetical country has a democracy with a volunteer army. The democratically elected leader chooses the profit maximizing level of warfare output in a given conflict for a given payoff p^{Dem}, enemy resistance Y^E, volunteer wage w^V, and capital rent r. The profit function in this representative democracy, however, is a little different from the two dictatorship scenarios analyzed earlier. Unlike dictatorship, democracy is governed by the agent that is elected to represent the preferences of his or her constituents. Therefore, this agent has to maximize warfare profit on the behalf of the median voter and his/her perceived share of conflict payoff p^{Dem} and external conflict cost C.

The interesting thing about conflict payoff p^{Dem} under democracy is that the larger the country the smaller is the share of payoff p^{Dem} that the median voter gets from a conflict. Arguably, the same concept could also apply to the external conflict cost C perceived by the median voter. If conflict payoff p^{Dem} is really small under democracies, then democracies would find it profitable to fight only the wars with much higher total payoffs compared to dictatorships. In other words, democracies should be more picky about who they fight, which agrees with Filson and Werner (2004). However, if C is also very small, then warfare incentives for a democracy could be similar to those for a dictatorship.

Another interesting point can be made by assuming that the payoff from a given conflict is like a public good, meaning that the share of payoff p^{Dem} that the median voter gets from a conflict is one and the same as the total conflict payoff. This could explain why democracies are more likely to go to war with non-democracies if fighting non-democracies results in the payoff with public good characteristics like giving freedom to the oppressed people, for example.

It is also reasonable to assume that civilian citizens care about how many of their countrymen fight and get killed or wounded in a given conflict. They might also care about their country's image, which could depend on how successfully the warfare is being conducted or what combat strategies are being used (Consider civilian or carpet bombing used in Vietnam, for example). Thus, in general, external conflict cost *C* could take the form of financial as well as emotional costs associated with losing one's family or friends, tarnished national image, etc. The external conflict cost *C* is modeled as a linear function of combat casualties, which depend on the amount of military personnel used in warfare and the degree of battlefield success reflected in the CSF. In other words, the external cost function is linked to casualties that are, in turn, linked to the relative war success and size of combat troops. Higher casualties mean higher external cost of conflict.

The objective function for this democracy with volunteer army is to maximize warfare profit with respect to labor and capital as shown in equation (3.1).

$$\underset{K,L}{Max}\ \pi_V^{Dem} = p^{Dem}Q(Y,Y^E) - rK - w^V L - C(L,Q(Y,Y^E)) \tag{3.1}$$

All variables are defined as previously. The first order conditions for this democracy with a volunteer army yield the marginal products ratio in equation (3.2) that shows what costs are considered in choosing the profit maximizing combinations of labor and capital.

$$\frac{\mathrm{F_L}}{\mathrm{F_K}} = \frac{w^V + C_L}{r} \tag{3.2}$$

In this scenario, the marginal products ratio in equation (3.2) equals the volunteer wage rate w^V plus the marginal external conflict cost C_L divided by the rental rate *r*.[3] Comparing this scenario to the previous two scenarios with dictatorship reveals that democracy with a volunteer army places the highest relative value on labor because it internalizes the marginal external conflict cost C_L perceived by the median voter. By internalizing both private and external costs of

[3] Assume that *C* is well behaved and $C_L > 0$, $C_{LL} \leq 0$.

warfare, democracy with volunteer army faces a higher cost of military personnel relative to military capital. Thus, it is economically optimal for democracies to go to wars with more capital intensive forces compared to dictatorships, ceteris paribus. This implies that democracy is expected to value life more and suffer fewer combat casualties as a result.

SCENARIO 4: DEMOCRACY WITH CONSCRIPTION ARMY

Now, consider the last scenario where the same hypothetical country is still a democracy, but with a conscription army. A democratically elected leader in representative democracy has to abide by the payoff p^{Dem} and the external conflict cost C as perceived by the median voter. Having a conscription army, on the other hand, places an indirect tax burden on the draftees in terms of below the market (if any) wages. Israel is a good example of this case. Israel, while a democracy, relies heavily on conscription.

The democracy with a conscription army chooses war profit maximizing levels of labor and capital. All variables are defined as previously.

$$\underset{K,L}{Max}\ \pi_V^{Dem} = p^{Dem} Q(Y, Y^E) - rK - w^C L - C(L, Q(Y, Y^E)) \tag{4.1}$$

The first order conditions yield the following marginal products ratio.

$$\frac{F_L}{F_K} = \frac{w^C + C_L}{r} = \frac{w^V - \varepsilon + C_L}{r} \tag{4.2}$$

Equation (4.2) shows that democracy with a conscription army faces a lower military personnel cost resulting in less capital intensive military compared to its democratic counterpart with volunteer army. Hence, as has been shown previously, conscription would reduce the value of life in military conflicts and increase total combat casualties.

Table 2.1 summarizes the results from the four scenarios by comparing the factor payments ratios from the first order conditions of profit maximization. The factor payments ratios listed in Table 2.1 show elegantly how different political regimes and military recruitment institutions considered in this paper affect the relative value of life in military conflicts.

Table 2.1
Marginal Products Ratios from Four Scenarios

	Volunteer Army	Conscription Army
Democracy	$\frac{w^V + C_L}{r}$	$\frac{w^V - \varepsilon + C_L}{r}$
Dictatorship	$\frac{w^V}{r}$	$\frac{w^V - \varepsilon}{r}$

It is clear from Table 2.1 that democracy with a volunteer army places the highest relative value on its military personnel (and on their lives consequently) compared to any other scenario in the paper. This result occurs because of the belief that representative democracy reflects the preferences of its constituents, thereby internalizing the external costs of war being reflected in the preferences of the median voter. In addition to that, Table 2.1 shows that a volunteer army increases the relative value of military personnel because volunteers earn a competitively determined wage rate that accounts for the private costs of war much better than the lower conscription wage rate. The interesting case to consider, however, is whether democracy with conscription army values life more than dictatorship with volunteer army. Depending on the values of ε and C_L, either democracy with conscription army or dictatorship with volunteer army may claim the second highest value of life among the four scenarios considered in this paper. Without knowing the values of ε and C_L, the difference between these two regimes is theoretically ambiguous and should be resolved only empirically. Finally, dictatorship with conscription army places the lowest value on life because this dictatorship does not account completely for either the private or external cost of a conflict in choosing the profit maximizing combination of inputs.

While the derived marginal products ratios offer elegant analytical conclusions about the role of political regimes and military manpower systems in the valuation of military personnel and resulting combat casualties, the real world is too complex to be fully captured by this model. Nevertheless, this model should be able to capture the main determinants of combat casualties. This claim would have to be examined empirically.

2.5 Empirical Analysis and Results

As summarized in Table 2.1, democracies with volunteer armies face a higher value (cost) of military personnel, which forces them to create a more capital intensive military force compared to dictatorships with conscription armies. A more capital intensive military force is likely to suffer fewer battlefield casualties compared to a less capital intensive military force, everything else being equal. The proposition that democratic regimes and volunteer armies lead to lower combat casualties can be turned into empirically testable hypotheses:

Ho 1. More democratic nations experience lower battlefield deaths.

Ho 2. Heavier conscription reliance leads to higher battlefield deaths.

Testing the above hypotheses by simply regressing battlefield casualties on democracy, conscription, and some control variables may prove to be a very ad-hoc and unsound approach. The theoretical model in this paper says that democracy and conscription affect battlefield casualties indirectly via military capital intensity. Moreover, a single-stage regression without addressing the endogenous nature of some explanatory variables can significantly bias the estimates. A two stage least squares with instrumental variable (2SLS-IV) estimation technique would be preferred, a priori.

There are two data samples used in this paper. The first sample (called pooled) is based on the data for specific conflicts and their country participants. This sample amounts to, at most, 311 observations and features interstate, civil, and extra systemic conflicts. There could be several observations in this sample for the same conflict but different country participants. In the case of civil wars, there is only one observation entry for each country experiencing a civil war. The second sample is based on cross-country averages (84 countries) and their battlefield deaths in the conflicts during the 1950-2002 period. The cross-country regressions should capture the long-run determinants of combat casualties, while the pooled sample regressions should capture the short-run determinants and idiosyncrasies of battlefield casualties. Table A.9 lists the conflicts featured in the pooled sample, while Table A.10 lists countries featured in the cross-country sample. An unfortunate constraint for these samples, however, is the limited availability of conscription and economic freedom data. Introducing conscription and economic freedom[4] variables into regression reduces the sample size to 169 and 75 observations, respectively, for the two samples.

The following structural form system of equations will be estimated using 2SLS-IV estimator in accordance with the theoretical model where political regimes and military manpower systems affect military's capital-labor ratio, which affects the total size of combat casualties. In other words, military capital intensity (proxied by military expenditures divided by military personnel) should be endogenous in democracy, conscription, and country's relative capital abundance (proxied by real GDP per capita) that are used as instruments in the first-stage regression shown in equation (5.1).

$$\begin{aligned} ME / PERSONNEL_{it} &= \beta_0 + \beta_1 DEMOCRACY_{it} + \beta_2 CONSC_{it} + \beta_3 FREEDOM_{it} \\ &+ \beta_4 (GDP / CAPITA_{it}) + \varepsilon_{it} \end{aligned}$$

(5.1)

[4] There are additional limitations with *FREEDOM* and *CONSC* variables. Because conscription and economic freedom indexes come mostly in 5-year intervals it is difficult to match them precisely to some conflicts. See the appendix for more information on this issue.

In turn, military capital intensity together with conflict duration, conflict type, and national capability to conduct warfare can affect the total number of battlefield deaths that would have to be estimated in the second-stage regression as shown in equation (5.2).

$$\begin{aligned} DEATHS_{ij} &= \beta_0 + \beta_2 (\widehat{ME / PERSONNEL_{it}}) + \beta_2 DURATION_{ij} + \beta_3 CAPABILITY_{it} \\ &+ \beta_4 CIVIL_{ij} + \beta_5 UPOP_{it} + \varepsilon_{it} \end{aligned} \tag{5.2}$$

Where *ME/PERSONNEL* is military expenditures per military personnel in country *i* in the first year *t*[5] of conflict *j*, *DEMOCRACY* is a nation's democracy score in the first year of conflict, *CONSC* is the index of conscription reliance, *FREEDOM*[6] is the index of economic freedom, *GDP/CAPITA* is real GDP per capita in the first year of conflict, *DEATHS* is the total number of battlefield deaths incurred by country *i* during conflict *j*, *DURATION* measures conflict duration in calendar years, *CAPABILITY* is the Composite Index of National Capability (CINC) in the first year of conflict, *CIVIL* is the dummy variable specifying conflict type (civil war), and *UPOP* is the size of urban population in the first year of conflict. Data on battlefield deaths, conflict type, and conflict intensity come from Gleditsch et al. (2002) made available by Uppsala University and the Peace Research Institute at Oslo (PRIO). Please look in the appendix for a more detailed description of variables and data sources.

There are four variables of primary interest in this paper's regression analysis: democracy, conscription, economic freedom, and military capital intensity. The first-stage regression estimates would show if democracy, conscription, and economic freedom variables are significant determinants of military capital intensity. The economic freedom variable is included here to control for the potentially important influence of free markets on battlefield deaths since Gartzke (2005) found it to be an important determinant of peace. A free market would allow an unconstrained flow of resources (labor and capital) to their most highly valued

[5] To avoid capturing the influence of warfare on some independent variables, I only use the first year of conflict values of these variables.

[6] Conscription is one of the components in the economic freedom index. Thus, the *FREEDOM* variable that is used in this paper is the economic freedom index net of conscription (courtesy of Robert Lawson).

usage. Thus, one would expect that the risk premium on serving in the army would be fully realized in the free market economy making labor relatively more expensive than capital. The estimate for military capital intensity in the second-stage regression would, in turn, show how capital to labor ratio affects battlefield deaths. Other independent variables function as control or instrumental variables for *ME/PERSONNEL* in equation (5.1). The conflict duration variable controls for the size of casualties. Variables like national military capability (CINC) and urban population may capture nation's natural resource, technological, and human capital capabilities, while real GDP per capita captures country's capital abundance per worker.

I first run single-stage regressions as a robustness check and test for model's specification. The first regression shown in Table A.4 is applied to the individual conflict (pooled) sample and performs a version of the so called robust regression that weighs observations to reduce the outlier bias in coefficient and error estimates. The list of explanatory variables in this robust single-stage regression consists of democracy, economic freedom, conscription, real GDP per capita[7], national military capability (CINC), civil war dummy, and military capital intensity (i.e. military expenditure per military personnel). The dependent variable is average annual battlefield deaths calculated as the best available estimate of a nation's battlefield deaths in a given conflict divided by its duration (in years). The regression estimates for the pooled sample show that democracy, economic freedom, and real GDP per capita are negatively related to battlefield deaths, while conscription, capability, civil war, and military capital intensity are positively related to battlefield deaths. However, only economic freedom, real GDP per capita, conscription, capability, and civil war are statistically significant at the 5% level.

[Table A.4 about here]

[7] Regression diagnostics show a high level of correlation (see Tables A.2 and A.3 in the appendix) between democracy, economic freedom, and real GDP per capita. Therefore, a residual obtained from regressing real GDP/capita on democracy and economic freedom is used in all regressions instead of the original real GDP/capita variable.

Since battlefield deaths vary widely across conflicts and country participants, we may expect more reliable and insightful estimates based on cross-country long term averages. The next robust regression (Table A.4) fits the same model and yields, at times, very different estimates compared to the pooled regression. Democracy, conscription, real GDP per capita, civil war, and military capital intensity are now negatively related to battlefield deaths, while economic freedom and capability are positively related to battlefield deaths. Only democracy, capability, and civil war are statistically significant at the 5% level. Clearly, the estimates are not very consistent across the two different samples. The specification (link) and omitted variable bias tests shown in Table A.5 indicate that the single-stage regression for the pooled sample is miss-specified, but the cross-country based regression is not.

[Table A.5 about here]

More importantly, the exogenous specification of military capital intensity is rejected by the Wu-Hausman and Durbin-Wu-Hausman endogeneity tests shown in Table A.6. These tests suggest that the 2SLS-IV estimator is more appropriate in this case.

[Table A.6 about here]

There are five 2SLS-IV regressions based on the pooled sample shown in Table A.7. All of them use battlefield deaths as the dependent variable, which is sometimes normalized (divided) by military personnel or years of conflict to check for robustness of regression results. The first-stage estimates in regression (1) in Table A.7 show that democracy and real GDP per capita are positively and significantly related to military capital intensity. This regression utilizes the entire sample size of 311 observations. Including economic freedom and conscription variables, however, reduces the sample size to 169 observations and makes the democracy coefficient negative but not statistical significant. Economic freedom and real GDP per capita turn out to be positively and significantly related to military capital intensity in regression (2), while conscription appears significantly but negatively related to military capital intensity. The other independent variables like capability, conflict duration, and urban population are also statistically significant in the first stages of regressions (1) and (2). Capability index (CINC) is negatively related to military capital intensity, perhaps, suggesting that countries with a strong national military capability do not have to rely as much on capital intensive militaries for defense as less resource abundant nations do. Urban population is positively related to military capital intensity, perhaps capturing a higher human capital and economic development effect. In turn, the negative effect of duration on military capital intensity could capture the resource (capital) depleting effect of warfare.

[Table A.7 about here]

The second-stage regression estimates in regressions (1) and (2) shown in Table A.7 indicate a statistically significant negative relationship between total battlefield deaths and (predicted) military capital intensity. This relationship captures the main point of my argument that political and military manpower institutions affect conflict casualties through military capital intensity. Conflict duration is significantly and positively (naturally) related to battlefield deaths, while urban population is weakly significant and negatively related to battlefield deaths.

Looking at 2SLS-IV regression (1) and (2) estimates in Table A.7, it may seem that democracy loses its significance after controlling for economic freedom and conscription. However, I argue that this would be a hasty conclusion that neglects the potential presence of outliers, sample bias, and non-normality of errors. To address these problems, I use robust and median 2SLS-IV regressions. The median regression decreases the potential outlier effect that could bias the estimates, while the weighted robust regression adjusts for the frequency of same country observations appearing in the data sample. [8] As seen in Table A.7, the 2SLS-IV models

[8] These robust regressions take the inverse of the probability that the observation is included in the dataset. The sample weighted robust regressions produce similar estimates as the reported simple robust regressions. Robust regressions also allow for the non-normality of errors and produce heteroskedasticity and outlier resistant coefficient estimates and standard errors.

estimated using robust and median estimators yield significant and consistently signed estimates for democracy, economic freedom, conscription, and real GDP per capita.

Similarly to the first two regressions in Table A.7, the second-stage estimates from robust and median regressions support the main claim that military capital intensity is negatively related to battlefield deaths. The second-stage estimates for military capital intensity in regression (2) show that a one time raise in the average expenditure per military personnel by $1,000 would save about 70 lives on average in a given conflict. For a numerically large army, this would be a prohibitively expensive life-saving policy. The other variables like capability, conflict duration, and civil war dummy appear statistically significant in both robust and median regressions. Conflict duration coefficient is negative in the robust regression (3) and positive in the median regression (4). Capability index (CINC), on the other hand is positively related to battlefield deaths, which might seem counterintuitive at first. However, I interpret the positive sign as an indication that countries with larger natural capabilities are perhaps capable of fighting more intensive and prolonged wars. Conversely, this positive relationship could capture the reverse causality effect in which warfare needs raise military expenditure and consumption of some natural resources that make up this capability index (CINC). The end result is higher battlefield deaths.

Another way to check for the robustness of my findings is to normalize the dependent variable. This procedure might be better suited for capturing the determinants of *relative* battlefield deaths rather than the total conflict size as proxied by total battlefield deaths. To normalize the dependent variable, I divide it by total military personnel, total population, total urban population, or years of conflict duration. Table A.7 reports only the estimates for the regressions with the dependent variable divided by total military personnel. The normalized median regression results confirm the previous findings.[9] The first-stage estimates from the normalized median regression (5) are the same as those in the median regression (4). The second-stage regression results are a little different, however. In regression (5), urban population and conflict duration are highly significant, while capability is not. Most importantly, military capital intensity remains highly significant. The interesting point of these estimates is that democracy and conscription remain significant even after controlling for economic freedom and per capita GDP. This evidence supports the view that political institutions matter even after controlling for economic factors. However, similar to Gartzke (2005), I find that economic freedom has a much stronger effect (as much as 13 times) than democracy on military capital intensity.

Another way to check for the robustness of my findings is to run the same regressions on the cross-country averages of battlefield deaths. These regressions should pick up the long-run determinants of the average conflict casualties. I first run the 2SLS-IV regression without the economic freedom and conscription variables. Then, I include these two variables in the conventional 2SLS-IV regressions estimated using robust and median techniques. The regression results reported in Table A.8 are similar to those reported in Table A.7. Namely, all regressions in Table A.8 consistently show that democracy, economic freedom, and real GDP per capita are positively and significantly related to military capital intensity, which in return is negatively and significantly related to battlefield casualties. As expected, conscription is negatively and significantly related to military capital intensity in all regressions. Conversely, conflict duration and capability turn out statistically significant more consistently compared to the short-run estimates in Table A.7. Otherwise, the long-run findings with respect to the main four variables appear to be very robust across different estimation techniques and dependent variables (i.e.

[9] Robust and median regressions with the dependent variable normalized by total population, urban population, and conflict duration produce similar results.

normalized or not). The tests for the validity of instruments (see Hansen J statistic in Table A.7 and A.8) used in 2SLS-IV regressions show that democracy, economic freedom, conscription, and real GDP per capita cannot be rejected as instruments. This evidence provides strong support for the proposed hypotheses.

[Table A.8 about here]

One of the most interesting or intriguing findings is the apparent convergence in the magnitudes of the coefficients for democracy (increase) and economic freedom (decrease) in the long-run. For example, the coefficient for economic freedom could be 13 times as large as the coefficient for democracy in raising military capital intensity in the short-run. In the long-run however, the difference between these coefficients decreases dramatically. While economic freedom remains more potent than democracy in raising military capital intensity even in the long-run, the estimates suggest that political and economic freedoms must converge over time in their effects on military capital intensity. Also, the coefficients for the military capital intensity in regression (7) indicate that a one time raise of $1,000 in the average expenditure per military personnel could save about 130 lives annually in an average conflict. These are much higher coefficients compared to the short-run coefficient estimates shown in Table A.7.

2.6 Concluding Remarks

Using warfare profit maximization as a theoretical framework, I show how different political regimes (democracy vs. dictatorship) and military manpower systems (volunteer vs. conscription) could affect military capital intensity, value of life, and subsequent combat casualties. The model shows that democracy with volunteer army values life the highest, while dictatorship with conscription army values life the lowest. The theoretically ambiguous result occurs when comparing the value of life under democracy with conscription army to that under dictatorship with volunteer army. Which political regime values life more in these two cases depends on how low the conscription wage compared to the external cost of conflict perceived by the median voter.

The empirical estimates obtained in this paper provide strong support for the model's predictions that more democratic regimes and more reliance on volunteer armies (or economic freedom in general) lead to higher capital intensity of military forces and lower combat casualties. These findings provide further support for the notion that democratic and free market nations try to avoid large (costly) military conflicts and suffer fewer combat casualties than less democratic and market friendly nations. It is also worth noting that economic freedom appears to be a more robust and potent (as much as 13 times more potent) determinant of military capital intensity and battlefield deaths than democracy. One of the interesting findings in this paper is that the effects of democracy and economic freedom on military capital intensity are closer together in the average cross-country regressions than in the individual (pooled) conflict regressions. This suggests some convergence in the effect of economic and political freedoms on military capital intensity in the long-run.

Chapter 3

Military Expenditure, Arms Trade, and Economic Growth

3.1 Introduction

Some people associate military expenditure with a guarantee of peace and security, yet others see it as a wasteful enterprise potentially resulting in arms races or direct military confrontation. Regardless of one's perspective, arms trade and production is a big business with nontrivial economic consequences. According to the latest SIPRI estimates, world military expenditure amounted to $975 billion in 2004 (constant prices), or $162 of military spending per capita and 2.6 percent of world GDP. The United States, for example, is the major determinant of the world trend in military expenditure with its 47 percent share. Some of the biggest military spenders in the word are also some of the biggest arms traders. Russia, for instance, established itself as the main supplier of conventional weapons during 2000–2004 replacing the United States, the largest supplier for many years. France, Germany, Russia, the UK, and the USA were responsible for 81 percent of all arms deliveries during 2000–2004. The SIPRI estimates also show that the combined arms deliveries of all 25 EU states to non-EU states made up about 19 percent of all arms deliveries in 2000–2004, making the EU the third largest arms exporter. The world arms trade rose to $51.6 billion in 1999 with developing countries now capturing the bigger share of arms trade, thereby reversing the previous trend. Developed nations accounted for 96 percent of total arms exports in 1999 compared to 92 percent a decade earlier.

These figures highlight the economic significance of the military sector and raise questions about the likely economic impacts of military expenditure and arms trade. One of the most relevant and researched issues is the relationship between economic growth and military expenditure. However, the empirical estimates of this relationship are contradictory or inconclusive. Some of this confusion might be due to the non-linear relationship between growth and military expenditure or incorrectly specified models. Dunne et al. (2005) point out that the identification (i.e. reverse causality) issues in the defense-growth nexus and the sensitivity of small deviations in military expenditures to estimation techniques plague the estimates in many empirical studies. Aizenman and Glick (2003) argue that linear empirical models lead to inconsistent results when the relationship between economic growth and defense spending is non-linear, which is what they find to be the case. Taking these arguments into consideration, I examine the growth effects of military expenditure, arms trade, and their interactions using a balanced panel data for 28 countries from 1965 to 2000. Using fixed effects, random effects, and Arellano-Bond GMM estimators, I investigate the non-linear effect of military spending on economic growth in the Solow and Barro style regressions. Controlling for panel-level heteroskedasticity and autocorrelation problems that typically plague panel data estimation, I find that the augmented Solow growth model described by Dunne et al. (2005) performs more robustly across different estimators than the reformulated Barro growth model. The estimates indicate a significant non-linear relationship between growth and military spending, being conditional on net arms exports.

3.2 Literature Review

This section provides a brief review of the commonly referred channels through which military spending and arms trade may influence economic growth. Whereas Smith (2000) and Dunne (1996) offer a more detailed description of the various channels of influence from military spending, I shall provide only a brief summary of these channels. The defense-growth literature has accumulated a large number of papers analyzing a wide variety of different channels through which military expenditure may influence growth. These channels can be broadly grouped into three major categories as done by Dunne et al. (2005): demand, supply, and security channels.

In the demand channel, military spending works through the Keynesian multiplier effect that depends on the level and composition of military expenditure. According to this channel, additional military spending increases aggregate demand in the presence of spare capacity, which reduces unemployment and increases capital utilization. Hence, military spending is often seen as having a growth enhancing effect in this specification. In many developing countries, military spending might be seen as being capable of enhancing social infrastructure (roads, communication networks, etc.) and human capital (military education and training) that are likely to contribute to future economic growth. However, military spending has an opportunity cost and may crowd out investment in human and physical capital. The extent and form of this crowding-out, as pointed out by Dunne et al. (2005), depends on prior utilization of resources and how the increase in military spending is financed. A constrained government budget requires that an increase in military expenditure must be financed by budget cuts in other government programs, higher taxes, higher debt, greater money supply, or some combination of these methods. Different ways of financing an additional military expenditure might, obviously, have different effects on output and growth. Moreover, a change in military expenditure may change the composition of industrial output through input–output effects, according to Dunne et al. (2005). Clearly, it may not be possible to deduce whether the net effect of higher military spending on output and growth is positive or negative in this demand channel specification.

In the supply channel, the military sector competes with the civilian sector for labor, physical capital, human capital, natural resources and, perhaps, technology. The resources used by the military are not available for civilian use; hence, the opportunity cost of military spending. Mylonidis (2006) lists a number of opportunity costs associated with a higher military burden that include: crowded-out public and private investment, adverse balance of payments in arms importing countries, inefficient bureaucracies (i.e. extensive rent seeking), fewer civilian public sector services, depleted R&D activities, and skilled workforce in the civilian sector. On the other hand, it can be argued that military R&D spending can result in the development of new technology (i.e. radar, jet engine, nuclear energy) that can spill over into the civilian (private) sector. Dunne et al. (2005) point out that training in the armed forces can make workers more or less productive when they return to civilian employment, while military R&D may lead to commercial spin-offs. Some proponents of military spending argue that some research projects will not be carried out in the private sector due to the high-risk environment and public-good characteristics of the final product. If this is true, then military R&D can be a net producer of positive technological externalities. To complicate things further, consider the argument by Stroup and Heckelman (2001) that the net effect of military spending on growth is described by a non-linear, concave function if the military sector exhibits diminishing marginal productivity. This argument implies that at low levels of military spending the net effect on growth is positive, but after a certain maximum point, growth declines as military spending continues to expand and may even become negative. Moreover, Dunne et al. (2005) state that conscription and ideological fervor may increase the mobilization of factors of production, particularly during times of a perceived threat of war, potentially leading to greater output if these mobilized resources are not used exclusively for military purposes. In other words, mobilization efforts could have, at best, a positive effect on growth in the short run.

In the case of the security channel, the provision of national defense fosters the security of persons and property rights from domestic or foreign threats, which is essential to the operation of markets and to the incentives to invest and innovate. This is a very old argument dating back to Adam Smith, who noted that the first two duties of the state were to protect its citizens from foreign and domestic oppression or violence. It has been often noted in the literature that wars and a lack of security are major obstacles to development in many poor countries. Defense expenditures, thus, can strengthen the incentives to accumulate capital and produce more output, leading to higher economic growth (Thompson, 1974). However, when military expenditures are not driven by basic security needs and are due to the rent-seeking activities, military expenditures may provoke arms races or damaging wars. Supportive of this argument is Aizenman and Glick's (2003) finding, indicating that economic growth increases with higher military spending when a country faces higher military threats, and that economic growth decreases with higher military spending when a country experiences high levels of corruption. In this case, less military spending would be desirable and could lead to positive security effects on economic growth. For instance, the disarmament process and dramatic cuts in defense budgets in many countries following the end of the Cold War have often been credited with generating the so called "peace dividend" that resulted in better standards of living.

Likewise, arms trade may affect economic growth through a number of different channels, and in a non-linear way, through an interaction with military expenditure similar to the interaction between military spending and threats examined by Aizenman and Glick (2003). It might be more insightful to examine arms exports and arms imports separately in order to identify more accurately the channels through which they may impact growth. In the case of arms imports, a component of military spending has to be allocated to pay for these purchases. Arms purchases are not cheap, and some countries have to resort to external borrowing in order to pay for their arms imports or some portion of their military budget in general. Of course, foreign borrowing does not necessarily lead to slower economic growth. In fact, reasonable levels of foreign borrowing might even stimulate growth. Dunne et al. (2003) suggest that, in evaluating the impact of debt on growth, it is important to consider how the external debt is being used. If it is used to increase productive capacity, external borrowing may even facilitate development. However, if the scarce foreign exchange resources are spent on arms imports instead of investment goods that are essential for self-sustaining growth, then the effect of external borrowing on growth is likely to be negative. Looney (1989) investigates how military expenditures and arms imports affect debt in resource-constrained countries and unconstrained countries and finds arms imports to be a significant contributor to Third World indebtedness. In another empirical study, Looney and Frederiksen (1986) find that the unconstrained developing countries are able to support higher level of arms imports. Gunluk-Senesen and Sezgin (2002) find that the growth in arms imports has a significant positive effect on external debt, while no such effect is found for the growth in military spending.

On the other hand, it could be argued that arms imports may help the importing countries to acquire new technology through reverse engineering or through the necessary training of military personnel required for operating high-tech weapons systems. In some instances, arms imports may result in direct technological transfers when they take the form of a licensed production of military weapons or some of their parts. India and Russia, for instance, signed a major defense deal for the purchase of 310 new Russian T-90 main battle tanks and their production under a Russian license in India. This agreement allows India to manufacture some critical components of the T-90 tanks. Between 1993 and 2005, China acquired the rights to produce 200 SU-27 and 250 SU-30 fighters domestically under a Russian license. This tendency toward more licensed production, rather than finished arms imports, is becoming more and more prevalent in international arms trade, which has become increasingly competitive in the last decade or so. In light of this tendency, it would be worthwhile to hypothesize about the reasons that governments have for preferring domestic production of arms instead of arms imports. At least three arguments come to mind. First, some countries may find themselves at risk when their defense capabilities depend on the supply of arms from other countries, especially from potential enemies. Second, some governments may believe that relying on arms imports instead of producing arms domestically is economically wasteful. Finally, arms imports might be very difficult to justify politically in election campaigns. Thus, arms exports could be considered beneficial, and arms imports detrimental, to the economy. Hence, the purpose of this study: to find out if there is a systematic relationship between arms trade and economic growth for a given level of military expenditure. In other words, would the evidence support the argument that arms imports are necessarily detrimental to growth, and that arms exports, by reverse logic, are necessarily beneficial for growth?

While this question will be rigorously explored in the empirical section of this paper, some obvious correlations are already clear. Between 2000 and 2004, according to the Stockholm International Peace Research Institute (SIPRI), the top ten suppliers of arms in the world were Russia, USA, France, Germany, UK, Ukraine, Canada, China, Sweden, and Israel (descending order). Also, the SIPRI records show that the world's top military spenders in total dollar value in 2004 were USA, UK, France, Japan, China, Germany, Italy, Russia, Saudi Arabia, and South Korea. Clearly, the majority of these countries are not only some of the biggest military spenders but also some of the biggest arms exporters. Moreover, the majority of these countries, with the exception of current and former planned economies, are developed countries. According to the World Military Expenditures and Arms Transfers (WMEAT) report, developed countries were overall net arms exporters in every year between 1989 and 1999 (see Figure A.1), as well as in the decade before that, which implies that developing countries were net arms importers over the same period. These casual observations suggest that arms trade patterns are correlated with military expenditures and the level of economic development. Perhaps whether or not a country is a net arms exporter depends on the level of military spending and technology that, in turn, could be affected by the level of economic development. Relevant to this idea is the finding by Goldsmith (2003) that economic growth, per capita income, and democracy are among the significant determinants of military spending. It is possible that arms exports depend on a country's technological progress and income. Thus, it is also possible that arms exports could proxy for spill-over effects or positive technological externalities stemming from military R&D.

As is the case with military spending, the net effect of net arms exports is ambiguous in theory and would ultimately have to be examined empirically. It is difficult to hypothesize about the direction of the net effect, given that there is a plethora of channels through which military spending and arms trade could impact economic growth. Since it is impossible to incorporate all the significant linkages from military spending within one model, researchers often choose to focus on cross-country growth models. They neglect these complex linkages in favor of a simple reduced form relationship between output and military spending state Dunne et al. (2005). The result of this approach is a variety of diverging empirical findings on the defense-growth nexus, which is not surprising considering the diversity of models, econometric techniques, time periods, and country samples used. Some of these contradictory findings are due to the severe econometric and theoretical problems of the Feder-Ram model (Ram, 1995), as Dunne et al. (2005) argue. Moreover, they conclude that the Feder-Ram model should be abandoned in favor of the conventional Barro or Solow growth models, which are better suited for analyzing the defense-growth relationship. Following their advice, I proceed to analyze the relationship between growth and military spending and arms trade within the context of the two commonly used Barro and Solow growth models.

3.3 The Augmented Solow Growth Model

In 1956, Robert Solow developed a model that revolutionized the study of economic growth. He assumed an economy with a standard Cobb-Douglass production function, with decreasing marginal returns to capital and a fixed level of technology. The textbook Solow growth model treats the rate of saving, population growth, and technological progress as exogenous. The model predicts that "poorer" countries should be able to grow at faster rates than "richer" countries, thereby leading to cross-country convergence, albeit a conditional one, in the standards of living over time. In their influential paper, Mankiw, Romer, and Weil (1992) augmented the textbook

Solow growth model with human capital. They showed that it could explain as much as eighty percent of cross-country variation in output per worker, and that it could approximately predict cross-country convergence in the standards of living. A variant of the augmented Solow growth model was used by Knight et al. (1996) and Dunne et al. (2004) in estimating the effect of military expenditure on growth.

The effect of military spending on growth could be modeled in a number of ways. One way is to assume that military spending (as a share of aggregate output) affects factor productivity via a level effect on the efficiency parameter that controls labor-augmenting technical change, as shown by Dunne et al. (2005). To see this, consider the aggregate neoclassical production function, now featuring the labor-augmenting technological progress with human capital following Mankiw et al. (1992):

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} [A(t)L(t)]^{1-\alpha-\beta}, \quad (1)$$

where Y denotes aggregate real income, H is the human capital stock, K is the real capital stock, L is labor, and A is the technology parameter. Technology parameter A evolves according to:

$$A(t) = A_0 e^{gt} m(t)^{\theta}, \quad (2)$$

where g is the exogenous rate of Harrod-neutral technological progress and m is the share of military spending in aggregate output. According to this specification by Dunne et al. (2005), a permanent change in military spending share does not affect the long-run steady-state growth rate, but it might have a permanent level effect on per-capita income along the steady-state growth path. Military spending (m) also can affect transitory growth rates along the path to the new steady-state equilibrium. Provided with this specification, one could estimate the influence of military spending on growth using panel-level data as was done by Dunne et al. (2004).

Continuing with a concise exposition of this model, one can now observe some of its dynamic properties. Given the standard assumptions of an exogenous saving rate s, a constant labor force growth rate n and capital depreciation d, the model exhibits conventional dynamics of capital accumulation where human capital per effective worker ($h_e=H/AL$) and physical capital per effective worker ($k_e=K/AL$) evolve the following way:

$$\dot{h}_e(t) = s_h y_e(t) - (n+g+d)h_e(t) \quad \text{and} \quad \dot{k}_e(t) = s_k y_e(t) - (n+g+d)k_e(t)\,, \tag{3}$$

where s_h and s_k denote the shares of human and of physical capital investment in aggregate income. Human capital is assumed to depreciate at the same rate (d) as physical capital. The steady-state physical and human capital stock levels are

$$k_e^* = \left[\frac{s_h^{\beta} s_k^{1-\beta}}{n+g+d}\right]^{1/(1-\alpha-\beta)} \quad \text{and} \quad h_e^* = \left[\frac{s_h^{1-\alpha} s_k^{\alpha}}{n+g+d}\right]^{1/(1-\alpha-\beta)}. \tag{4}$$

The transitory dynamics of income per effective worker near the steady state are approximated by

$$\frac{\partial \ln y_e}{\partial t} = (\alpha+\beta-1)(n+g+d)[\ln y_e(t) - \ln y_e^*]\,. \tag{5}$$

Now, the transitory dynamics of output per effective worker near the steady state need to be made suitable for empirical analysis. For a more detailed exposition of the model please see Dunne et al. (2004) and (2005). The equation for income per actual worker is now

$$\begin{aligned} \ln y(t) = e^{z} \ln y(t-1) + (1-e^{z})\left\{\ln A_0 + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+d)\right\} \\ +\theta \ln m(t) - e^{z}\theta \ln m(t-1) + (t-(t-1)e^{z})g \end{aligned} \tag{6}$$

where $z\equiv(\alpha-1)(n+g+d)$ and θ is the elasticity of steady-state income with respect to the long-run military expenditure share. While there is a distinction between models of the level of output and the growth rate, the distinction is less important in practice as shown in Dunne et al. (2005). It is common in the empirical analysis of economic growth to treat s and n as variant across countries and time, while g and d as uniform time-invariant constants and A_0 as country-specific and time-invariant (see Knight et al. (1993), Islam (1995), and Dunne et al. (2004)). While s and n are often assumed to be constant in cross-sectional long-run growth regressions, it is much easier to justify this assumption when working with panel data. Using five-year averages instead of annual values can diminish the effect of business cycles and serial autocorrelation in the empirical analysis.

The conceptual equation shown above can be adapted for empirical analysis using the dynamic panel model specification of the following form:

$$\Delta \ln y_{it} = \beta_0 + \beta_1 \ln y_{it-1} + \beta_2 \ln s_{it} + \beta_3 \ln(n_{it} + g + d) + \beta_4 \ln h_{it} + \beta_5 \ln m_{it} + \beta_6 \ln m_{it-1} + \varepsilon_{it} . \quad (7)$$

This equation will serve as the basis for the forthcoming empirical analysis of economic growth in the Solow-style regressions. Recalling the earlier discussion of possible linkages between development (technology) and arms exports, the relationship between growth and arms exports (*ax*) or imports (*am*) can be specified in a manner similar to that of military spending. As with military spending, arms exports may have a permanent level effect on per-capita income as well as on transitory growth rates along the steady-state growth path that can be specified for empirical estimation in the following way:

$$\begin{aligned} \Delta \ln y_{it} &= \beta_0 + \beta_1 \ln y_{it-1} + \beta_2 \ln s_{it} + \beta_3 \ln(n_{it} + g + d) + \beta_4 \ln h_{it} \\ &+ \beta_5 \ln m_{it} + \beta_6 \ln m_{it-1} + \beta_7 \ln ax_{it} + \beta_8 \ln ax_{it-1} + \varepsilon_{it} \end{aligned} . \quad (8)$$

This dynamic panel model specification, but with net arms exports, will serve as the basis for the forthcoming empirical analysis of military spending and arms trade effects on growth in the Solow framework. As with many empirical models, the above specification is not without its problems. Dunne et al. (2005) and Lee et al. (1997) point out that military expenditure and the error term in this specification influence output in an ad hoc way, which makes it harder to believe that the share of military expenditure could change technology. The same criticism that applies to modeling military spending would apply to modeling the effect of arms trade on economic growth. Whatever the assumed specification of arms trade and military spending might be, if there exists a significant and robust relationship between growth, military spending, and arms trade, a thorough empirical analysis may pick it up regardless of the chosen specification. Bleaney and Nishiyama (2002) test some recent growth models and fail to reject any of them. However, they also find that an encompassing (combined) model provides a significant improvement over any of the candidate models they tested. Similarly, I attempt to combine the specifications of military spending in Aizenman and Glick (2003), Dunne et al. (2004), and Mylonidis (2006), hoping to find a robust relationship between economic growth, military spending, and arms trade, regardless of the chosen specification.

3.4 The Barro Growth Model

In their review of theoretical models on military expenditure and growth, Dunne et al. (2005) conclude that the mainstream models of economic growth like the augmented Solow and the endogenous Barro growth models should be more suitable for analyzing the defense-growth nexus than the Feder-Ram model. The Barro (1990) growth model explicitly allows for different forms of tax financed government expenditures to influence output through the production function. This model also features the representative agent with explicit utility function that the government maximizes. Barro's (1990) model postulates that the government expenditure has a non-linear effect on growth produced by the interaction between the productivity enhancing and tax distorting effects of government spending. The theoretical equation describing the relationship between economic growth and its determinants turns out rather too complex to be estimated explicitly. This problem is often circumvented in the so-called Barro-style regressions, in which the theory suggests what variables should enter the unrestricted and ad hoc growth regression. The same approach is taken by Aizenman and Glick (2003) and Mylonidis (2006), from whom I borrow my Barro-style specified equation to examine the joint effect of arms trade and military spending on growth. The Barro-style regression could take on the following form:

$$growth_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 s_{it} + \beta_3 popg_{it} + \beta_4 educ_{it} + \beta_5 m_{it} + \varepsilon_{it}, \qquad (9)$$

where traditional variables like the log of initial per capita GDP, share of investment in GDP, population growth, and the log of average years of schooling (human capital) are included in the regression addition to the share of military spending in GDP. Other control variables could include institutional, demographic, and geographic characteristics or an interaction term between military spending and threats or corruption as in Aizenman and Glick (2003). In their paper, Aizenman and Glick (2003) attempt to clarify a common finding that military spending has an insignificant or negative impact on economic growth. They conjecture that this finding arises from non-linear interactions between military expenditure, external threats, and corruption. Aizenman and Glick (2003) explain the presence of these non-linear interactions in an extended version of Barro and Sala-i-Martin (1995) by allowing growth to depend on the severity of external threats and the size of military expenditure associated with these threats. In this novel specification, national output is influenced by security or military expenditure relative to the threat. This might be a more plausible specification of the defense-growth nexus for many countries than the specification in which defense spending influences output through technology. Aizenman and Glick (2003) hypothesize that military expenditure induced by external threats should increase output by increasing security, while military expenditure induced by rent seeking and corruption should reduce growth by displacing productive activities. They suggest a basic growth equation specification of the following form:

$$gy = a_1 mil + a_2 (mil)(thr) + b_1 thr + \beta X + \varepsilon \,, \tag{10}$$

where *gy* is the growth rate of real per capita GDP, *mil* is the share of military spending in output, *thr* is the level of military threat faced by a country, and *X* is a set of control variables. In this specification, the direct effects of military spending and external threats on growth are assumed negative, while the interactive effect of military spending and threat is positive. Aizenman and Glick's (2003) cross-country estimates over the period 1989-98 indicate that when the threat is low, military expenditure reduces output, especially in countries with a lot of corruption. However, when the threat is high, military expenditure increases output. Among the avenues for further empirical research, Aizenman and Glick (2003) suggest investigating the relationship between arms trade and corruption as pertaining to growth.

I follow Aizenman and Glick (2003) and analyze the effect of military spending and arms trade on growth in the Barro-style regression using an interaction term, but with military spending and net arms exports forming the interaction term instead of military spending and threats. I also use the same interaction term in the Solow-style regressions.

3.5 Data Description

The two Solow-style and Barro-style regressions used in this paper are based on the same balanced panel dataset and are very similar in terms of the independent variables included, but they differ slightly in the specification and format of military spending and some control variables. Specifically, the Solow-style regression includes lagged net arms exports and natural log of lagged military spending, whereas the Barro-style regression does not. The other control variables like investment and population growth enter the Solow-style regression in the natural log form unlike in the Barro-style regression.

In the Solow-style regression, the dependent variable (*growth*) is the annual growth rate of real per capita GDP averaged over five-year intervals. The set of explanatory variables includes some typical control variables used in the empirical growth literature such as initial real per capita GDP (y_{it-1}), the average number of years of schooling attained by both sexes 25 years old and over at all levels of education (h_{it}) taken from the Barro-Lee data set[1], annual population growth rate[10] ($n_{it}+g+\delta$) averaged over five-year intervals, and real investment as a share of GDP

[1] Education data is taken from Barro and Lee (1994) dataset, which can be found at: http://www.cid.harvard.edu/ciddata/ciddata.html

[10] Given the difficulty of obtaining panel data on working age population, I resort to the common alternative of using population growth rates instead. Following Mankiw, Romer and Weil (1992), I assume $g+\delta=0.05$ to be the same for all countries and years and add this value to population growth.

(s_{it}) averaged over five-year intervals. Military expenditure (m_{it}) is measured as a share of GDP averaged over five-year intervals. A lagged value of military expenditure (m_{it-1}) preceding a five-year average is also included in the Solow-style regressions. Net arms exports (nax_{it}) are measured as (arms exports – arms imports)/(arms exports + arms imports), averaged over five-year intervals (all in current dollars). The interaction term (nax_{it})($\ln m_{it}$) is the product of net arms exports and the natural log of military spending. Alternatively, the interaction term is also split into two different variables that are similar to Aizenman and Glick's (2003), who create two interaction terms corresponding to the low and high levels of military threat multiplied by military spending. In this paper, I split net arms exports into two variables that feature either net arms exports or net arms imports (or negative net arms exports in absolute value) and zeroes otherwise. Then, the two new interaction terms are the product of military spending and net arms exports ($naxpos_{it}$)($\ln m_{it}$) and the product of military spending and net arms imports ($nampos_{it}$)($\ln m_{it}$). The two interaction terms enter the regression together with net arms exports and net arms imports.

In the Barro-style regressions, the dependent variable (*growth*) and the explanatory variables like the initial real per capita GDP, the average number of years of schooling, military expenditure, and net arms exports are measured the same way, except that they may enter the Barro-style regression without logs (except for schooling and initial real per capita GDP), following Mylonidis (2006) and Aizenman and Glick (2003). Investment share, military expenditure share, and population growth enter Barro-style regressions without logarithms. The interaction terms in the Barro-style regressions are constructed in the same way as those in the Solow-style regressions.

Data on GDP, population, and investment are obtained from the Penn World Tables, version 6.1. Education data for the human capital proxy are taken from the Barro-Lee (1994) dataset. Data on military spending[11] come from various SIPRI Yearbooks (Stockholm International Peach Research Institute), while data on arms exports and imports are taken from various editions of WMEAT (World Military Expenditures and Arms Transfers), published by the U.S. Department of State after integration with the U.S. Arms Control and Disarmament Agency. Please refer to the appendix for more variable descriptions and data sources. The value of each explanatory variable either represents the calculated average over the seven five-year periods of the dependent variable (1966 – 1970, 1971 – 1975, 1976 – 1980, 1981 – 1985, 1986 – 1990, 1991 – 1995 and 1996 – 2000) or the lagged value that correspond exactly to the base years 1965, 1970, 1975, 1980, 1985, 1990 and 1995 (like y_{it-1}, m_{it-1}, and nax_{it-1}). Data reflecting the seven five-year periods are analyzed for a sample of 28 countries (Argentina, Australia, Belgium, Brazil, Canada, Chile, Denmark, France, Germany, Greece, India, Israel, Italy, Japan, South Korea, Malaysia, Netherlands, Norway, Pakistan, Philippines, Portugal, South Africa, Spain, Sweden, Turkey, United Kingdom, United States, and Venezuela). The total number of observations in this cross-sectional time-series data set is 196 (7 five-year periods for each of the 28 countries).

3.6 Empirical Analysis and Results

The approach taken in this section consists of estimating and comparing the effects of military spending and arms trade on economic growth in the Solow and Barro style regressions. The effects of military spending and arms trade on growth will be analyzed separately and together (via interaction terms) using different estimation techniques for the robustness of results.

While growth models have been most successful in cross-sectional empirical studies, panel data estimation can provide a number of significant advantages over cross-sectional

[11] Military spending and some GDP data missing from the PWT was kindly provided by Dunne, Smith, and Willenbockel (2004).

analysis. Given the availability of cross-country time-series data, the fixed effects estimator or the least squares dummy variable (LSDV) model seems like the appropriate choice. When the unobserved effects are correlated with the observed covariates, the standard estimator used to eliminate the potential bias caused by omitted heterogeneity is the fixed effects (within) estimator. The fixed effects estimator is popular because it is simple, easily understood, and makes robust standard errors readily available, writes Wooldridge (2001). When analyzing the fixed effects estimator, the standard assumptions are that the time-varying errors have zero means, constant variances and zero correlations. In the presence of omitted variable bias and unobserved country and time effects that often appear in country level panel data, the fixed effects estimator is preferred over the pooled or random effects estimators. Islam (1995) explores the suitability of LSDV fixed effects estimator for growth estimation with panel data. He argues that fixed effects estimator is a very suitable technique because of the individual country effects being correlated with the exogenous variables in the model. After conducting a Monte-Carlo study, Islam (1995) finds that the LSDV estimator, although being consistent in the direction of T only, performs very well.

However, there are a number of problems that plague panel data models in general and the LSDV models in particular. Too many dummy variables, for example, may significantly deplete the degrees of freedom, while country-specific (groupwise) heteroskedasticity or autocorrelation over time would violate the normality and homogeneity of errors assumption. Outliers can bias regression slopes, and heteroskedasticity problems from groupwise differences can bias standard errors. Panel data may exhibit panel specific or general autocorrelation, requiring dynamic panel analysis. The fixed effects OLS estimator would suit fine for panel estimation as long as there are no heteroskedasticity and autocorrelation problems. However, these conditions are so rare that it is often unrealistic to expect that OLS will suffice for such models, notes Yaffee (2003). Under these conditions, the more suitable and commonly used estimator, according to Yaffee (2003), is the feasible generalized least squares (FGLS). Greene (2002) and Wooldridge (2002) also recommend using White's heteroskedasticity consistent covariance estimator with OLS estimation in fixed effects models for it can produce standard errors robust to unequal variance along the predicted line.

For robust estimation in the presence of heteroskedasticity, autocorrelation, and outliers Yaffee (2003) recommends using a generalized method of moment (GMM) estimation with robust (White, Newey-West) panel standard errors. Wooldridge (2001) notes that some of the most interesting recent GMM applications are to panel data. According to Wooldridge (2001), if either heteroskedasticity or serial correlation is present, a GMM procedure can be more efficient than the fixed effects estimator, but the potential gains over standard applications are largely unknown. Generalized method of moments is applied more often to unobserved effects models when the explanatory variables are not strictly exogenous even after controlling for an unobserved effect. Thus, GMM appears indispensable for more sophisticated applications such as dynamic unobserved effects panel data models, concludes Wooldridge (2001). Although GMM estimators can be asymptotically normal, they may not always be the most efficient ones, argues Yaffee (2003). Another concern associated with using a dynamic GMM estimator is a loss of valuable observations (information to infer from) in small samples.

Concerned with the typical issues plaguing panel data estimation, I perform the Breusch-Pagan heteroskedasticity and Arellano-Bond autocorrelation tests, which confirm the suspected heteroskedastic and AR (1) error structure. In light of this evidence, it is clear that the FGLS and Arellano-Bond GMM, with the correctly specified error structure, should be my preferred estimators. Considering the growing popularity of the fixed effects estimator and the preceding discussion of recommended panel estimators, I propose using the two-way fixed effects FGLS estimator with standard errors robust to groupwise heteroskedasticity and autocorrelation as a benchmark with which the GLS random effects and Arellano-Bond GMM estimators are to be compared. The estimates from two-way fixed effects FGLS, or analogously FGLS-DV (FGLS with dummy variables), can be compared to the random effects estimates using the Hausman specification test. The random effects model is very different from the fixed effects model and requires that the cross-sectional error must be uncorrelated with explanatory variables. One way to handle the error term is to assume that the intercept is a random effect (outcome) variable in the time-series cross-sectional regression model. The Hausman specification test is the commonly used method of deciding which model, fixed or random effects, is more appropriate for the chosen empirical analysis. The dynamic panel data estimation method, known as the Arellano-Bond GMM estimator, can be very useful in addressing the endogeneity of explanatory variables in growth regressions, as noted by Dreher (2005) in his application of Arellano-Bond estimator in globalization and growth study. The GMM estimator is convenient for estimating interesting extensions of the basic unobserved effects model when unobserved heterogeneity interacts with observed covariates, according to Wooldridge (2001). The one and two step Arellano-Bond GMM estimator can be robust to violations of heteroskedasticity, normality, and autocorrelation in errors. As suggested by Yaffee (2003), the Arellano-Bond GMM estimator with instrumental and first-differenced lagged variables may circumvent problems with correlations of errors and help obtain additional efficiency gains over other panel data estimators.

Now, I am ready to present and compare the estimates from Solow and Barro style regressions. The basic Solow-style fixed effects regression equation can be specified as follows:

$$\begin{aligned} growth_{it} &= \alpha_i + \alpha_t + \beta_1 \ln y_{it-1} + \beta_2 \ln s_{it} + \beta_3 \ln(n_{it} + g + d) + \beta_4 \ln h_{it} + \beta_5 \ln m_{it} \\ &+ \beta_6 \ln m_{it-1} + \beta_7 nax_{it} + \beta_8 nax_{it-1} + \beta_9 (nax_{it})(\ln m_{it}) + \varepsilon_{it} \end{aligned}, \quad (11)$$

where m_{it} and nax_{it} are the military spending and net arms exports variables and $(nax_{it})(m_{it})$ is their interaction term. The interaction term in this Solow-specified model is an ad hoc empirical extension done for the purpose of comparing the Solow-style regression results with the Barro-style regression results. Note that military spending enters regressions in the log form, while the net arms exports variable does not, due to its taking on negative values in some observations. The basic Barro-style fixed effects regression equation is specified as follows:

$$\begin{aligned} growth_{it} &= \alpha_i + \alpha_t + \beta_1 \ln y_{it-1} + \beta_2 s_{it} + \beta_3 popg_{it} + \beta_4 \ln h_{it} \\ &+ \beta_5 m_{it} + \beta_6 nax_{it} + \beta_7 (nax_{it})(m_{it}) + \varepsilon_{it} \end{aligned}, \tag{12}$$

where military spending, net arms exports, and the interaction term are defined as before.

Beginning with the basic Solow-style regression results reported in Column 1 of Table A.14, current military spending appears to be negatively and significantly (at 1%) related to economic growth in the two-way fixed effects FGLS regression with groupwise heteroskedastic and panel-specific AR (1) adjusted standard errors. Using the same dataset, Dunne et al. (2004) also find the same negative and significant relationship between current military spending and economic growth using fixed effects and random coefficient estimators. Lagged military spending is not statistically significant in this FGLS regression. Traditional growth regressors such as the lagged per capita GDP, investment share, population growth, and human capital (schooling) all have the expected signs and appear statistically significant (except for human capital). Adding net arms exports to a regression does not change the negative sign or significance level of current military spending, but it makes lagged military spending statistically significant and positively related to growth. The current and lagged net arms exports are negatively related to growth, but they are not statistically significant and nor is human capital (Column 2, Table A.14). The human capital variable in this regression has a wrong sign: it is negatively related to growth. This anomalous result regarding the role of human capital in growth regressions is not new, according to Islam (1995). He attributes this illogical finding to the discrepancy between the theoretical variable *H* used in the model and the actual variable used in regressions. Moreover, the true levels of human capital in some countries have not increased by much. Statistically, this leads to a negative *temporal* relationship between the human capital variable used in regressions and economic growth. A richer specification of production function with respect to human capital, writes Islam (1995), would allow the theoretical properties of the human capital variable to be better reflected in the regression results.

The next step is to add an interaction term (military spending times net arms exports) in order to test for a significant non-linear relationship between current military spending and economic growth that is contingent upon the level of net arms exports. This is the approach used by Aizenman and Glick (2003) in their study of the interaction between military spending and threats resulting in non-linear relationship between military spending and growth. The regression results listed in Column 3 (Table A.14) show a significant positive relationship between the interaction term and growth and significant negative relationship between net arms exports and growth, while maintaining a significant and negative relationship between current military spending and growth. These estimates suggest that while current military spending and net arms exports have a negative effect on growth, the effect of military spending on growth becomes positive with higher net arms exports. This finding is similar to the non-linear relationship between growth and military spending in the presence of military threats found by Aizenman and Glick (2003). In this regression, however, population growth and human capital are not statistically significant. What is surprising, however, is the negative and significant relationship between growth and net arms exports; I had expected to see a positive relationship between the two. Perhaps this estimated relationship captures the fact that richer countries tend to be net arms exporters and that they tend to grow more slowly than poor countries, as predicted by the Solow growth model.

The next step is to explore the endogenous nature of military spending. As previous research has shown, some variables in growth regressions may also exhibit endogeneity problems. Fertility, for example, could be influenced by measures of wealth, according to Barro and Lee (1994). Similarly, the military spending variable could be subject to the same endogeneity problem. Using the Durbin-Wu-Hausman endogeneity test, I find that military spending is indeed significantly endogenous.[12] One way of addressing this endogeneity problem is to use the Arellano-Bond GMM estimator. In the Arellano-Bond one-step GMM estimation, the right-hand side variables can be instrumented with first-differenced lags, as well as other instruments, and the validity of the exogeneity assumption can be tested. The Arellano-Bond GMM estimator consists of first-differencing the estimated equation and using lags of the dependent variable and explanatory variables as instruments. Due to first-differencing, this estimator also removes the individual country effects and first-order autocorrelation that might be present in the data.

Often, good instruments (those correlated with the included explanatory variables and uncorrelated with the error term) are hard to find. Goldsmith (2003) finds several significant determinants of military spending that could aid in choosing the appropriate instruments. Goldsmith (2003) identifies the lagged military spending, economic growth, wealth, and political regime type as significant and robust determinants of military spending. Since economic growth and lagged wealth (per capita GDP) are already included in the model, I use the natural log of political regime type, natural log of total country population, and Composite Index of National Capability (CINC) as instruments.[13] Among these three instruments, the natural log of political regime type was found to be negatively and significantly related to military spending in a separate 2SLS-IV regression (results not shown to save space). The same regression also picked up a significant negative relationship between military spending and net arms exports. The Hansen J statistic from the same 2SLS-IV regression showed that the instruments chosen to identify current military spending could not be rejected.

[12] One interesting result that comes out of the endogeneity testing is that democracy (used as an instrument for military spending) appears negative and statistically significant suggesting that the apparent correlation between democratic regimes and income per capita could be at least partially attributed to lower military burdens.

[13] Political regime type is constructed according to this commonly used formula (DEMOC-AUTOC+10)/2. The democracy (DEMOC) and autocracy (AUTOC) measures come from Polity IV Project.

To address the endogeneity of military spending with the available instruments, I use the one-step Arellano-Bond GMM estimator with robust standard errors for coefficient inferences. However, I use the two-step Arellano-Bond GMM estimator for autocorrelation and validity of instruments inferences.[14] The results from the one-step Arellano-Bond regression are shown in Column 4, Table A.14. Like Dreher (2005), I use the natural logarithm of per capita GDP (five-year average) as a dependent variable instead of the growth rate because the Arellano-Bond estimator is formulated in differences, which means that the regression shows how changes in levels are converted into changes in growth. In this specification, the lagged dependent variable is no longer capturing growth convergence; instead, it is likely to capture growth momentum. All explanatory variables come out of the regression expressed in first-differences or lagged first-differences. The regression results show that lagged dependent variable, investment share, and population growth are statistically significant and have the expected signs. Moreover, the human capital variable has the expected positive sign, but is not statistically significant. The military spending variable appears statistically significant and negatively related to growth, while both net arms exports and the interaction term are negatively related to growth but not statistically significant. The Sargan test of over-identifying restrictions (i.e. validity of instruments) shown in Column 4 (Table A.14) implies that the instruments chosen to identify current military spending could not be rejected. However, different specifications of Arellano-Bond regression produce different signs and significance levels for the net arms exports variable and the interaction term, while the estimates for military spending seem robust to different specifications. Only in one specification, where military spending is treated as an independent variable rather than an endogenous one, does the one-step Arellano-Bond estimator produce a statistically significant

[14] Arellano and Bond (1991) recommend using the one-step GMM estimator for coefficient inferences because in small samples like mine standard errors tend to be under-estimated by the two-step estimator. The two-step estimator weighs the instruments asymptotically efficiently using the one-step estimates. The Arellano-Bond estimator, however, leads to a loss of observations from 196 to 140 since information from two periods is discarded by first-differencing.

and negative coefficient for net arms exports. Although the interaction term has the expected positive sign in the same specification of the Arellano-Bond regression, it is not statistically significant. Although this specification of the Arellano-Bond regression supports the findings from the other specifications, its results are not shown here in order not to give the questionable exogenous specification of military spending too much credit.

Now, let's compare the above Solow-style regressions with the forthcoming Barro-style regressions. Table A.15 lists the results for the Barro-style regressions that mimic the Solow-style regressions in Table A.14. The lagged per capita GDP, investment share, and population growth variables (but not human capital) exhibit robust relationship with growth as found in the Solow-style regressions. Military spending is statistically significant and negatively related to growth, which is a similar to what was found with FGLS by Mylonidis (2006). However, the Barro-style regressions do considerably worse than the Solow-style regressions when it comes to picking up statistical significance for military spending and net arms exports when the interaction term is included. More specifically, military spending is statistically significant and negatively related to growth as long as the interaction term does not enter the regression (Column 3, Table A.15). Net arms exports and the interaction term are not statistically significant at the 5% level, but they have the expected signs. Similar results are observed in the Arellano-Bond GMM regression shown in Column 4, Table A.15. Neither military spending nor net arms exports, nor the interaction term, are significant in this Arellano-Bond GMM regression. The Sargan and Arellano-Bond autocorrelation tests fail to reject the validity of instruments and absence of second-order autocorrelation, respectively. Clearly, the estimates for military spending and net arms exports do not appear as robust in the Barro-style regressions as the do in the Solow-style regressions.

The next step is to explore separately the effects of arms exports and imports on growth. To do so, I split the net arms exports variable into two variables: net arms exports and net arms imports (in absolute value). If a country is a net arms exporter, then it has zero for the net arms imports variable. If a country is a net arms importer, then it has zero for the net arms exports variable. Splitting the net arms exports variable into two allows me to create two interaction terms through which net arms imports and net arms exports can separately influence growth. As before, I begin with the Solow-style regressions listed in Table A.16. In the first such regression (Column 5, Table A.16), current military spending is significantly and negatively related to growth, while current net arms exports and net arms imports are positively related to growth, but only net arms imports are statistically significant. A slightly different story unfolds in the next regression (Column 6, Table A.16) when the two interaction terms are included. The major difference between the two regressions is that current net arms exports and its interaction with military spending appear statistically significant, as shown in Column 6. The net arms exports variable is negatively related to growth, and its interaction with the military spending variable is positively related to growth.

The next regression utilizes the GLS random effects estimator with the AR (1) disturbance term. This estimator examines the impact of military spending, arms trade and their interactions on growth by producing a matrix-weighted average of the between and within effects. Surprisingly, the random effects regression performs very well. Variables like per capita GDP, investment share, population growth, military spending, and even human capital come out statistically significant and have the expected signs (Column 7, Table A.16). However, this random effects estimator is rejected by the Hausman specification test in favor of the two-way fixed effects FGLS estimator.

In the new Arellano-Bond GMM regression (Column8, Table A.16), the lagged per capita GDP, investment share, population growth, and military spending show significant and robust relationship with growth in various specifications of this estimator. The same cannot be said about net arms exports, net arms imports, and their interactions terms. None of these variables appear statistically significant at the 5% level in the Arellano-Bond one-step GMM estimator (see results in Column 8, Table A.16). The other variables in this regression have the expected signs and appear statistically significant (except for human capital). This Arellano-Bond regression also passes the instrumental variable and second-order autocorrelation tests.

Let's repeat and contrast the same regressions in the Barro-style analysis where the net arms exports variable is also split up into two. Again, the Barro-style regressions do not produce as robust results as the comparable Solow-style regressions do. While, lagged per capita GDP, investment share, population growth, military spending, and net arms imports appear significant and correctly signed, adding the two interaction terms to this regression eliminates significance for the military spending variable and net arms imports. However, the net arms exports interaction term is now highly significant and positively signed (see Column 5 and 6, Table A.17).

The GLS random effects estimator does relatively well in terms of producing the expected signs and significance for key control variables in this Barro-style regression (Column 7, Table A.17), but it does worse than the two-way fixed effects FGLS estimator in terms of picking up significance for the interaction terms. Moreover, the random effects estimator is rejected by the Hausman specification test in favor of the fixed effects estimator. The Arellano-Bond one-step GMM estimator in the Barro-style specification returns only the lagged per capita GDP and investment share variables as statistically significant (Column 8, Table A.17). However, this regression passes the instrumental variable and second-order autocorrelation tests.

Now is a good time to summarize the results from the Solow and Barro-style regressions. There are two main conclusions that I can draw from these results. First, although the Solow growth model is very tight or restrictive theoretically, its empirical specification adapted from Dunne et al. (2004) performs much better empirically, compared to the Barro-style empirical specification adapted from Mylonidis (2006) and Aizenman and Glick (2003). In other words, the estimates for military spending are more robust in the Solow-style regressions, compared to the Barro-style regressions. Furthermore, I provide the results from the link and omitted variable tests for the two models (Table A.18). These tests indicate that the basic OLS estimated Solow and Barro style regressions are correctly specified, but the Solow-style regression has more explanatory power as evidenced by the R-squared. Thus, I recommend using the augmented Solow growth model approach for studying the defense-growth nexus as described in Dunne et al. (2004) and Dunne et al. (2005).

The second important conclusion is that the estimates for military spending are much more robust across different estimators than are those for net arms exports (imports) and the interaction terms. Since the random effects estimator was rejected in favor of the fixed effects, I am left to choose between the fixed effects FGLS and Arellano-Bond GMM estimators. According to Wooldridge (2001), generalized method of moments can improve, in large samples, over the standard panel data methods like ordinary, two-stage least squares or fixed effects when auxiliary assumptions fail. However, Wooldridge (2001) also notes that because these standard panel data methods can be used with robust inference techniques allowing for heteroskedasticity or serial correlation, the gains to practitioners from using GMM may be small, especially in small samples. Considering that the Arellano-Bond GMM estimator reduces my sample from 196 to 140 observations, it is a very valid concern. Moreover, the existing ambiguity with the correct specification of the endogenous variables and sensitivity of Arellano-Bond estimates to different specifications complicate the reliability of inference for this estimator. Moreover, the fixed effects FGLS takes into account time invariant and individual country effects, whereas the Arellano-Bond GMM estimator does not. Thus, I am more inclined to infer about the effects of military spending, arms trade, and their interaction terms on growth from the two-way fixed effects FGLS or the FGLS-DV estimator. The two-way fixed effects FGLS based on the Solow growth model suggests that while higher military spending and net arms exports lead, on their own, to lower economic growth, higher military spending is less damaging to growth when a country is a large net arms exporter.

3.7 Concluding Remarks

Using fixed effects, random effects, and Arellano-Bond GMM estimators I investigate the effect of military spending, arms trade, and their interactions on economic growth in the Solow and Barro style regressions. The estimates suggest that the augmented Solow growth model with military spending described by Dunne et al. (2005) provides more robust estimates than the reformulated Barro model used by Aizenman and Glick (2003). According to the Solow-style regression estimates, military spending is negatively related to economic growth. This is a finding that is robust to different estimation techniques in the Solow model. However, the estimates for net arms exports and interaction terms are not as robust across different estimators. Nevertheless, some conclusions can be reached. Higher military spending and net arms exports separately lead to lower economic growth, but higher military spending is less damaging to growth when a country is a large net arms exporter. In other words, if a country hopes to gain (or lose less) in terms of economic growth from additional military spending, it better be a net arms exporter. As for a future research avenue, it would be interesting to investigate what determines whether a country is a net arms exporter or importer, and whether policy makers can or should do anything about it.

Chapter 4

Ideology, Legislative Shirking, and the Incumbency Advantage: Evidence from the U.S. House of Representatives

4.1 Introduction

In a perfectly competitive legislative market voters would deter shirking politicians by voting them out of office and reward hard working politicians by reelecting them. In theory, this sorting or selection mechanism would lead to reelection of highly qualified incumbents and low incumbent turnover rates. Indeed, the turnover rate for incumbents in the U.S. Congress has been very low in most years. Apparently, incumbents enjoy a significant advantage over challengers, which allows incumbents to win, on average, more than 80% of the time in the U.S. Congressional elections. In primaries, incumbents win even more often. While it may seem that this evidence supports the outcome expected from a perfectly competitive legislative market, one could also argue that the same evidence is consistent with the view that incumbents have significant monopoly power in the electoral market giving them significant advantage over challengers. This incumbency advantage could stem from gerrymandering, disparities in campaign resources, and asymmetric information. If this is true, then the selection process cannot effectively deter politicians from shirking or enacting their own ideological preferences while in office.

In this paper, I examine the role of the incumbency advantage in allowing incumbents to legislate their own ideological preferences that are different from their constituents. In other words, would a rise in the incumbency advantage lead to a rise in legislative shirking? To answer this question, I augment the political competition model of Chen and Emerson (2003) by showing that incumbents face a tradeoff between vote maximizing and legislating their own ideological preferences. In the case of risk-averse voters, the model suggests that incumbents are able to propose a platform farther away from the median voter compared to challengers and still get reelected. I proceed to test the model predictions empirically. In their review of the literature on voting and legislative shirking, Bender and Lott (1996) acknowledge the lack of empirical studies addressing legislative shirking on the aggregate level. I attempt to fill this void by testing the predictions of the model using the aggregate statistics for the U.S. House of Representatives. I find evidence suggesting that a rise in the incumbency advantage leads to more total legislative shirking. In light of these findings, the pattern of declining incumbent turnover in the U.S. Congress suggests that the incumbency advantage has risen and so did legislative shirking purchased with incumbent vote surplus.

4.2 Theoretical Model

In a perfectly competitive political environment, one may conclude that an incumbent's defeat in a primary election is nothing but a punishment for legislative shirking or inadequate representation of constituents' interests. The available statistics for the U.S. House and Senate elections in the post war period show an increasing likelihood of incumbent reelection. Incumbents appear to enjoy a significant advantage over challengers, which allows them to win on average 80% of the time in the U.S. Senate, according to Gowrisankaran et al. (2004). The re-lection rate for incumbents in primary elections is even higher. The idea of efficient market sorting of shirking politicians may seem, at first, to agree with this evidence. Gowrisankaran et al. (2004) investigate why incumbent senators win so often. They find that the apparent incumbency advantage can be explained by selection effects and lower quality of challengers running against incumbents relative to higher quality of challengers running for open seats.

However, a rising likelihood of incumbent reelection may also agree with the well documented evidence (Smith, 1999) on decreasing political competition for incumbent seats, growing incumbency advantage in campaign resources, and declining importance of party identification. Given this evidence, a persistent increase in the number of reelected incumbents may reflect a significant monopolization of the electoral process rather than an efficient sorting of shirking incumbents. Asymmetric information, information costs, and ideological bias are among the factors that can limit the degree of competitiveness in the legislative process.

In contrast to the previous research, this paper is less concerned with explaining the incumbency advantage and more concerned with its implications for legislative shirking. This paper links incumbency advantage with legislative shirking (and ideology) in the context of the legislator-voter agency problem. In this paper, I assume that incumbents maximize not only the probability of winning an election but also the rents they derive from legislative shirking in the broadest sense, regardless of whether it is pursuing their own legislative ideology or collecting rents from lobby groups. The idea of incumbents trading some of the incumbency advantage for their own preferences is not new. For instance, Sobel (1992) points out that the idea of viewing politicians only as the vote maximizing agents is simply naïve. Hence, Sobel (1992) models politicians as vote maximizing agents who also pursue their own interests, even sometimes rationally getting themselves voted out of office. The obvious conclusion of Sobel's model is that incumbents should be willing to trade some of the extra votes in exchange for pursuing their own preferences. This is the same concept that I build on in this paper. I speculate that voter risk aversion towards uncertainty may allow an incumbent to get reelected even if that incumbent has deviated from the promised platform (i.e. shirked) on which he or she was voted into office.

In order to build a model of legislative shirking, I borrow the basic model setup from Chen and Emerson (2003) who address the issues associated with incumbency and term limits. I augment their model to show that an incumbent can shirk and win in an election in the presence of risk-averse voters. Like Chen and Emerson (2003), I assume a one-dimensional policy space [0, 1]. Furthermore, only two candidates (incumbent and challenger) compete for office in this static model. The incumbent's actual platform that he chooses to implement while in office is denoted by x_I and the challenger's proposed platform is denoted by x_C. Let x_{PI} denote the incumbent's platform that he promised and was elected upon in the previous election. Assume that x_{PI} is given exogenously in the current period. Similar to Chen and Emerson, I let x_{PC} to be the position (platform) of the challenger as perceived by the voters based on the party's or challenger's history. In other words, x_{PC} means that voters do not accept the challenger's platform at the face value. Unlike the challenger, the incumbent runs for reelection on the platform x_I that he chooses to implement while in office. The idea behind this specification is that the incumbent may have an incentive or ideological preference for implementing platform x_I that is different from the platform x_{PI} promised to the voters in the previous election.

Assume that the incumbent is the left-wing candidate and that the challenger is the right-wing candidate such that

$$0 \leq x_{PI} \leq \frac{1}{2} \leq x_{PC} \leq 1 .$$

Also, assume that voters' preferences over policies are single-peaked and characterized by the following quadratic utility function

$$u_x(y) = -(y-x)^2 ,$$

where x is the voter's most-preferred policy and y is the actually policy implemented. From now on, a voter x is identified by his most preferred policy x in one-dimensional policy space. I assume that x is uniformly distributed on [0, 1].

Like Chen and Emerson, I argue that a challenger and an incumbent may differ in their ability to propose platforms in an election. Thus, when a challenger proposes some platform x_C, the voters form an expectation of that platform due to the uncertainty associated with whether or not the promised platform will be implemented. Chen and Emerson allow voters to form an expectation of the challenger's platform that is represented by the random variable $\tilde{x}_C$ with density function $g(\tilde{x}_C)$. Then, voter x's expected utility associated with platform x_C becomes

$$u_x(x_C) = -\int_0^1 (\tilde{x}_C - x)^2 g(\tilde{x}_C) d\tilde{x}_C = -V(x_C) - [m(x_C) - x]^2$$

where $m(x_C)$ is the mean of the random variable $\tilde{x}_C$ with variance $V(x_C)$. Chen and Emerson further assume that $m(x_C) = x_C$, which means that the mean of $\tilde{x}_C$ is exactly the proposed platform. Then, $V(x_C)$ is the extent to which the voters perceive the candidate's real position with uncertainty. Hence, the challenger's utility to voters is a function of uncertainty regarding the candidate's true position ($V(x_C)$) and the distance between the voter's and the candidate's expected positions $(x_C - x)$. The voter's utility for the challenger decreases in both variables. Like Chen and Emerson, I further decompose $V(x_C)$ into $v + k(x_C - x_{PC})^2$, where v is voter disutility from *intrinsic* uncertainty that is associated with the challenger and $k(x_C - x_{PC})^2$ is the disutility of voters from *extrinsic* uncertainty caused by the challenger's strategic positioning. Interpret v as the voter's risk premium for being indifferent between accepting a definite position x_C and accepting a random position $\tilde{x}_C$ with the mean value x_C. Meanwhile, $k(x_C - x_{PC})^2$ could be interpreted as voter's skepticism towards the platform proposed by the challenger. Thus, the more the challenger deviates away from his historical platform or his party's platform the greater is the uncertainty with which he will be perceived by the voters. By introducing voter risk aversion towards uncertainty, this framework constrains the challenger's ability to propose any platform by making the voters suspicious (risk averse) about the challenger and his platform.

In contrast to Chen and Emerson, I apply the same variance concept to the incumbent but without the *intrinsic* utility v. This variance, then, represents voter disutility associated with the incumbent choosing platform x_I that deviates from the promised platform x_{PI}. I interpret the departure from the promised platform ($(x_{PI} - x_I)$) as legislative shirking that adversely affects voter utility. This legislative shirking specification can include the incumbent's pursuit of his own ideology, rent-seeking, or whatever else the incumbent does that adversely affects voter utility. The greater is $k(x_I - x_{PI})^2$ the greater is voter disutility from the incumbent's shirking. I assume that incumbent shirks in the direction away from the median voter or $(x_{PI} - x_I) > 0$ so that the incumbent is forced to trade off some of his potential votes for some amount of legislative shirking. In other words, the incumbent's platform x_I must be always to the left of x_{PI} if he chooses to shirk. If $(x_{PI} - x_I) < 0$ and $x_{PI} < 1/2$, the problem would be trivial because vote and shirking maximizing would become identical and maximizing x_I would be the dominant strategy. This would mean that there is no tradeoff between pursuing legislative shirking and maximizing votes. Now, voter x's utility functions associated with each candidate can be written as:

$$u_x(x_C) = -v - k_C(x_C - x_{PC})^2 - (x_C - x)^2 \quad (1)$$

$$u_x(x_I) = -k_I(x_{PI} - x_I)^2 - (x_I - x)^2 \quad (2)$$

Define x_C as the platform chosen by the challenger. Define v as a fixed level of voter disutility from *intrinsic* uncertainty associated with the challenger and $k(x_C - x_{PC})^2$ as the disutility of voters from *extrinsic* uncertainty caused by the challenger's strategic positioning. Also, define x_I as the incumbent's strategic platform chosen to be implemented during his term in office and x_{PI} as the platform promised by the incumbent in the previous election. Assume that both x_{PC} and x_{PI} are given exogenously. Now, define $\bar{x}$ such that it is the position of the voter who is indifferent between the incumbent and the challenger, which yields the following expression:

$$-k_I(x_{PI} - x_I)^2 - (x_I - \bar{x})^2 = -v - k_C(x_C - x_{PC})^2 - (x_C - x)^2 \quad (3)$$

Solving this expression for $\bar{x}$ yields:

$$\bar{x} = \frac{x_I{}^2 + k_I x_{PI}{}^2 - 2k_I x_{PI} x_I + k_I x_I{}^2 - x_C{}^2 - v - k_C x_C{}^2 + 2k_C x_C x_{PC} - k_C x_{PC}{}^2}{2(x_I - x_C)} \tag{4}$$

In accordance with the earlier assumptions, the share of votes obtained by the incumbent is determined by this CDF:

$$\int_0^{\bar{x}} f(x)dx = F(\bar{x}) \tag{5}$$

The share of votes obtained by the challenger is then:

$$\int_{\bar{x}}^1 f(x)dx = 1 - F(\bar{x}) \tag{6}$$

Now, think of the competition between the incumbent and the challenger as a sequential Stackelberg game. The incumbent chooses his platform x_I first. The challenger observes the incumbent's choice and chooses his platform x_C based on x_I. The incumbent, in turn, chooses the optimal x_I taking into account the challenger's response.

To solve this game, I let the challenger to maximize his vote share $1 - F(\bar{x})$ with respect to x_C. Solving the first-order condition for x_C yields the following positive root (the negative root is discarded as meaningless).

$$x_C{}^* = \frac{x_I + k_C x_I + \sqrt{(-(k_C + 1)(2k_C x_{PC} x_I - k_C x_{PC}{}^2 - k_C x_I{}^2 - v + k_I x_{PI}{}^2 - 2k_I x_{PI} x_I + k_I x_I{}^2))}}{k_C + 1} \tag{7}$$

Then, substitute $x_C{}^*$ in (4) to get the vote maximizing objective function for the incumbent. Now, let's specify the objective function for the incumbent in such a way as to give the incentive to trade votes in exchange for shirking (or endogenous rents):

$$U_I = \bar{x} + (x_{PI} - x_I) \tag{8}$$

The above function says that the incumbent maximizes both ego-rents ($\bar{x}$) from holding office and endogenous rents from legislative shirking ($((x_{PI} - x_I))$). The incumbent maximizes $\bar{x}$ by choosing such a platform (x_I) that yields $\bar{x} > 1/2$ or victory in the election. The incumbent also maximizes $(x_{PI} - x_I)$ by choosing such a platform (x_I) that increases the rents from shirking ($((x_{PI} - x_I))$). Thus, the incumbent maximizes U_I with respect to x_I, and then solves for x_I in order to get the optimal platform that guarantees his reelection. Thus, the optimal platform of the incumbent is:

$$x_I^* = \frac{k_C^2(k_I - 1)x_{PC} - \sqrt{k_C^2(k_C(k_I - 1) + k_I)(k_I v + k_C(k_I(x_{PC} - x_{PI})^2 - v)} - k_I^2 x_{PI} + k_C k_I (x_{PC} + x_{PI} - k_I x_{PI})}{k_C^2(k_I - 1) - k_C(k_I - 2)k_I - k_I^2} \quad (9)$$

The above expression is the incumbent's optimal platform x_I^* that maximizes votes and legislative shirking simultaneously. One can substitute this expression into $\bar{x}$ or equation (4) and plug in various parameters to see for which values the incumbent wins the election. The incumbent wins the election if $\bar{x} > 1/2$. Because the expressions for $\bar{x}$ and x_I^* are so cumbersome and complex, I use numerical simulations to determine what values $\bar{x}$ and x_I^* can take on for different parameter values of $x_{PI}, x_{PC}, k_I, k_C,$ and v. Using a numerical simulation will allow to examine what the model says about the tradeoff between vote maximizing and legislative shirking at the optimum. Intuition should help choosing some reasonable parameter values. For example, one would expect that x_I^* should increase (i.e. shirking would decrease) with higher values of k_I and lower values of v, x_{PC}, x_{PI}, and k_C. Let's see if this intuition is supported by numerical simulations.

For sufficiently small values of v and certain values of x_{PC} and x_{PI} (for example, $v \leq 0.1$, x_{PI}=1/3, and x_{PC}=2/3) the simulation results suggest that $\frac{dx_I^*}{dk_I} > 0$ and

$\frac{dx_I^*}{dk_C} < 0$, while $\bar{x}$ is within the logical policy range [0, 1]. For lower values of v and higher values of x_{PC} and x_{PI} (within the assumed restriction placed on x_{PC} and x_{PI} previously) these relationships also seem to hold. However, these relationships do not hold globally when $k_C = k_I$ because the simulation yields no value for x_I^* and $\bar{x}$ due to a division by zero. Otherwise, the obtained signs make sense. One would expect that as shirking becomes more costly for the incumbent (i.e. either k_I rises or k_C and v fall) and causes higher disutility to voters, the incumbent will choose such platform x_I^* that is closer to x_{PI} (i.e. that reduces shirking). Thus, for certain parameter values, the simulations appear to support the idea that the incumbent with some incumbency advantage or political capital (higher k_C and lower k_I) can afford to trade some of potential votes for legislative shirking as was expected.

For higher values of v and x_{PI}, however, $\frac{dx_I^*}{dk_I}$ and $\frac{dx_I^*}{dk_C}$ reverse signs. Also, for some x_I^* and $\bar{x}$ solutions do not exist because of complex numbers in square roots. Higher values of v and x_{PI} often result in $\bar{x}$ exceeding the assumed platform range of [0, 1]. These problems cast doubt on the results obtained with higher values of v and x_{PI}, which makes sense because for sufficiently high values of v and x_{PI} the incumbent is guaranteed a victory regardless of his or the challenger's proposed platforms. In other words, these bizarre results imply that competition between the incumbent and the challenger is virtually nonexistent.

Another interesting simulation result shows that $\frac{dx_I^*}{dk_C}$ is greater than $\frac{dx_I^*}{dk_I}$ in absolute value, which implies that the incumbent is likely to shirk more with higher k_C than with comparable values of k_I. If incumbent can influence k_C and k_I via campaigning (assuming for a moment that k_C and k_I are endogenous), than the incumbent would choose negative campaigning (i.e. to increase k_C) as his dominant strategy. With risk-averse voters, this means that negative campaigning is more effective than positive campaigning.

Given the assumptions about political competition in this paper, my model shows that for certain parameter values the incumbent would find it optimal to trade some of his votes for the ability to shirk and would still be able to win the election. One could introduce uncertainty, information costs, and make some variables endogenous to enrich the model. For instance, the variances associated with the legislators and the information costs could be endogenous in the resources that the challenger and the incumbent have and would be willing to use in campaigning. The recent presidential campaign inspires to interpret the catchphrases like "flip-flopper" and "way out of the mainstream" as attempts on the part of the incumbent to increase v and k_C for the challenger.

The model has some testable predictions. High incumbency reelection rates in themselves may not be indicative of shirking, but they may be indicative of the incumbency advantage. The incumbency advantage expressed in terms of electoral votes, on the other hand, may be indicative of political capital that incumbents can spend to pursue legislative shirking or their own ideological preferences. One can think of this incumbency advantage in terms of low k_I relative to high k_C and v in my model. If an incumbent has a high level of incumbency advantage, it means that he or she can spend much of it in exchange for shirking, which would mean losing some votes as long as he or she can still get 51% of votes. This suggests a possible test for legislative shirking by looking at how much victory margins incumbents give up in exchange for shirking.

4.3 Data Description and Empirical Estimates

My model predicts that incumbents will spend some of their victory margin or surplus votes in exchange their ideological preferences or legislative shirking. If this is so, we should be able to observe that an increase in the incumbency advantage does not translate into any significant increases in votes for incumbents. Incumbents need to get only 50% plus one of the votes to win the election. In the real world, we would have to consider the effect of uncertainty on reelection prospects, which suggests a positive risk premium in terms of the extra votes ensuring a shirking incumbent against losing the election in the presence of uncertainty. A shirking incumbent, therefore, would try to get more than 51% of votes to ensure his victory. After the risk premium, the extra votes that an incumbent can get can be spent on shirking. This line of reasoning suggests that if there is some shirking optimization going on in the U.S. House of Representatives, we should see no significant relationship between incumbency advantage and incumbents' victory margins. In addition, I also test for how changes in the incumbency advantage affect the aggregate ideological score for Democrats and Republicans. If the ideological score shows a significant deviation away from the median voter in response to a larger incumbency advantage, this would suggest that efficient shirking occurs. Hence, I propose two different hypotheses to test for the presence of shirking in the U.S. House of Representatives at the aggregate level.

Hypothesis 1: An increase in the incumbency advantage should have no significant effect on the share of votes incumbents win.

Hypothesis 2: An increase in the incumbency advantage should have a significant effect on incumbent's voting platform in the direction away from the median voter (i.e. in the direction of increasing legislative shirking).

Most of the aggregate data in this study comes from *Vital Statistics on Congress* by Ornstein et al. (2002). The scarcity of some aggregate data for the U.S. House of Representatives puts a serious constraint on the sample size and the choice of applicable estimation techniques. The sample used in the first hypothesis testing spans from 1958 to 2000 in two year intervals, while the sample used in the second hypothesis testing spans from 1948 to 2000 in two year intervals. Since this is time series data it might exhibit some dynamic properties that I need to test for in order to choose the appropriate estimators. I also test for endogeneity issues, omitted variable bias, and general model specification. Because of the small samples used in this paper, the time series tests may not be very reliable. The endogeneity and model specification tests could become more useful in this case. The tests suggest using 2SLS-IV besides in addition to ARCH and ARIMA. I also use this diverse set of estimation techniques as a robustness check.

For the first hypothesis testing, I propose this basic OLS regression:

$$votes = \beta_0 + \beta_1 reelected + \beta_2 redistrict + \beta_3 turnout + \beta_4 bills + \beta_5 swing + \varepsilon \, . \qquad (10)$$

Where *votes* is the dependent variable measuring the percentage of incumbents in the U.S. house of Representatives reelected with at least 60% of the votes, *reelected* is the incumbent reelection rate, *redistrict* is the dummy variable controlling for redistricting, *turnout* is the voter turnout rate, *bills* is the average number of introduced bills per Congressman, *swing* is the percentage of seats that changed party. Other control variables such as the unemployment rate and real per capita GDP are included in some regressions, but they do not change the main findings. The key variable of interest here, however, is *reelected*. It represents the apparent re-election success of incumbents (84% on average during 1948-2000) and a variety of underlying factors contributing to it embodied in the so called incumbency advantage. If, for some reason, the incumbency advantage rises and leads to higher incumbent re-election rates, then we might expect incumbents to win elections with higher victory margins or higher vote shares. If there is no statistically significant relationship between these two variables, then my first hypothesis that incumbents give up some of their surplus votes in exchange for shirking cannot be rejected. As evident in Table A.19, this basic OLS specification passes the link specification and omitted variable tests. However, the *reelected* variable suspected of being endogenous is likely to be exogenous according to the Durbin-Wu-Hausman endogeneity test (Table A.19) when instrumented with the *bills* and *swing* variables.

[Table A.19 about here]

The next step is to test for possible autocorrelation and unit root presence in the data. As Table A.20 shows, the *votes* variable is trend stationary, serially uncorrelated and exhibits no ARCH effects according to the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, Breusch-Godfrey autocorrelation test, and Lagrange multiplier (LM) test for autoregressive conditional heteroskedasticity.[15] Moreover, the two series *votes* and *reelected* pass the Wald cointegration test, Breusch-Pagan independence of residuals test, multivariate Portmanteau (Ljung-Box) white noise in residuals test, and Omnibus multivariate normality of residuals test (Table A.20). All of the above tests suggest that given the limited number of observations, the suggested OLS model should do fine as a benchmark estimator for the proposed hypothesis testing.

[Table A.20 about here]

I also fit the model using the ARIMA estimator and the OLS with Newey-West standard errors robust to heteroskedastic and AR (1) error structure. The estimates from different regressions are presented in Table A.21 and show no significant effect of *reelected* on *votes*, thereby failing to reject the proposed hypothesis that the higher incumbency advantage provides incumbents with freedom to shirk more. The coefficient for *reelected* is positive but less than one, which suggests that even if *reelected* would appear statistically significant, a rise in the incumbency advantage would not translate one-for-one to higher victory margins since some of this incumbency advantage would be spent on shirking. The only variable that appears

[15] The Augmented Dickey-Fuller unit root test using Generalized Least Squares (DF-GLS) shown in Table A.20 detects no unit root presence in the first lag, but cannot reject the unit roots in the subsequent lags. The Schwarz criterion and Ng-Perron test shown in Table A.20 suggest that the optimal econometric model should have one lag.

statistically significant in Table A.21 regressions is real GDP per capita, which is positively related to the share of incumbent reelected with at least 60% of the votes.

[Table A.21 about here]

For the second hypothesis testing, I propose this basic OLS regression:

$$ideology = \beta_0 + \beta_1 reelected + \beta_2 redistrict + \beta_3 turnout + \beta_4 bills + \beta_5 swing + \varepsilon \,. \qquad (11)$$

Where *ideology* is the combined Democrat and Republican aggregate ideological (D-NOMINATE) score for the House party coalitions that were developed by Poole and Rosenthal (2001) and taken from *Vital Statistics on Congress* by Ornstein et al. (2002). All other variables are the same as before. The ideological scores can range from -0.5 to 0.5. Poole and Rosenthal assign the negative range to liberal ideologies and positive range to conservative ideologies. I combine the scores for the two party coalitions by taking a simple average of their absolute values in order to get a measure of ideological divergence that would be robust to changes in median voter preferences. The higher is the average combined ideological score the wider is the ideological distance between the two parties. This measure is alternative to subtracting Democrat ideology scores (absolute value) from Republican in order to show the degree of ideological divergence away from the median voter towards more partisan ideologies on both sides of the spectrum.

To determine the appropriate estimator(s) for testing the second hypothesis I also utilize the same specification, endogeneity, and time series tests.[16] The evidence presented in Table A.19 suggests that the 2SLS-IV estimator is preferred to a single stage OLS estimator in testing

[16] The abovementioned OLS model does not pass the link specification and omitted variable tests shown in Table A.19. However, the exogeneity of the *reelected* variable is rejected by the Durbin-Wu-Hausman endogeneity test, first, at the 10% level of significance and then 5% level of significance when unemployment rate is included as one of the regressors. The *redistrict* and *swing* instrumental variables appear statistically significant and negatively related to the endogenous *reelected* variable. The two instrumental variables also pass the Sargan over identification test as can be seen in Table A.19.

the second hypothesis that a rise in the incumbency advantage leads to greater legislative shirking reflected in the diverging ideological scores.

[Table A.19 about here]

The next step is to examine the time series aspects of this dataset.[17] The time series and endogeneity tests indicate that the ARCH (1/1) and 2SLS-IV with Newey-West AR (1) and heteroskedasticity corrected standard errors appear as suitable estimators for testing the second hypothesis.

[Table A.20 about here]

The estimates used in the second hypothesis testing are shown in Table A.22. All three regressions (2SLS, 2SLS with Newey-West errors, and ARCH) in Table A.22 indicate that the *reelected* variable is positively and significantly related to the combined House Democrat and Republican ideological score. The highest statistical significance (significant at 1% level) for the *reelected* variable occurs in the ARCH regressions (Column 3, Table A.22). These results appear robust to estimation techniques and support the proposed hypothesis that a rise in the incumbency advantage leads to more self-interested ideological pursuits by incumbents.

[Table A.22 about here]

A number of other interesting inferences can be made from the same three regressions. Redistricting can be used by one party against another party as a tool to eliminate the toughest competitors—the other party's incumbents. Reinforcing this intuitive explanation is the negative and statistically significant relationship between the *redistrict* and *reelected* variables in the

[17] The Wald and the likelihood ratio cointegration tests shown in Table A.20 suggest that the two series, *ideology* and *reelected*, appear to be cointegrated. When the two series are non-stationary, but a linear combination of them is stationary, they are said to be cointegrated. In fact, both the *ideology* series and its residuals do not pass the KPSS trend stationary test. However, the *ideology* series passes the Breusch-Pagan independence of residuals test, multivariate Portmanteau (Ljung-Box) white noise in residuals test, and Omnibus test of multivariate normality of residuals as shown in Table A.20. However, the DF-GLS test shows unit root presence in the series and the Lagrange multiplier (LM) test for autoregressive conditional heteroskedasticity indicates significant ARCH effects (Table A.20) suggesting using an ARCH estimator. The Schwarz criterion (7) and modified AIC (1) tests show in Table A.20 disagree on the optimal number of lags that should be included in the model. Given the small number of observations, I lean towards the smaller lag suggested by AIC.

2SLS-IV regressions (Columns 1 and 2, Table A.22). Also, the *swing* variable is a significant instrument for the *reelected* variable suggesting that structural changes or shifts in the ideological preferences of voters have a negative effect on the incumbent reelection rates (possibly working through the same redistricting mechanism). Another significant variable that is negatively related to the combined average ideology score is voter turnout (Column 2, Table A.22). The rational voter model developed by Downs (1957) suggests that if voters observe a significant difference between the candidates, they have more incentives to show up to vote in that election. Thus, the more dissatisfied the voters are the more likely they are to show up to vote, which forces the opposing parties to scale back their ideological departures from the median voter. This provides additional support for my argument that the higher the incumbency induced ideological divide (legislative shirking) leads to greater voter turnout in subsequent elections as statistically significantly observed only in the regressions accounting for autoregressive error structure (Columns 2 and 3, Table A.22). Another statistically significant variable in all three regressions in Table A.22 that is negatively related to the combined average ideology score is the average number of bills introduced per Congressman. This relationship has a very intuitive explanation. As the ideological divide between the two House parties grows, it becomes harder to strike a consensus and pass the newly introduced bills. This is an example of reverse causality issue though.

4.4 Concluding Remarks

This paper examines the implications of the incumbency advantage for legislative shirking. The model developed in this paper rests on the assumption that incumbents in determining their optimal political platform face a tradeoff between maximizing votes and perusing their own ideological preferences while in office. As a result, incumbents are willing to sacrifice some surplus votes in exchange for engaging in legislative shirking. Numerical simulations show that for some reasonable parameter values an incumbent can trade some surplus votes for being able to enact a political platform that is closer to his ideological preferences rather than to his/her constituents.

This empirical analysis of aggregate data for the U.S. House of Representatives supports the model's prediction that incumbents sacrifice some of their surplus votes in exchange for shirking or implementing legislation closer to their own ideological preferences. I find evidence that a rise in the incumbent reelection rates leads to greater ideological departure from the median voter preferences in the U.S. House of Representatives. Overall, the evidence in this paper suggests that an increase in the incumbency advantage exacerbates the agency problem between legislators and their constituents. In other words, the empirical evidence suggests that the electoral market for the U.S. House of Representatives is not very effective in preventing incumbents from legislative shirking.

Chapter 5

Summary and Conclusions

The field of political economy addresses a variety of interesting and relevant issues within the nexus between political and economic forces, and the existing research on political regimes and their effects on government policy and economic well-being is both vast and impressive. Nonetheless, not all of the questions in this field have been completely answered, and not all of its puzzles have been resolved. Therefore, any new piece of knowledge that is added to this field can help its scholars to uncover the new inner workings of the world and can also provide them with new areas for further study. My dissertation is no exception to this rule. This is how the progress is made, and the frontier of knowledge is pushed even farther.

The previous chapters of my dissertation intend to answer the following three general questions: (1) Do political and economic freedoms affect the value of life in military conflicts through military capital intensity? (2) How do arms trade and military spending affect economic growth? (3) Does the incumbency advantage increase the level of legislative shirking in the representative democracy? While these may appear as seemingly unrelated issues, they do intersect when one thinks about how different political forces come together to influence military expenditures, which affect battlefield casualties, economic growth, and general well-being. Some creative theoretical modeling and sophisticated econometric techniques are used to answer these questions.

To answer the first question, I develop a theoretical model to analyze if democracies and dictatorships, with volunteer or conscription army, value life differently in military conflicts. The model allows for formal theoretical insights into how economic and institutional factors may affect military capital intensity and subsequent combat casualties. The empirical evidence presented in this work supports the model's prediction that more democratic nations with volunteer armies experience lower conflict casualties due to higher military capital intensity. Higher reliance on conscription leads to lower military capital intensity, while higher real GDP per capita leads to higher military capital intensity. Economic freedom is found to be thirteen times more potent than democracy in increasing military capital intensity. One intriguing finding is that political and economic freedoms converge in their effects on military capital intensity and battlefield deaths in the long-run.

Following the Dunne et al. (2005) suggestion to study the growth effects of military spending in the Solow and Barro growth models, I answer the second question and bring the new evidence I discover into the old "butter vs. guns" debate. I accomplish this by controlling for the interaction between arms trade and military spending, and I use sophisticated econometric techniques to show how the two variables interact to influencing economic growth. I find that higher military spending and net arms exports result in lower economic growth, but higher military spending is less detrimental to growth when a country is a large net arms exporter. I also find that democratic regimes are inversely related to the size of military spending as a share of GDP, which provides some economic explanation for why democracy appears to be correlated with per capita income.

To answer the third question, I develop a theoretical model to analyze the implications of incumbency advantage for legislative shirking. The model shows that an incumbent finds it optimal to spend some surplus votes on legislative shirking in the presence of risk-averse voters. The empirical estimates, based on the aggregate time series data for the U.S. House of Representatives, show that a rise in the incumbent reelection rate increases the ideological departure of incumbents from the median voter. Additional empirical estimates indicate that a change in the incumbency advantage has no significant effect on the share of votes that incumbents win. This evidence suggests that the incumbency advantage leads to more legislative shirking, as evidenced by the departure from the median voter ideological preference. This evidence suggests that representative democracy can be vulnerable to rent-seeking or ideologically driven legislation in the presence of significant incumbency advantage.

The above chapters provide analyses of several important issues that are typically addressed under the realm of political economy. By applying standard economic theory and sophisticated econometric techniques, I have secured some interesting findings on the inner workings of democracy and its affects on military spending and economic growth. My results confirm that political regimes play an important role in government policy formulation and economic well-being. However, a democratic regime, with all of its benefits, may not be a good substitute for the free market since politicians have strong incentives to pursue their own agendas at the expense of public interests. Important knowledge might be gained by analyzing the dynamic properties of conflict under different political regimes. An empirical analysis of what determines arms exports would also be warranted.

Appendix

Table A.1
Variable Description and Sources (Pooled Sample)

Variable Name (source)	Description	Mean (st. dev.)
Democracy (1)	Democracy score consists of the two indexes (*DEMOC*) and (*AUTOC*) taken from Polity IV database and combined according to the formula $[(DEMOC_i - AUTOC_i)+10]/2$ that is used extensively in the literature. These two 11-point indexes of political regimes are based on formal constraints on the executive (*AUTOC*) and institutional support for democracy (*DEMOC*).	5.88 (3.82)
Conscription (2)	Index of reliance on military conscription (0-10). A rating of 10 assigned to countries without military conscription. The index is subtracted 10 and multiplying by (-1) for easier interpretation. Since conscription is available in 5-year intervals, average values are used for those conflicts that fall between the intervals.	5.41 (4.52)
Economic Freedom (2)	The freedom index identifies seven broad areas of economic freedom. It is available in 5-year intervals from 1970 to 1995 for some 123 countries. Average values are used for those conflicts that fall between the intervals. Since conscription is a component of the economic freedom index, it is factored out from the index.	5.56 (1.25)
GDP/Capita (3) (Residual)	Real GDP per capita (chained) in the first year of conflict. Residual from regressing real GDP/Capita on democracy and economic freedom indexes is used in the regressions to avoid biasing the estimates. GDP/Capita is used as a proxy for relative capital abundance (wealth) in a given country.	5,834 (6,487)
Population (3)	Country population (in thousands) in the first year of conflict. Since countries with larger populations may arguably experience more casualties, it is reasonable to normalize conflict deaths by dividing it by a country’s population.	126,010 (245,149)
ME/Mil. Personnel (4)	Military expenditures (in constant dollars) divided by military personnel, in the first year of conflict. This variable is a proxy for capital intensity of military forces given the limitations of military data.	16,535 (30,481)
Capability (4)	Capability variable is the Composite Index of National Capability (CINC) in the first year of conflict. It is computed as the weighted average of a state’s total population, urban population, iron and steel production, energy consumption, military personnel, and military expenditure during 1816-2001.	0.03 (0.05)
Urban Population (4)	Country’s urban population (in thousands) in the first year of conflict. Urban population may proxy for a number of factors like education, life expectancy, industrialization, development, and concentrated availability of citizens who could be easier mobilized during conflict.	20,207 (33,109)
Duration (5)	Conflict duration measured in calendar years from the first year to the last.	5.50 (6.71)
Civil War (5)	Dummy variable for civil war.	0.63 (0.48)
Deaths (5)	The best available estimate of the total number of battlefield deaths (both military and civilian) for a given country in a given conflict.	4,671 (19,176)

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3. Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002.
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5. Gleditsch, Nils Petter; Peter Wallensteen, Mikael Eriksson, Margareta Sollenberg & Håvard Strand, 2002. "Armed Conflict 1946–2001: A New Dataset", *Journal of Peace Research* 39(5): 615–637.

Table A.2
Correlation Matrix (Pooled Sample)

	Democracy	Conscription	Freedom	GDP/Capita
Democracy	1.0000			
Conscription	-0.2625	1.0000		
Freedom	0.5650	-0.1043	1.0000	
GDP/Capita	0.6272	-0.0294	0.7357	1.0000

Table A.3
Correlation Matrix (Cross-Country Average Sample)

	Democracy	Conscription	Freedom	GDP/Capita
Democracy	1.0000			
Conscription	-0.0494	1.0000		
Freedom	0.6231	-0.0118	1.0000	
GDP/Capita	0.7384	0.0805	0.7418	1.0000

Table A.4
Single-Stage Robust Regressions (Dep. Var.: Deaths/Conflict Duration)

	Sample: Pooled	Sample: Cross-Country
Estimator	Robust	Robust
Democracy	-2.96 (1.99)	-21.27*** (7.99)
Economic Freedom	-21.89** (8.79)	2.40 (28.94)
Conscription	3.32** (1.53)	-3.81 (4.26)
GDP/Capita (Residual)	-0.01*** (0.00)	-0.01 (0.01)
Capability	396** (168)	4,932*** (719)
Civil War	27.58** (12.94)	-119** (54)
ME/Mil. Personnel	0.00 (0.00)	-0.00 (0.00)
Constant	147*** (40)	323* (163)
F-statistic	5.14***	11.07***
Observations	169	75

Standard errors are in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%.

Table A.5
Single-Stage Regression Specification Tests (After OLS Estimation)

	Sample: Pooled	Sample: Cross-country
Observations	169	75
Link test for model specification:		
Prob > F	0.00	0.00
R-squared	0.15	0.21
y_hat	0.19 (0.38)	0.05 (0.62)
y_hatsq	0.0005** (0.0002)	0.0009 (0.0005)
Ramsey RESET test--Ho: model has no omitted variables:		
Prob > F	0.01	0.23

Standard errors are in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%.

Table A.6
Testing for Endogeneity of Military Capital Intensity (After 2SLS-IV procedure)

H_0: Regressor is exogenous		
Observations: 196 Sample: Pooled	Wu-Hausman F test	Durbin-Wu-Hausman chi-sq test
P-value[1]	0.02073	0.01723
P-value[2]	0.05566	0.05159

[1]Instruments used: democracy.
[2]Instruments used: democracy, economic freedom, conscription, GDP/capita (Residual).

Table A.7
Determinants of Battlefield Deaths, Pooled Sample, 1950-2002

	(1) 2SLS-IV (OLS)	(2) 2SLS-IV (OLS)	(3) 2SLS-IV (Robust)	(4) 2SLS-IV (Median)	(5) 2SLS-IV (Median)
1st Stage Estimates. Dependent variable: ME/Mil. Personnel					
Duration	-382*** (140)	-406** (201)	-92 (70)	-139 (134)	-139 (134)
Capability	-117,626*** (22,506)	-187,420*** (48,341)	-47,988** (16,762)	-104,638*** (25,843)	-104,638*** (25,843)
Civil War	3,919** (1,952)	1,639 (2,941)	298 (1,020)	-339 (2,042)	-339 (2,042)
Urban Population	0.24*** (0.03)	0.20*** (0.05)	0.05** (0.02)	0.08** (0.03)	0.08** (0.03)
Democracy	3,147*** (240)	-260 (424)	508*** (147)	638** (292)	638** (292)
Economic Freedom	-	19,940*** (1,254)	8,328*** (435)	13,999*** (860)	13,999*** (860)
Conscription	-	-1,804*** (289)	-434*** (100)	-877*** (199)	-877*** (199)
GDP/Capita (Residual)	4.66*** (0.17)	4.45*** (0.29)	2.06*** (0.10)	3.15*** (0.19)	3.15*** (0.19)
Constant	11,540*** (1,610)	-97,209*** (7,489)	-34,447*** (2,600)	-63,991*** (5,134)	-63,991*** (5,134)
F-statistic	154.77***	82.28***	150.82***	-	-
R-squared	0.75	0.81	-	0.47	0.47
	Deaths	Deaths	Deaths	Deaths	Deaths/ Mil. Personnel
2st Stage Estimates. Dependent variable:					
ME/Mil. Personnel	-0.09*** (0.03)	-0.07*** (0.02)	-0.003*** (0.001)	-0.003*** (0.001)	-0.00006*** (0.00001)
Duration	1,093*** (373)	599*** (189)	-4.51** (1.61)	32.47*** (2.87)	0.13*** (0.05)
Capability	16,863 (16,145)	51,430 (48,957)	1,977*** (380)	1,349** (683)	-7.26 (11)
Civil War	485 (1,187)	980 (1,079)	79*** (24)	114** (42)	1.35** (0.71)
Urban Population	-0.03* (0.02)	-0.05* (0.03)	-0.0006* (0.0004)	-0.00 (0.00)	-0.00003*** (0.00001)
Constant	167 (704)	1,290 (782)	94*** (24)	53 (41)	3.07*** (0.68)
F-statistic	3.90***	4.16***	11.39***	-	-
R-squared	0.16	0.17	-	0.01	0.01
Observations	311	169	169	169	169

Notes: Standard errors are shown in parentheses. The OLS regressions use robust standard errors to correct for heteroskedasticity. Pseudo R-squared are reported for median regressions. Significance levels: *** at 1%, ** at 5%, and * at 10%. Hansen J statistic (over-identification test of all instruments) for regression (2) has a P-value of 0.42 implying that the instruments cannot be rejected.

Table A.8
Determinants of Battlefield Deaths, Cross-Country Sample, 1950-2002

	(6) 2SLS-IV (OLS)	(7) 2SLS-IV (OLS)	(8) 2SLS-IV (Robust)	(9) 2SLS-IV (Median)	(10) 2SLS-IV (Median)
1st Stage Estimates. Dependent variable: ME/Mil. Personnel					
Duration	64 (186)	-73.58*** (230)	60 (116)	21 (174)	21 (174)
Capability	10,3170 (66,551)	68,701 (68,773)	255,999 (168,335)	194,556*** (26,190)	194,556*** (26,190)
Civil War	6,063** (2,947)	4,822 (3,102)	526 (1,566)	818 (2,296)	818 (2,296)
Urban Population	0.07 (0.09)	0.12 (0.10)	-0.20 (0.15)	-0.12** (0.05)	-0.12** (0.05)
Democracy	3,440*** (292)	2,199*** (394)	1,706*** (202)	2,421*** (305)	2,421*** (305)
Economic Freedom	-	8,082*** (1,469)	4,578*** (763)	4,508*** (1,079)	4,508*** (1,079)
Conscription	-	-531** (247)	-277** (125)	-366* (198)	-366* (198)
GDP/Capita (Residual)	2.83*** (0.27)	3.07*** (0.32)	1.82*** (0.17)	2.32*** (0.26)	2.32*** (0.26)
Constant	6,895*** (2,481)	-40,582*** (9,373)	-18,138*** (4,836)	-17,109** (6,959)	-17,109** (6,959)
F-statistic	54.48***	40.54***	54.76***	-	-
R-squared	0.81	0.83	-	0.58	0.58
2st Stage Estimates. Dependent variable:					
	Deaths	Deaths	Deaths	Deaths	Deaths/Mil. Personnel
ME/Mil. Personnel	-0.33** (0.16)	-0.13** (0.04)	-0.03*** (0.01)	-0.04** (0.02)	-0.0005** (0.0001)
Duration	2,240** (1,060)	501** (200)	41** (17)	131*** (44)	0.68 (0.83)
Capability	135,101** (67,560)	65,360*** (18,489)	36,992*** (6,259)	41,544*** (8,692)	294* (163)
Civil War	6,396 (4,071)	1,977 (1,396)	-544** (233)	-324 (602)	13 (11)
Urban Population	-0.07 (0.08)	-0.04 (0.03)	-0.01** (0.01)	-0.02* (0.01)	-0.00 (0.00)
Constant	-6,418 (5,232)	598 (1,187)	820*** (215)	660 (552)	8.54 (9.87)
F-statistic	1.30	7.09***	16.13***	-	-
R-squared	0.27	0.19	-	0.07	0.02
Observations	84	75	75	75	75

Notes: Standard errors are shown in parentheses. The OLS regressions use robust standard errors to correct for heteroskedasticity. Pseudo R-squared are reported for median regressions. Significance levels: *** at 1%, ** at 5%, and * at 10%. Hansen J statistic (over-identification test of all instruments) for regression (7) has a P-value of 0.33 implying that the instruments cannot be rejected.

Table A.9
Featured Conflicts and Their Participants, Pooled Sample

Conflict Case	Freq.	Percent	Conflict Case	Freq.	Percent
Algeria (FIS)	1	0.32	Iran (Mujahideen e Khalq) 2000-1	1	0.32
Algeria v. Morocco 1963	2	0.64	Iran v. Iraq 1974	1	0.32
Angola (UNITA) I	2	0.64	Iraq v. Kuwait & Multinational Coalition	22	7.07
Angolan Independence	1	0.32	Israel v. Egypt 1969-70	2	0.64
Argentina (ERP, Montoneros)	1	0.32	Israel v. Egypt, Iraq, Jordan, Syria 19	4	1.29
Argentina (Military) 1963	1	0.32	Israel v. Egypt, Syria 1973	5	1.61
Argentina vs UK 1982	2	0.64	Israel, UK & France v. Egypt 1956	4	1.29
Azerbaijan (OPON)	1	0.32	Kenya (Military faction) 1982	1	0.32
Bangaldesh (Chittagong Hill Insurgency)	1	0.32	Korean War	13	4.18
Bolivia (ELN)	1	0.32	Laos Civil War II	1	0.32
Brunei rebellion v. UK	1	0.32	Laos v. Thailand 1986-8	1	0.32
Burkina Faso (Popular Front)	1	0.32	Lebanon (Independent Nasserites)	1	0.32
Burkina Faso v. Mali 1985	2	0.64	Lebanon Civil War 1975-90	4	1.29
Burundi Civil War 1990	1	0.32	Madagascar (Monima Nations)	1	0.32
Cambodian Civil War I	1	0.32	Malaysia (CCO)	1	0.32
Cameroon (Military Faction)	1	0.32	Malaysia (CPM) 1974-5	1	0.32
Cameroon Independence	1	0.32	Malaysia (CPM) 1981	1	0.32
Cameroon v. Nigeria 1996	2	0.64	Mali (Tuareg Insurgency) 1990	1	0.32
Chad v. Libya 1987	1	0.32	Mali (Tuareg Insurgency) 1994	1	0.32
Chad v. Nigeria 1983	1	0.32	Mau Mau Rebellion	1	0.32
Chadian Civil War I	2	0.64	Mexico (Chiapas) 1994	1	0.32
Chadian Civil War II	1	0.32	Morocco (Military faction) 1971	1	0.32
Chile (Military Faction)	1	0.32	Mozambique Civil War 1976-92	3	0.96
China v. Burma 1969	1	0.32	Mozambique Indep.	1	0.32
China v. India 1962	2	0.64	Namibia Indep.	1	0.32
China v. Taiwan 1952-5	2	0.64	Nepal (Nepali Congress) 1960-2	1	0.32
China v. Taiwan 1958	3	0.96	Nepal Civil War 1997-2002	1	0.32
China v. USSR 1969	1	0.32	Nicaragua (Contras) 1981-9	1	0.32
China v. Vietnam 1978-9	1	0.32	Nicaragua (FSLN) 1978-9	1	0.32
China v. Vietnam 1980-1	1	0.32	Niger (Toubou) 1996-7	1	0.32
China v. Vietnam 1983-4	1	0.32	Niger (Tuareg Insurgency) 1990-2	1	0.32
China v. Vietnam 1986-8	1	0.32	Niger (Tuareg Insurgency) 1994	1	0.32
Congo/Zaire (Katanga)	1	0.32	Niger (Tuareg Insurgency) 1997	1	0.32
Cuba (National Revolutionary Council)	1	0.32	Nigeria (Biafra)	1	0.32
Cyprus (Turkish Cypriots & Turkey)	1	0.32	Nigeria (Military faction) 1966	1	0.32
Dominican Republic (Military Faction)	1	0.32	Oman (Dhofar Rebellion)	1	0.32
Ecuador v. Peru 1995	2	0.64	Oman Civil Strife 1957	1	0.32
Egypt (Islamists)	1	0.32	Pakistan (Baluchi Insurgency)	1	0.32
Egypt v. UK 1951-2	2	0.64	Pakistan (East Pakistan)	1	0.32
El Salvador (Military Faction)	1	0.32	Pakistan (Islamists)	1	0.32
El Salvador v. Honduras 1969	2	0.64	Panama (Military faction)	1	0.32
Ethiopia (Eritrea)	1	0.32	Panama v. USA 1989	2	0.64
Ethiopia (Military Faction)	1	0.32	Papua New Guinea (Bougainville) 1989-90	1	0.32
Ethiopia (Oromiya) II	1	0.32	Papua New Guinea (Bougainville) 1992-6	1	0.32
Ethiopia Civil War 1976-91	1	0.32	Paraguay (Military faction) 1954	1	0.32
Ethiopia v. Somalia 1973	1	0.32	Paraguay (Military faction) 1989	1	0.32
Ethiopia v. Somalia 1983	1	0.32	Peru (MIR , Tpac Amaru , ELN) 1965-6	1	0.32
Ethiopia v. Somalia 1987	1	0.32	Peru (Sendero Luminoso)	1	0.32
Gabon (Military faction)	2	0.64	Philippines (Mindanao) 1970-90	1	0.32
Ghana (Military Faction) 1983	1	0.32	Philippines (Mindanao) 1993-2002	1	0.32
Ghana (Military faction) 1966	1	0.32	Philippines (NPA) 1972-95	1	0.32
Ghana (Military faction) 1981	1	0.32	Philippines (NPA) 1997	1	0.32

Table A.9
Featured Conflicts and Their Participants (Continued)

Grenada (US Invasion)	1	0.32	Philippines (NPA) 1999-2002	1	0.32
Guatemala (Conservative Coup and Army)	1	0.32	Russia (Parliamentary forces)	1	0.32
Guatemalan Civil War (1965-95)	1	0.32	Rwanda Civil War 1990-4	1	0.32
Guinea (Military Faction) 2000	1	0.32	Rwanda Civil War 1998-2002	1	0.32
Guinea (Military faction) 1970	1	0.32	Senegal (Casamance) 1990	1	0.32
Guinea Bissau Independence	1	0.32	Senegal (Casamance) 1992-3	1	0.32
Haiti 1991	1	0.32	Senegal (Casamance) 1995	1	0.32
Honduras v. Nicaragua 1957	2	0.64	Senegal (Casamance) 1997-2001	1	0.32
India (Assam)	1	0.32	Sierra Leone Civil War 1991-2000	2	0.64
India (Jarkhand) 1993	1	0.32	Somalia Civil War 1981-96	21	6.75
India (Kashmir)	1	0.32	South Africa Civil War 1991-93	1	0.32
India (Manipur Insurgency) 1982-9	1	0.32	Spain & France vs. Moroccan insurgency	2	0.64
India (Manipur Insurgency) 1991-4	1	0.32	Spain (ETA) 1980-1	1	0.32
India (Manipur Insurgency) 1997-2000	1	0.32	Spain (ETA) 1987	1	0.32
India (Mizoram) 1966-8	1	0.32	Spain (ETA) 1991-2	1	0.32
India (NNC, NSCN) 1956-9	1	0.32	Sri Lanka (JVP) 1971	1	0.32
India (NNC, NSCN) 1961-8	1	0.32	Sri Lanka (JVP) 1989-90	1	0.32
India (NNC, NSCN) 1989-97	1	0.32	Sri Lanka (Tamil Insurgency) 1983-2001	2	0.64
India (Naxalites & CPI-M) 1967-72	1	0.32	Syria (Military faction) 1966	1	0.32
India (Naxalites, PWG, MCC) 1989-94	1	0.32	Syria (Muslim Brotherhood) 1966	1	0.32
India (Naxalites, PWG, MCC) 1996-2002	1	0.32	Tajikistan (Movement for Peace) 1998	1	0.32
India (Sikh Insurgency)	1	0.32	Thailand (CPT) 1970-82	1	0.32
India (Tripura Insurgency) 1978-88	1	0.32	Thailand (Military faction)	1	0.32
India (Tripura Insurgency) 1993	1	0.32	Togo (MTD) 1986	1	0.32
India (Tripura Insurgency) 1995-2002	1	0.32	Tunisia (Tunisienne Restance Army)	1	0.32
India v. Pakistan 1964	1	0.32	Tunisia v. France 1961	2	0.64
India v. Pakistan 1965	1	0.32	Turkey (Devrimci Sol)	1	0.32
India v. Pakistan 1984	2	0.64	Turkey (Kurdish Insurgency)	1	0.32
India v. Pakistan 1987	2	0.64	UK v. Cypriot Insurgents	1	0.32
India v. Pakistan 1989-90	2	0.64	UK v. S Yemen Insurgency	1	0.32
India v. Pakistan 1992	2	0.64	US v. Puerto Rican Nationalists	1	0.32
India v. Pakistan 1996-2002	2	0.64	Uganda (Military faction) 1971	1	0.32
Indonesia (Aceh) 1989-91	1	0.32	Uganda (Military faction) 1977	1	0.32
Indonesia (Aceh) 1999-2002	1	0.32	Uganda (UPA) 1972	1	0.32
Indonesia (East Timor) 1975-89	1	0.32	Uganda Civil War 1978-9	2	0.64
Indonesia (East Timor) 1992	1	0.32	Uganda Civil War 1981-91	1	0.32
Indonesia (East Timor) 1997-8	1	0.32	Uganda Civil War 1994-2002	1	0.32
Indonesia (West Papua) 1965	1	0.32	United Kingdom (N. Ireland) 1971-93	1	0.32
Indonesia (West Papua) 1976-8	1	0.32	United Kingdom (N. Ireland) 1998	1	0.32
Iran (Kurdish Insurgency) 1966-8	1	0.32	Venezuela (Military faction) 1962	2	0.64
Iran (Kurdish Insurgency) 1990	1	0.32	Vietnam War	6	1.93
Iran (Kurdish Insurgency) 1993	1	0.32	Western Sahara Insurgency	2	0.64
Iran (Mujahideen e Khalq) 1986-8	1	0.32	Yemen (Royalists) 1962-70	1	0.32
Iran (Mujahideen e Khalq) 1991-3	1	0.32	Yemen Civil War 1994	1	0.32
Iran (Mujahideen e Khalq) 1991-3	1	0.31	Yugoslavia (Kosovo)	17	5.47
			Total	**311**	**100.00**

Notes: "Best" estimates of total battlefield deaths for a country or country's military in the above conflicts are used in both samples in this paper. The cross-country sample uses country averages of these battle deaths. Data source: Polity IV Project.

Table A.10
Countries Featured in the Average Cross-Country Sample

Algeria	Guinea	Peru
Angola	Haiti	Philippines
Argentina	Honduras	Poland
Australia	Hungary	Portugal
Azerbaijan	India	Russia
Bangladesh	Indonesia	Rwanda
Belgium	Iran	Senegal
Bolivia	Israel	Sierra Leone
Botswana	Italy	South Africa
Burkina Faso	Jordan	Spain
Burundi	Kenya	Sri Lanka
Cameroon	Madagascar	Sweden
Canada	Malaysia	Syria
Chad	Mali	Taiwan
Chile	Mauritania	Tajikistan
China	Mexico	Tanzania
Colombia	Morocco	Thailand
Czech Republic	Mozambique	Togo
Denmark	Nepal	Tunisia
Ecuador	Netherlands	Turkey
Egypt	New Zealand	Uganda
El Salvador	Nicaragua	United Kingdom
Ethiopia	Niger	United States
France	Nigeria	Venezuela
Gabon	Norway	Yemen
Germany	Pakistan	Zimbabwe
Ghana	Panama	Total number of countries: 84*
Greece	Papua New Guinea	
Guatemala	Paraguay	

* When dropped, missing values for the economic freedom index and conscription index reduce this sample to 75 countries.

Table A.11
Variable Description and Summary Statistics

Variable Name	Variable Description	Mean (Std. Dev.)
$growth_{it}$ (2)	Non-overlapping five-year average growth rate of real GDP per capita (Laspeyres).	2.46 (2.17)
y_{it-1} (2)	Real GDP per capita in the year preceding the five-year average period.	9.09 (0.80)
s_{it} (2)	Five-year average investment as a share of GDP (Laspeyres).	21.42 (6.36)
$n_{it}+g+\delta$ (2)	Five-year average population growth rate $n + 0.05$ (the assumed value for $g+\delta$).	1.83 (0.15)
$popg_{it}$ (2)	Five-year average population growth rate.	1.27 (0.94)
h_{it} (6)	Average number of years of schooling for both sexes 25 years of age or older.	6.59 (2.63)
m_{it} (5)	Five-year average military expenditure as a share of GDP.	3.69 (3.13)
nax_{it} (4)	Five-year average of net arms exports computed as (arms exports - arms imports)/ (arms exports + arms imports), all in current values.	-0.39 (0.63)
$naxpos_{it}$	Five-year average of net arms exports computed as (arms exports - arms imports)/ (arms exports + arms imports). Set equal to zero when the value is negative.	0.14 (0.28)
$nampos_{it}$	Five-year average of net arms imports computed as (arms imports - arms exports)/ (arms exports + arms imports). Set equal to zero when the value is negative.	0.53 (0.41)
dem_{it} (1)	Democracy score. Consists of the two indexes (*DEMOC*) and (*AUTOC*) taken from Polity IV database and combined according to the commonly used formula [(*DEMOCi-AUTOCi*)+10]/2.	2.01 (0.63)
pop_{it} (2)	Natural log of total country population.	17.19 (1.23)
$cinc_{it}$ (3)	Natural log of the Composite Index of National Capability (CINC). It is computed as the weighted average of a state's total population, urban population, iron and steel production, energy consumption, military personnel, and military Expenditure.	-4.74 (1.14)

1. Polity IV Project. 2000. *Political Regime Characteristics and Transition, 1800–2000*. Electronic data. (version p4v2000). College Park, Md.: CIDCM, University of Maryland.
2. Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), October 2002.
3. Singer, J. David, Stuart Bremer, and John Stuckey. (1972). "Capability Distribution, Uncertainty, and Major Power War, 1820-1965." in Bruce Russett (ed) *Peace, War, and Numbers*, Beverly Hills: Sage, 19-8.
4. Compiled from various issues of World Military Expenditures and Arms Transfers (WMEAT) by the U.S. Arms Control and Disarmament Agency.
5. Compiled by Dunne et al. (2004) from Stockholm Peace Research Institute (SIPRI) Yearbooks.
6. Barro and Lee (1994) data can be found at: http://www.cid.harvard.edu/ciddata/ciddata.html

Figure A.1
Arms Trade in Developed Countries: 1989-1999

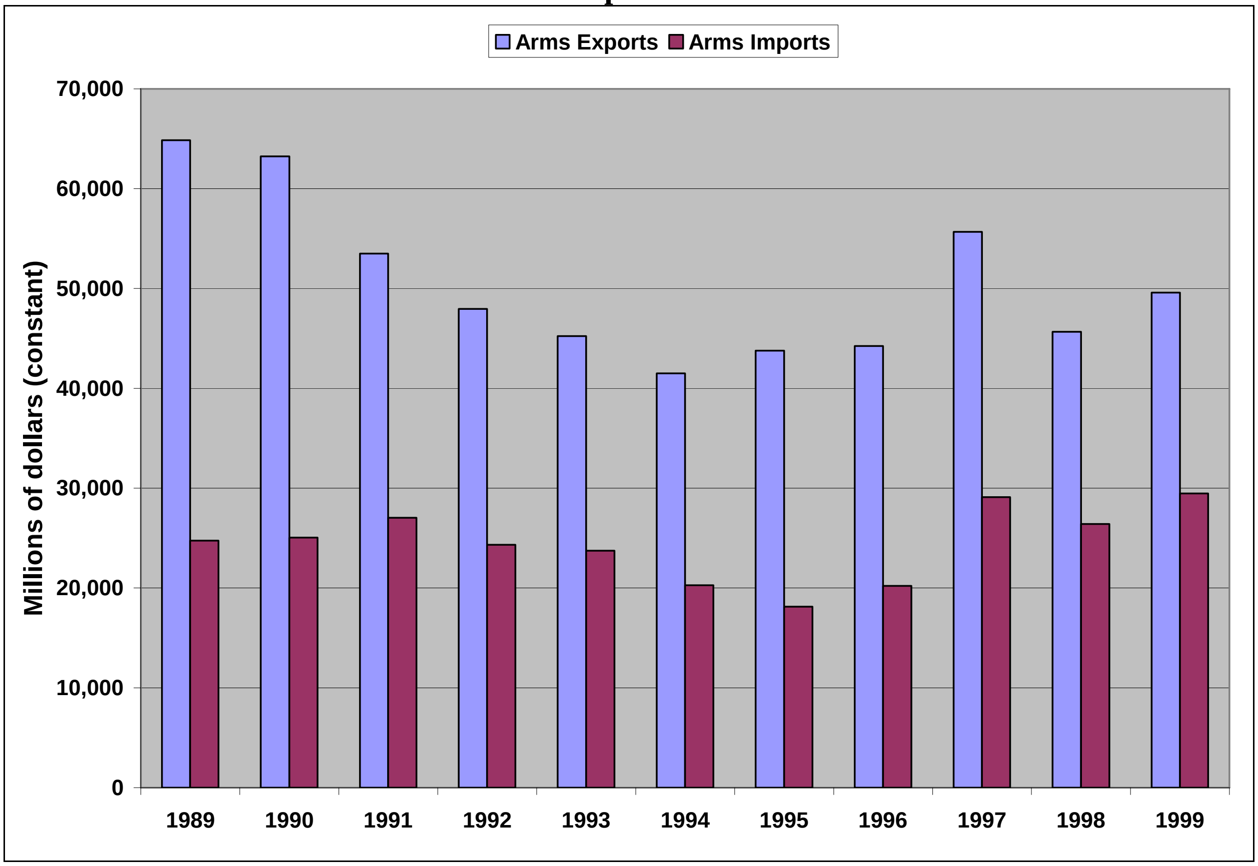

Table A.12
Countries Featured in the Sample

Country	Freq.	Percent	Cum.
Argentina	7	3.57	3.57
Australia	7	3.57	7.14
Belgium	7	3.57	10.71
Brazil	7	3.57	14.29
Canada	7	3.57	17.86
Chile	7	3.57	21.43
Denmark	7	3.57	25.00
France	7	3.57	28.57
Germany	7	3.57	32.14
Greece	7	3.57	35.71
India	7	3.57	39.29
Israel	7	3.57	42.86
Italy	7	3.57	46.43
Japan	7	3.57	50.00
Korea, Republic of	7	3.57	53.57
Malaysia	7	3.57	57.14
Netherlands	7	3.57	60.71
Norway	7	3.57	64.29
Pakistan	7	3.57	67.86
Philippines	7	3.57	71.43
Portugal	7	3.57	75.00
South Africa	7	3.57	78.57
Spain	7	3.57	82.14
Sweden	7	3.57	85.71
Turkey	7	3.57	89.29
United Kingdom	7	3.57	92.86
United States	7	3.57	96.43
Venezuela	7	3.57	100.00
Total	196	100.00	

Table A.13
Pair-wise Correlations of Variables

	growth	$\ln y_{it-1}$	$\ln s_{it}$	$\ln(n_{it}+g+\delta)$	$\ln h_{it}$	$\ln m_{it}$	nax_{it}
$growth_{it}$	1.0000						
$\ln y_{it-1}$	-0.2037*	1.0000					
$\ln s_{it}$	0.3323*	0.5713*	1.0000				
$\ln(n_{it}+g+\delta)$	-0.0496	-0.6735*	-0.4499*	1.0000			
$\ln h_{it}$	-0.0940	0.8257*	0.4900*	-0.5208*	1.0000		
$\ln m_{it}$	-0.0074	-0.0006	0.0289	0.0969	0.1200	1.0000	
nax_{it}	-0.0830	0.4461*	0.1480*	-0.3872*	0.3651*	0.0574	1.0000
dem_{it}	-0.0972	0.3464*	0.1495*	-0.2760*	0.3489*	-0.0966	0.2704*
pop_{it}	0.0238	-0.3552*	-0.3356*	0.1499*	-0.2815*	-0.3010*	0.1878*
$cinc_{it}$	-0.0298	0.1168	-0.0578	-0.1424*	0.0079	-0.1184	0.4132*

* Significant at 5%.

Table A.14
The Growth Effects of Military Spending and Net Arms Exports in the Augmented Solow Growth Model

	1	2	3	4
$\ln y_{it-1}$	-5.28*** (0.54)	-5.32*** (0.56)	-5.51*** (0.56)	0.72*** (0.06)
$\ln s_{it}$	4.51*** (0.31)	4.59*** (0.37)	4.78*** (0.37)	0.30*** (0.03)
$\ln(n_{it} + g + \delta)$	-4.28*** (1.28)	-2.96** (1.39)	-2.17 (1.40)	-0.21** (0.08)
$\ln h_{it}$	0.23 (0.57)	-0.12 (0.63)	-0.17 (0.62)	0.03 (0.07)
$\ln m_{it}$	-1.53*** (0.48)	-2.16*** (0.51)	-1.71*** (0.54)	-0.09** (0.04)
$\ln m_{it-1}$	0.49 (0.44)	1.17*** (0.43)	0.80* (0.45)	-0.01 (0.04)
nax_{it}	-	-0.32 (0.24)	-1.03*** (0.38)	-0.01 (0.02)
nax_{it-1}	-	-0.33 (0.22)	-0.28 (0.21)	0.01 (0.02)
$(nax_{it})(\ln m_{it})$	-	-	0.63** (0.27)	-0.01 (0.02)
Constant	35.54*** (7.78)	36.55*** (10.39)	35.80*** (11.19)	0.01 (0.01)
Estimator	FGLS	FGLS	FGLS	GMM
F-test (Prob>F)	0.00	0.00	0.00	0.00
Sargan test (p-level)	-	-	-	0.74
Arellano-Bond (p-level)	-	-	-	0.84
Observations	196	196	196	140

Notes: Dependent variable: five-year average growth rate of real per capita GDP from 1965 to 2000. Standard errors shown in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%. FGLS uses errors corrected for panel-specific heteroskedasticity and AR (1) autocorrelation with adjusted Durbin-Watson computation. Null hypothesis in two-step Arellano-Bond test: no second-order autocorrelation in the residuals. A-B one-step GMM estimator uses robust errors with Huber-White sandwich. Instruments include: *dem*, *pop*, *cinc*.

Table A.15
The Growth Effects of Military Spending and Net Arms Exports in the Reformulated Barro Growth Model

	1	2	3	4
$\ln y_{it-1}$	-5.18*** (0.55)	-5.26*** (0.55)	-5.41*** (0.57)	0.67*** (0.09)
s_{it}	0.25*** (0.02)	0.25*** (0.02)	0.26*** (0.02)	0.02*** (0.00)
$popg_{it}$	-0.85*** (0.22)	-0.83*** (0.21)	-0.78*** (0.23)	-0.03* (0.02)
$\ln h_{it}$	-1.01 (0.62)	-0.76 (0.64)	-0.82 (0.64)	0.04 (0.08)
m_{it}	-0.08** (0.04)	-0.09** (0.04)	-0.05 (0.07)	-0.01 (0.01)
nax_{it}	-	-0.36 (0.24)	-0.51* (0.30)	-0.02 (0.02)
$(nax_{it})(m_{it})$	-	-	0.04 (0.06)	0.00 (0.00)
Constant	37.61*** (7.95)	38.47*** (7.95)	38.82*** (8.34)	0.02 (0.01)
Estimator	FGLS	FGLS	FGLS	GMM
F-test (Prob>F)	0.00	0.00	0.00	0.00
Sargan test (p-level)	-	-	-	0.89
Arellano-Bond (p-level)	-	-	-	0.33
Observations	196	196	196	140

Notes: Dependent variable: five-year average growth rate of real per capita GDP from 1965 to 2000. Standard errors shown in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%. FGLS uses errors corrected for panel-specific heteroskedasticity and AR (1) autocorrelation with adjusted Durbin-Watson computation. Null hypothesis in two-step Arellano-Bond test: no second-order autocorrelation in the residuals. A-B one-step GMM estimator uses robust errors with Huber-White sandwich. Instruments include: *dem*, *pop*, *cinc*.

Table A.16
The Effects of Military Spending, Net Arms Exports and Imports on Growth in the Augmented Solow Growth Model

	5	6	7	8
$\ln y_{it-1}$	-4.83*** (0.55)	-5.18*** (0.53)	-2.94*** (0.40)	0.69*** (0.07)
$\ln s_{it}$	4.34*** (0.41)	4.91*** (0.41)	4.65*** (0.56)	0.29*** (0.03)
$\ln(n_{it} + g + \delta)$	-2.14 (1.48)	-1.59 (1.37)	-4.04*** (1.38)	-0.18** (0.08)
$\ln h_{it}$	-0.29 (0.65)	-0.91 (0.61)	1.15** (0.55)	0.04 (0.07)
$\ln m_{it}$	-2.72*** (0.53)	-3.13*** (0.63)	-2.16** (0.87)	-0.09** (0.04)
$\ln m_{it-1}$	1.55*** (0.43)	1.34*** (0.46)	0.87 (0.67)	-0.00 (0.05)
$naxpos_{it}$	0.15 (0.42)	-2.20*** (0.60)	-2.83 (1.80)	-0.07 (0.06)
$naxpos_{it-1}$	0.29 (0.36)	0.29 (0.30)	1.03 (0.72)	0.04 (0.04)
$nampos_{it}$	0.62** (0.33)	0.18 (0.55)	-1.34 (0.96)	0.00 (0.03)
$nampos_{it-1}$	0.98*** (0.35)	0.83*** (0.31)	0.06 (0.51)	-0.00 (0.05)
$(naxpos_{it})(\ln m_{it})$	-	2.83*** (0.50)	2.54* (1.33)	0.10 (0.10)
$(nampos_{it})(\ln m_{it})$	-	0.26 (0.39)	1.44* (0.76)	0.03 (0.03)
Constant	30.05*** (8.43)	26.97*** (7.78)	21.57*** (4.79)	0.01 (0.01)
Estimator	FGLS	FGLS	GLS-RE	GMM
F-test (Prob>F)	0.00	0.00	0.00	0.00
Hausman test (Prob>chi2)	-	-	0.00	-
Baltagi-Wu LBI (Durbin-Watson statistic)	-	-	2.32 (2.06)	-
Sargan test (p-level)	-	-	-	0.99
Arellano-Bond (p-level)	-	-	-	0.81
Observations	196	196	196	140

Notes: Dependent variable: five-year average growth rate of real per capita GDP from 1965 to 2000. Standard errors shown in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%. FGLS uses errors corrected for panel-specific heteroskedasticity and AR (1) autocorrelation with adjusted Durbin-Watson computation. Random effects (GLS-RE) regression estimated with GLS and AR (1) error structure. The Baltagi-Wu LBI statistic is equivalent to the Durbin-Watson statistic: if it is far below 2.00 then a correction for serial correlation is necessary. Null hypothesis in two-step Arellano-Bond test: no second-order autocorrelation in the residuals. A-B one-step GMM estimator uses robust errors with Huber-White sandwich. Instruments include: *dem*, *pop*, *cinc*.

Table A.17
The Growth Effects of Military Spending, Net Arms Exports and Imports in the Reformulated Barro Growth Model

	5	6	7	8
$\ln y_{it-1}$	-5.02*** (0.56)	-5.29*** (0.57)	-2.61*** (0.37)	0.63*** (0.09)
s_{it}	0.24*** (0.02)	0.27*** (0.02)	0.22*** (0.03)	0.01*** (0.00)
$popg_{it}$	-0.81*** (0.22)	-0.69*** (0.23)	-0.63*** (0.21)	0.04 (0.08)
$\ln h_{it}$	-0.77 (0.65)	-1.09* (0.65)	0.91* (0.52)	-0.03 (0.02)
m_{it}	-0.10** (0.04)	-0.13 (0.09)	-0.17 (0.11)	-0.01 (0.01)
$naxpos_{it}$	0.41 (.41)	-0.60 (0.62)	-1.59 (1.41)	-0.06 (0.05)
$nampos_{it}$	0.82** (0.32)	0.71 (0.44)	-0.82 (0.68)	0.02 (0.02)
$(naxpos_{it})(m_{it})$	-	0.40*** (0.15)	0.55* (0.30)	0.03 (0.02)
$(nampos_{it})(m_{it})$	-	0.03 (0.08)	0.17 (0.15)	0.00 (0.00)
Constant	34.08 (8.28)	-	21.22*** (2.93)	0.03* (0.01)
Estimator	FGLS	FGLS	GLS-RE	GMM
F-test (Prob>F)	0.00	0.00	0.00	0.00
Hausman test (Prob>chi2)	-	-	0.00	-
Baltagi-Wu LBI (Durbin-Watson statistic)	-	-	2.23 (1.95)	-
Sargan test (p-level)	-	-	-	0.98
Arellano-Bond (p-level)	-	-	-	0.22
Observations	196	196	196	140

Notes: Dependent variable: five-year average growth rate of real per capita GDP from 1965 to 2000. Standard errors shown in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%. FGLS uses errors corrected for panel-specific heteroskedasticity and AR (1) autocorrelation with adjusted Durbin-Watson computation. Random effects (GLS-RE) regression estimated with GLS and AR (1) error structure. The Baltagi-Wu LBI statistic is equivalent to the Durbin-Watson statistic: if it is far below 2.00 then a correction for serial correlation is necessary. Null hypothesis in two-step Arellano-Bond test: no second-order autocorrelation in the residuals. A-B one-step GMM estimator uses robust errors with Huber-White sandwich. Instruments include: *dem*, *pop*, *cinc*.

Table A.18
Link and Omitted Variable Tests of the Solow and Barro Style Regressions

	Solow	Barro
Link test for model specification:		
Prob > F	0.00	0.00
R-squared	0.68	0.65
y_hat	0.95***	0.91***
	(0.09)	(0.10)
y_hatsq	0.01	0.02
	(0.01)	(0.02)
Ramsey RESET test--Ho: model has no omitted variables:		
Prob > F	0.13	0.12

Standard errors are in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%.

Table A.19
Link Specification, Omitted Variable, and Endogeneity Tests

	Hypothesis/Model 1	Hypothesis/Model 2
Link test for model specification (after OLS)		
P-value	0.01	0.00
R-squared	0.42	0.79
y_hat	-0.71	-3.47**
	(6.50)	(1.36)
y_hatsq	1.24	7.53***
	(4.71)	(2.28)
Ramsey RESET test—H_0: model has no omitted variables		
P-value	0.75	0.01
Durbin-Wu-Hausman chi-sq test—H_0: reelected variable is exogenous		
P-value	0.68	0.08†
Sargan over-identification test of all instruments		
P-value	0.33	0.86

Notes: Standard errors are shown in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%.
†The Durbin-Wu-Hausman test P-value is 0.04 and Sargan test's P-value is 0.85 when unemployment rate is included as a regressor in the 2SLS-IV regression.

Table A.20
Autocorrelation and Unit Root Tests

	Hypothesis/Model 1	Hypothesis/Model 2
Breusch-Godfrey LM test for autocorrelation—H_0: no serial correlation		
P-value	0.23	0.00
Durbin's alternative test for autocorrelation—H_0: no serial correlation		
P-value	0.33	0.00
Lagrange multiplier test for autoregressive conditional heteroskedasticity (ARCH) H_0: no ARCH effects		
P-value	0.69	0.02
Cointegration likelihood ratio test		
P-value	0.143	0.351
Cointegration Wald test		
P-value	0.022	0.283
Breusch-Pagan independence of residuals test (optimal lag)		
P-value	0.125 (lag 3)	0.159 (lag 1)
Multivariate Portmanteau (Ljung-Box) white noise in residuals test (optimal lag)		
P-value	0.177 (lag 3)	0.196 (lag 1)
Omnibus test of multivariate normality of residuals (optimal lag)		
P-value	0.795 (lag 1)	0.871 (lag 1)
KPSS test—H_0: trend stationary		
KPSS test statistic	0.113	0.275***
KPSS test statistic —H_0: trend stationary in residuals		
KPSS test statistic	0.116	0.121*
Augmented Dickey-Fuller Generalized Least Squares (DF-GLS) test—H_0: unit root		
DF-GLS tau test statistic (lag 1)	*-3.567***	*-0.807*
DF-GLS tau test statistic (lag 2)	*-1.423*	*-0.923*
DF-GLS tau test statistic (lag 3)	*-1.351*	*-0.884*
DF-GLS tau test statistic (lag 4)	*-1.102*	*-0.785*
DF-GLS tau test statistic (lag 5)	*-1.543*	*-2.681**
DF-GLS tau test statistic (lag 6)	*-0.651*	*-2.794**
DF-GLS tau test statistic (lag 7)	*-0.667*	*-4.054****
DF-GLS tau test statistic (lag 8)	*-0.472*	*-3.152***
Optimal lag length (Ng-Perron seq t)	1	7
Minimum Schwarz criterion at lag	1	7
Minimum MAIC at lag	6	1

Notes: Significance levels at which H_0 is rejected: *** at 1%, ** at 5%, and * at 10%. Dickey–Fuller Generalized Least Squares (DF-GLS) is the Elliott, Rothenberg, and Stock (1996) approach of unit root testing and is preferred by many time series econometricians to the "first–generation" tests like that of Dickey and Fuller. The DF-GLS test is similar to the augmented Dickey-Fuller "t" test, but has the best overall performance in terms of small-sample size and power. Inferences drawn from the DF–GLS test are likely to be more robust than those based on the first–generation tests. Hence, DF–GLS should be your unit root test of choice, states Baum (2001).

Table A.21
Determinants of the Share of Incumbents in the House of Representatives Reelected with at Least 60% of the Votes, 1958-2000 (Hypothesis 1 Testing)

	1	2	3	4
Percent of incumbents reelected	0.26 (0.56)	0.61 (0.59)	0.61 (0.54)	0.13 (0.42)
Redistricting dummy	0.02 (0.06)	0.03 (0.06)	0.03 (0.05)	0.02 (0.04)
Voter turnout	-0.33 (0.24)	-0.11 (0.26)	-0.11 (0.23)	-0.00 (0.12)
Bills per Congressman	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.01)
Percent of seats that changed party	-0.43 (0.62)	0.08 (0.66)	0.08 (0.63)	1.06 (0.48)
Unemployment rate	-	0.02 (0.02)	0.02 (0.02)	-0.01 (0.02)
Real GDP/capita (in thousands)	-	0.009* (0.005)	0.009** (0.004)	0.00 (0.00)
Constant	0.68 (0.52)	-0.15 (0.70)	-0.15 (0.59)	(0.58) (0.65)
P-value (F test)	0.32	0.26	0.02	0.00
R-squared	0.29	0.42	-	-
Observations	22	22	22	22
Estimation Method	OLS	OLS	OLS (Newey-West)	ARIMA (1,0,0)

Notes: Dependent variable: percentage of incumbents reelected with at least 60% of the votes. Standard errors are shown in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%. Regression 3 utilizes Newey-West standard errors with assumed heteroskedastic and autocorrelated (up to lag 1) error structure.

Table A.22
Determinants of Combined Democrat and Republican Ideology in the House of Representatives, 1948-2000 (Hypothesis 2 Testing)

	1	2	3
Percent of incumbents reelected	0.33* (0.17)	0.33* (0.18)	0.38*** (0.03)
Redistricting dummy†	-	-	-
Voter turnout	-0.10 (0.09)	-0.10* (0.06)	-0.02 (0.06)
Bills per Congressman	-0.004*** (0.001)	-0.004*** (0.001)	-0.0015*** (0.0004)
Percent of seats that changed party†	-	-	-
Constant	0.16 (0.15)	0.16 (0.14)	-
P-value (F test)	0.00	0.00	0.00
R-squared	0.64	-	-
Observations	27	27	27
Estimation Method	2SLS-IV	2SLS-IV (Newey-West)	ARCH (1/1)

Notes: Dependent variable: Joint Democrat and Republican ideology index calculated as (|Dem| + Rep)/2. Robust standard errors are shown in parentheses. Significance levels: *** at 1%, ** at 5%, and * at 10%. †Instruments used in the 1st stage regression (both are negative and statistically significant at 1%) where endogenous variable is percent incumbents reelected. Regression 2 utilizes Newey-West standard errors with assumed heteroskedastic and autocorrelated (up to lag 1) error structure.

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