What goes up, must come down? The asymmetric effects of economic growth and international threat on military spending

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Abstract

Do considerations that cause military spending increases symmetrically cause spending cuts? Models of military spending that estimate a single effect for major independent variables implicitly assume that this is the case. In reality, the mechanisms that cause military spending increases do not always imply symmetrical cuts, and vice versa. This article examines two considerations widely held to influence military spending: economic growth and international threats. In both cases, there are reasons to suspect asymmetric effects on military spending. While recessions always create pressure for cuts in military spending, which frequently constitutes a substantial share of national budgets, economic growth does not necessarily imply a symmetric need for spending increases. Similarly, while national security policymakers, including the military, are likely to call for spending increases when international threats worsen, they have self-interested reasons to minimize the budgetary implications of declining threats. A cross-national analysis of military spending since World War II shows that economic decline has a larger impact on the military spending than economic growth. In regards to international threat, the findings are more complex. There is no evidence that international threat is related to changes in military spending in the short run, and little evidence of a long-run relationship. The threat variables appear to account for cross-sectional variation in military spending but not variation within each state over time. These results suggest military budgets require more time to recover from economic decline than benefit from economic growth as recessions can thus produce long deviations from the equilibrium relationship between the size of the economy and the military budget. This finding in military spending suggests consequences for our understanding the balance of power and power transitions.

Key Words: military spending, economic growth and decline, international threat

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Introduction

The automatic spending cuts to US military expenditures associated with the Budget Control Act of 2011, otherwise known as sequestration, raise important questions about changes in military spending (Belasco 2014). Quantitative research on military spending commonly emphasizes the causes of spending increases. Sequestration, however, suggests understanding military spending decreases is critical to our understanding of military power. Thus, we explore and test the symmetry of military spending. Put differently, when increases in a particular variable motivate spending increases, do decreases in that variable lead to similarly sized spending cuts?

We explore symmetry by examining two variables widely held to influence military spending: economic growth and international threats. An examination of the mechanisms linking these variables to military spending suggests asymmetric effects. Economic decline should produce larger changes in military spending than economic growth. A decline in the size of the economy almost always affects state revenue, forcing national leaders to choose between spending cuts, increasing debt, or higher taxes. Because there is often greater pressure for civilian spending on unemployment and the like during recessions, military spending is an inviting target for cuts. By contrast, economic growth does not produce symmetrical pressure for greater military spending. National defense is a public good. More spending is not necessarily required to provide the same level of this good when the economy grows. Economic decline thus puts different pressures on policymakers than does economic growth.

Increasing and declining international threats also imply asymmetric effects on military spending. The same state organizations that benefit from greater military spending are also heavily involved in assessing international threats. They are also professionally responsible for coping with both existing and emerging threats. When international threats become more serious,

they have strong incentives to point it out. On the other hand, when these same threats decline, these organizations have no symmetric incentive to seek cuts in their budget. Indeed, it makes more sense for them to warn of other potential threats in order to avoid budget cuts and remain prepared for any contingency.

To explore the presence of symmetry, our analysis relies principally on the military spending data assembled by the Stockholm International Peace Research Institute (SIPRI) (2016). Consistent with our hypothesis, we find economic decline has a much larger impact on the military budget than economic growth. Military budgets require more time to recover from an economic downturn than to benefit from economic growth. Recessions can thus produce long deviations from the equilibrium relationship between the size of the economy and the military budget. We find only limited evidence that international threat is related to military spending. Because other research has found threat to be a strong predictor of defense budgets (Nordhaus, Oneal, and Russett. 2012), this finding gives us pause. At a minimum, it suggests that there are important—and often overlooked—differences in the effects of key variables when they are evaluated across cases or over time. There are also implications for our understanding of balance of power and power transition theories.

Existing Military Spending Literature

There is a vast literature exploring the determinants of military spending. Yet, understanding relative symmetry or asymmetry is an unresolved question. How much states spend on defense varies across different states, regimes, and regions at the same point in time. The factors accounting for this variation can be subdivided into external or international variables and domestic variables. External variables that have been correlated with a state's military spending

include the state's overall strategic environment (Krell 1981, Lebovic and Ishaq 1997), the relative spending of its rivals (Hartley and Russett 1992, Hewitt 1992; Mintz and Ward 1989; Nordhaus et al. 2012) and strategic rivals (Dunne and Perlo-Freeman 2003; Fordham and Walker 2005; Rosh 1988), arms races (Fordham 2004; Ostrom and Marra 1986; Richardson 1960), alliances (Olsen and Zeckhauser 1966; Murdoch and Sandler 1984), and geography (Hewitt 1992). International economic conditions such as development aid (Collier and Hoeffler 2007) and sanctions and embargoes have also been found to impact spending (Batchelor et al. 2002).

Domestic factors—both political and economic—have been correlated with variation in defense spending. Military spending may increase as a political lever for counter-cyclical economic growth (Griffin et al.1982; Mintz and Stevenson 1995), or "Military Keynesianism" (Barro 1991; Mintz and Hicks 1984), either as an economic end in itself (Mintz and Hicks 1984; Mintz 1992; Whitten and Williams 2011), or to improve an incumbent's electoral chances (DeRouen and Heo 2001; Nincic and Cusack 1979). Political and institutional factors also explain defense spending, such as regime type (Goldsmith 2003; Lebovic 2001; Maizels & Nissanke 1986), types of autocracies (Bove and Brauner 2011; Fordham and Walker 2005), electoral systems (Mintz and Ward 1989, Zuk and Woodbury 1986), public opinion (Eichenberg and Stoll 2003; Hartley and Russett 1992), and civilian-military relations (Bove and Nistico 2014; Flynn 2014; Ostrom 1978). Lastly, socio-economic and organizational factors also partially explain spending, such as bureaucratic inertia (Looney and Frederiksen 2000; Marra 1985; Nordhaus et al. 2012), bureaucratic competition (Ball 1985; Schneider 1988); and parochial economic interests and corruption (Fordham 2008; Gupta et al. 2001; Hewitt 1992; Lindsay 1991; Rundquist et al. 1996; Thorpe 2014).

Two key variables in the literature are international threat environment and domestic political economic conditions. Yet, multifactor studies including both domestic and international variables have reached contradictory conclusions about the relative weight of international and domestic factors. For example, international factors such as arms races or international threat levels "lose statistical significance when controls are introduced for domestic political and economic influences. In peacetime, the level of defense burden that a state bears seems largely determined at home rather than by the international environment" (Goldsmith 2003, 551). Other studies find international security variables such as threat levels and rival military spending to be prior to domestic conditions (Hartley and Russett 1992; Nordhaus, Oneal, and Russett. 2012). In addition, there are contradictory conclusions regarding the strength of relative variables on a state's military spending over time. For example, many have explored the relationship between economic decline and the use of military spending for counter-cyclical economic growth. These works, however, often find that military spending is insignificantly correlated with subsequent economic contractions (e.g. Griffin, Devine and Wallace 1982, 119 and 121; Dunne 2013; Alexander 2015).

Finally, the existing literature does not account for the frequency of military spending cuts. While works theorizing decreases in spending are rare[1], military spending cuts are recurrent. For example, during the Cold War, the U.S. defense budget decreased 17 times, and "[i]n over 40 percent of the annual budgets for defense, the incremental expectation of a marginal increase on last year's base does not fit the change in defense spending" (Domke 1992,

[1] For an example of the few works that explore decreases in military spending see: Bueno de Mesquita, Morrow, Siverson and Smith 2004; Carter and Palmer 2015; and Cappella Zielinski and Schilde 2016. In addition, works on the "peace dividend" in the 1990s and early 2000s explored decreases in military spending (e.g. Ward and Davis 1992, Huang and Mintz 1990, Mintz and Stevenson 1995; Gleditsch et al 1996; Cohen, Mintz, Stevenson and Ward 1996) yet looked to understand the effect of military spending on economic growth, not how changes in economic performance effects military spending.

34). These cuts averaged between 2–5% (Zuk and Woodbury 1986). The frequency of decreases relative to increases suggests military spending are not two sides of the same coin.

The Case for Asymmetry

We examine two factors widely held to influence military spending: economic growth and international threats. We argue that the mechanisms linking these variables to military spending imply asymmetric effects. National decision makers and domestic institutions face different pressures when deciding how to respond to increases and decreases in these conditions.[2]

Economic growth

In comparisons across states, GDP is a strong predictor of defense expenditure: the higher a state's GDP, the more it spends on its military (e.g., Goldsmith 2003, Nordhaus, Oneal, and Russett 2012). Do increases and decreases in GDP have symmetric effects?

We propose that economic decline should have a greater effect on the budget than will economic growth. Low or negative economic growth will reduce government revenue and put downward pressure on the budget.[3] Economic contraction results in decreased state revenue as declining incomes lead to lower corporate, income, and value-added tax payments (Swank and Steinmo 2002, Morrisey et. al. 2016).[4] Revenue may be further reduced as states implement countercyclical tax cuts in order to stimulate the economy (Romer and Romer 2010).

[2] E.g. Ripsman et al. 2016, Mastanduno Lake and Ikenberry 1989, Lamborn 1983

[3] See Frey and Schneider 1978 for a discussion of the degree to which revenue, particularly in the form of tax receipts, is a budgetary constraint (Frey and Schneider 1978, 178).

[4] Developing countries are associated with higher revenue volatility in response to economic shocks due to smaller tax base (Morrissey et al 2016). That said, various developing countries, particularly in Latin American and Asia, have moved towards increasing their revenue reliance on 'hard taxes' such as personal and corporate income taxes and VAT taxes (Aizenman, Jinjarak, Kim and Park 2015; Barrientos

While economic contraction puts downward pressure on the entire budget due to decreased revenue, we expect military budgets to be more vulnerable to discretionary pressures. There are systematic tradeoffs against defense when budgets decline, specifically in favor of civilian spending (Mok and Duval 1984), particularly when spending is curtailed for deficit management (Ward and Mahajan 1984). In addition to deficit management and tax cuts, civilian spending rises via automatic fiscal stabilizers (Auerbach and Feenberg 2000) and other welfare transfer payments such as unemployment compensation, social retirement benefits, and health care (Pierson 2001; For developing countries and tax-financed transfers see Barrientos 2010, Barrientos 2013, Barrientos, Nino-Zarazua and Maitrot 2010).

While states may face pressure to use the military budget as a form of counter cyclical spending, we expect fiscal pressures on the civilian budget to be greater. This mechanism may be particularly strong in advanced market economies where voters remain strongly attached to the welfare state as "support for the welfare state is intense as well as broad . . . the welfare state's electoral base is not only enormous, but primed to punish politicians for unpopular initiatives" (Pierson 2001, 411-413).[5] Military spending is also not the most effective counter-cyclical fiscal policy tool. The economic benefits from nonmilitary spending (Pollin and Garrett-Peltier 2009) are at least 50 percent larger than those from defense spending during periods of normal growth (Auerbach and Gorodnichenko 2012). These findings align with the research demonstrating that the effects of counter-cyclical military spending policies on economic growth are mixed (e.g. Cappelen, Gleditsch and Bjerkholt 1984; Dunne, Smith and Willenbockel 2005; Bernauer, Koubi and Ernst 2009; Alptekin and Levine 2010).

2013, 180). Aid flows remain a significant contribution to financing government expenditure in low-income countries in sub-Saharan Africa but show a diminishing role in middle-income countries.

[5] See also Timmons 2005, Töngür and Elveren 2015, and Töngür, Hsu and Elveren 2015.

While economic decline puts particular fiscal pressures on the military budget, economic growth does not result in symmetrical upward pressures. While economic growth may lead to greater government revenue, there are many competing demands for its use, including tax cuts as well as other civilian programs.[6] In the developing world, social spending is correlated with growth (Granado et al. 2013), as gains from growth require leaders to increase spending on public employment (Nooruddin and Rudra 2014) or subsidies (Rickard 2012) for politically sensitive constituents. Along these lines, inflationary pressures have also been found to "have a parameter that was effectively zero and nonsignificant" to levels of military spending (Mintz and Ward 1989, 529–530).

In addition, although a fast growing state might have increasing people, resources, and interests to defend commensurate with its wealth (Sandler and Hartley 1995), we do not expect increasing GDP to logically necessitate more defense spending to the same degree decreasing GDP to necessitate cuts. As national defense is a public good (Dunne and Perlo-Freeman 2003), it does not cost more to defend a state just because its population or economy grows (Deger and Smith 1983). Once a public good exists, it can be made more broadly available "at little or no marginal cost" (Olson and Zeckhauser 1966, 27) resulting in a possible nonlinear or negative relationship between GDP and share of resources allocated for defense spending (Fordham and Walker 2005).

International Threat

One of the most salient findings in the military expenditure literature is that war onset and increased likelihood of military disputes increases defense spending (Nordhaus, Oneal, and Russett 2012). Do increasing and decreasing threat have symmetric effects?

[6] e.g., Wilson and Gordon 2003.

There are a number of reasons threat is unlikely to have a symmetrical effect on military spending. War onset, rivalry, or the increased chance of militarized disputes result in the establishment or expansion of bureaucracies and/or the acquisition of new foreign policy interests that make cuts difficult once threat declines. Institutions often persist or outlive their functional purpose resulting in a "ratchet effect" in military spending after wars (Lucier 1979; Moll and Luebbert 1980; Peacock and Wiseman 1961; Russett 1970). In addition, the prices of defense goods are asymmetrical between the beginning and ends of wars. Domestic political decisions during demobilization—such as rewarding returning soldiers with wage increases, protecting domestic defense industries from collapse, and managing the sales of surplus arms markets—can "limit falling prices when spending declines at the ends of wars" (Fordham 2003, 585).

Wars end and threats abate. However, as military budgets are the product of political institutions and bureaucratic organizations, political constituencies and standard operating procedures can affect them. Organizations and institutions cannot always be cut back by merely reversing the sequence of activity and resource allocation by which their parts were originally assembled. Organizations are "organic social wholes with emergent qualities that allow their parts to recombine into intricately interwoven semi-lattices when they are brought together" (Levine 1978, 317). Therefore to attempt to disaggregate and cutback on one element of such an intricate and delicate political and organization arrangement may jeopardize the functioning and equilibrium of an entire organization. Thus, decreases in spending do not necessarily follow a decline in international threats.

Moreover, expanding institutions have different dynamics from those that are contracting.

Increases and decreases in military expenditure and fiscal budgeting have different political and organizational dynamics within states. When budgets increase, they do not demand strategic reassessments, and any political debates over a budget concentrate on where best to allocate any increases. Decreasing budgets require more attention, political strategy, and organizational capacity than automatic institutionalized increases (Meese 2014). With decremental spending, there is rarely an obvious reduction of strategic ends to guide the reduction in means: "Decrementalism diverges from incrementalism in at least three significant ways. Decremental budgeting is redistribution rather than distributions; it is less stable than incremental decisions; and it generates more conflict" (Schick 1983; quoted in Meese 2014).

The suggestion that budget incrementalism has a different logic than decrementalism is also reinforced by the psychology of Prospect Theory, in which individuals and react differently to the prospect of losses than they do the chance of reaping gains. Individuals are risk-acceptant for losses and risk-averse for gains, and will pay a higher price and accept greater risks when faced with the prospect of losses, which threats imply, but are reluctant to take advantage of opportunities to reap gains at some risk (Goldman 2001). In government bureaucracies, public fiscal management, and individual risk-taking, increases have a completely different logic than decreases.

While prospect theory applies to individual reasoning, a similar logic applies to organizations, particularly those facing declining resources, "...the diminution of the cushion of spare resources necessary for coping with uncertainty, risking innovation, and rewarding loyalty and cooperation—presents for government a problem that simultaneously challenges the underlying premises and feasibility of both contemporary management systems and the institutions of pluralist liberal democracy" (Levine 1978, 316). Indeed, nearly everything about

the training and practice of public management strategies are predicted on assumptions of the continuing enlargement of public revenues and expenditures. These expansionist assumptions are particularly prevalent in public financial management systems that anticipate budgeting by incremental additions to a secure base (ibid).

Research Design

Our argument focuses on the effects of positive and negative changes in the economy and the international threat environment on military spending. The hypotheses we wish to test concern whether positive and negative changes in these independent variables have asymmetric effects on military spending.

> H1: Declines in the size of the economy will produce larger changes in military spending than will increases in the size of the economy.
>
> H2: Increases in the level of international threat will produce larger changes in military spending than will declines in the level of international threat

Because our hypotheses concern changes in military spending rather than its level, the annual change in military spending will be the dependent variable in our empirical analysis. In order to test whether positive and negative changes have asymmetric effects, we will use an interaction term. Our primary independent variables will be the change in GDP or the level of threat. We will interact these changes with a variable indicating whether they were more or less than zero. The basic model to test our hypothesis about the asymmetric effect of economic growth is thus:

(1) $\Delta MIL_{it} = \alpha_i + \beta_1 \Delta GDP_{it-1} + \beta_2 GROW_{it-1} + \beta_3(\Delta GDP_{it-1} * GROW_{it-1}) + \varepsilon_{it}$

In this model, ΔMIL indicates the change in military spending, ΔGDP is change in the size of the economy, and *GROW* is a dummy variable coded 1 when the ΔGDP is greater than zero. All of these are lagged to reflect the fact that the current year's budget is planned during the preceding year, and reflects the conditions prevailing then. The coefficient β_1 thus indicates the effect of the change in GDP on military spending when the economy is shrinking. (If it is, *GROW* will be equal to zero, so β_2 and β_3 would have no effect.) The significance test for the estimate of β_3 evaluates our hypothesis that the effect of the change in GDP is less when the economy is growing rather than shrinking. We expect it to be negative.

As the α_i in the equation suggests, the models will include fixed effects for each state to account for unmodeled heterogeneity. Substantively, we recognize that some countries tend to have larger or smaller swings in military spending than others for many reasons. A Hausman specification test of each of the models estimated below suggests that these fixed effects are warranted. Our hypotheses, which concern the response to change in key independent variables, concern change over time rather than cross-sectional differences in military spending. As we note in our survey of the literature, there are many substantively interesting reasons for these differences, but they are not our focus here. Fixed effects simplify our analysis, but we certainly do not mean to imply that cross-national variation is merely a nuisance.

The model will also include a lagged dependent variable and the lagged levels of military spending and GDP. The lagged dependent variable controls for autocorrelation, generally interpreted as bureaucratic inertia in models of military spending. The lagged levels control for the possibility that changes in military spending might be different at very high or very low levels of these variables. These variables are necessary for estimating the effects of our main

variables of interest, but they do not test our hypotheses. Equation 2 shows the model we will actually estimate, including these controls.

$$(2)\ \Delta MIL_{it} = \alpha_i + \beta_1 \Delta GDP_{it-1} + \beta_2 GROW_{it-1} + \beta_3(\Delta GDP_{it} * GROW_{it}) + \beta_4 \Delta MIL_{it-1} + \beta_5 MIL_{it-1} + \beta_6 GDP_{it-1} + \varepsilon_{it}$$

The addition of the lagged dependent variable and the lagged levels of military spending and GDP make equation 2 an error-correction model (Banerjee, et al. 1993; DeBoef and Keele 2008). Our hypothesis concerns the impact of changes in economic growth on the next budget year, but this model also allows us to test whether there is a long-run relationship between GDP and the level of military spending. Equation 2 implies the following long-run multiplier (LRM) for this relationship:

$\beta_6 / -\beta_5$

Though not immediately relevant to our hypothesis about the asymmetric effects of economic growth and decline, the long-run relationship between GDP and military spending is substantively very important. If growth and decline really do have different effects, as we expect, then efforts to estimate this relationship without considering these asymmetric effects could produce misleading results. We will consider this possibility in our empirical analysis.

Our analysis of changes in the international threat environment will follow exactly the same form as our analysis of economic growth. With threat level replacing GDP in equation 2, we get the following basic model:

$$(3)\ \Delta MIL_{it} = \alpha_i + \beta_1 \Delta THREAT_{it-1} + \beta_2 MORETHREAT_{it-1} + \beta_3(\Delta THREAT_{it-1} * MORETHREAT_{it-1}) + \beta_4 \Delta MIL_{it-1} + \beta_5 MIL_{it-1} + \beta_6 THREAT_{it-1} + \varepsilon_{it}$$

In this model, *THREAT* is the indicator of international threat and *MORETHREAT* is the dummy indicating whether it is increasing. As in our analysis of economic growth and decline,

we will consider the long-run relationship between the level of threat and the level of military spending. The presence of the lagged change in military spending, the lagged level of military spending, and the lagged level of threat produces an error-correction model exactly like the one in equation 2. We will once again check for a long-run relationship, and whether the expected asymmetry in the effect of increasing and decreasing international threat influences estimates of this relationship.

Data

Our analysis relies principally on the military spending data assembled by the Stockholm International Peace Research Institute (SIPRI) Military Expenditures Database, which covers the period from 1949 through 2015 (SIPRI 2016). For our analysis, we used the data SIPRI reported in constant 2014 dollars. We combined these figures with real GDP data assembled by Gleditsch (2002; 2015), which cover 1950 through 2011. We excluded states that maintained no military forces, where SIPRI judged the quality of the data to be especially uncertain, or where the base years for presenting real spending data changed over time.[7] All told, the data cover 154 countries for up to 61 years.

We use Nordhaus, Oneal, and Russett's (2012, 492–6) measure of threat to test the hypotheses about the asymmetric effects of this consideration. Their operationalization is attractive both because it reflects something important about the concept of threat—the likelihood of militarized conflict—and because they have shown that it is related to the level of military spending. Their indicator is the annual probability that a state will experience a

[7] These were Congo, Costa Rica, Gambia, Haiti (after 1994), Iceland, Iraq (before 2008), Libya, Myanmar (after 2005), Nicaragua, North Yemen, Peru, Somalia, Trinidad and Tobago, Uzbekistan, and Vietnam.

militarized dispute with another state with at least one fatality. They derive this probability from a model of dyadic interstate conflict similar to the one that Russett and Oneal (2001; Oneal and Russett 2005), among others, have used to test the democratic peace proposition and other claims. It includes both variables derived from research on the democratic peace and considerations commonly associated with realist thought, such as relative power and geographic proximity. They aggregate the predicted probability of conflict within each dyad from this "liberal-realist model" to estimate a probability that each state will experience at least one fatal dispute. They find that this variable, which they designate MID P-HAT, is strongly related to the logged level of military spending in each state (Nordhaus, Oneal, and Russett 2012, 501-2).

Empirical Results

We will begin our empirical analysis with the effect of economic growth and decline on military spending. We will then turn to the impact of international threats.

The Effect of Economic Growth and Decline

Table 1 presents the results of three models. The first estimates equation 2. The coefficient on the interaction term in this model tests hypothesis 1, that economic decline has a larger impact on the military budget than economic growth. The second model omits the interaction term, imposing the assumption that economic growth and decline have symmetric effects. The third model excludes economic growth and GDP altogether. It serves as a baseline to assess the value added by the additional independent variables in the other two models.

[Table 1 about here.]

The results support hypothesis 1. The coefficient on the interaction term is statistically significant and negative. Increasing GDP had less effect on military spending than did declining GDP. Indeed, increases in GDP had no statistically significant short-run effect on military spending. It is important to stress that this is only the immediate effect of a growing economy. The positive coefficient on the level of GDP, as well as the significant and positive long-run multiplier statistic, indicate that the level of GDP was positively associated with the level of military spending in the long run. However, economic downturns had nearly immediate effects on military spending, whereas the effect of economic growth took much more time. Recessions can thus produce long deviations from the equilibrium relationship between the size of the economy and the military budget.

How does this relationship look in realistic cases? To answer this question, Figure 1 depicts the effect of a one-year, 3 percent recession in GDP, followed by sustained 2 percent annual growth, on two national economies. The hypothetical recession is roughly what happened to the United States economy in the global financial crisis of 2008. It is worth remembering that the impact of the crisis was more severe in many other states. While GDP returns to its pre-recession level within two years, expected cuts in military spending continue for a longer period. The positive coefficient on the lagged dependent variable implies that the cuts stemming from a one-year recession will last for several years. This is apparent in Figure 1. These cuts are more severe and longer-lasting in larger economies. The larger economy depicted in Figure 1 is roughly the size of France in 2011. Here the cuts are larger than the decline in GDP, and the expected level of military spending remains below its pre-recession level for a full decade after the recession ends. The smaller economy in the figure is roughly the size of Egypt or Colombia in 2011. Here the cuts are less severe, but military spending still remains below its pre-recession

level for 8 years after the recession ends. As the figure suggests, the predicted effect of economic growth and recession in the model depend on the size of the economy in question and the current level of military spending. Equilibrium military spending is also higher as a share of GDP in smaller economies.[8] This higher equilibrium makes sense because small economies must spend a larger share of their national income to maintain a viable military force.

[Figure 1 about here.]

Modeling the asymmetric effects of economic growth and decline requires a more complex specification than does simply assuming symmetric effects. It is important to ask whether the additional complexity really produces a superior model. The second and third models, which omit the interaction term, provide useful points of comparison for answering this question. The Bayesian Information Criterion (BIC), reported beneath the coefficients for each model, can be used to compare the overall fit of both nested and non-nested models. As Long (1997, 111) puts it, the BIC "assesses whether [a model] performs well enough to justify the number of parameters that are used." The BIC statistic for the interactive specification is 5.8 points lower than the model without the interaction term, and more than 500 points lower than the baseline model. By conventional standards, this supports the more complicated specification.[9] The long-run multiplier for GDP is also somewhat larger in the interactive specification, suggesting that failing to consider the asymmetric effect of change in GDP in military spending might lead researchers to underestimate this important relationship.

[8] Error-correction models imply an equilibrium relationship between the levels of the independent and dependent variables, at which the predicted change in military spending is zero. In practice, the level of GDP is constantly changing, so the level of military spending moves along with it.

[9] Long (1997, 112) and Clarke (2001, 738) both use Raftery's (1995) criterion for assessing relative performance. Differences of 0–2 weakly support the lower scoring model, differences of 2–6 indicate positive support, 6–10 strong support, and differences of greater than 10 very strong support.

Robustness Tests

We conducted a series of robustness tests of the relationship between military spending and economic growth. The appendix contains the full results, which we will summarize here.

First, we tried several different approaches to determining the threshold between "growth" and "decline" in the economy, rather than assuming it to be zero, as we do here. In reality, economic decline, for purposes of changes in the military budget, might begin at a number greater than zero. There may be pressure to reduce military spending when the economy is growing relatively slowly. Demand for many other government services, such as education and healthcare, rises with population, so if GDP does not increase at least as rapidly, military spending will have to compete with these other demands for an effectively smaller pool of resources. As the results in the appendix indicate, the use of other plausible thresholds does not substantively change our results. We find no statistically significant results with thresholds of 3 percent or 4 percent growth, but much the same pattern presented here when we use a 2 percent threshold, or one tied to population growth.

We also re-estimated the models in Table 1 against sub-samples where we had reason to believe the results might be different. The results do not threaten our basic finding that there is an asymmetric relationship, but they do suggest some limits. States involved in rivalries remain sensitive to economic growth, and display the same asymmetry found in the full sample. The results also persist among large and wealthy economies, but are much less robust among small or poor economies. As Figure 1 indicates, even the model estimated using the full sample suggests a weaker effect of economic growth and decline on military spending in small economies. The results are also sensitive to regime type in some instances, particularly when a military regime is in power. Finally, the specific international historical context may make a difference. We find

more evidence of asymmetry in the 2001-11 period than we do during the 1989-2000 or 1949-88 periods.

Finally, we estimated a model using instrumental variables for economic growth and decline, in order to deal with the possibility that military spending may influence change in the economy, rather than the other way around, as we have hypothesized here. We used average temperature and rainfall as instruments for economic growth. Recent research by Burke, Hsiang, and Miguel (2015) has found that these considerations have a strong, non-linear relationship to economic growth, even in relatively wealthy and developed states. They are also exogenous to military spending. The results are similar to those in Table 1, and those estimated on the same sample without the instruments. There is no evidence that the impact of cuts in military on the economy threaten the validity of our results.

The Effect of Rising and Declining International Threat

Table 2 presents the results of two sets of models using Nordhaus, Oneal, and Russett's indicator of international threat. The first set includes fixed effects, while the second set omits them. As was the case with GDP, our principal concern is with the impact of change in international threat on the change in military spending. Hypothesis 2 holds that positive change in threat should have a greater impact on military spending than negative change. We estimated both the interactive model specified in equation 3 in order to test hypothesis 2, and a simpler model that omits the interaction terms, just as we did for economic growth in Table 1. The simpler models, as well as the baseline model presented in Table 1, help in assessing the overall performance of the interactive specifications that test hypothesis 2.

[Table 2 about here.]

The results from the fixed effects models do not support hypothesis 2. Indeed, we find no evidence that international threat is related to changes in military spending at all. Neither increases nor decreases in threat are related to military spending. Both the level of threat and the long-run multiplier are also statistically insignficant. The BIC statistics indicate that the interactive specification performs worse than both a simple model without the interaction term and a model that omits the threat variables entirely. These results contrast with the findings of Nordhaus, Oneal, and Russett (2012), as well as with our own expectations.

Is international threat really irrelevant to military spending? It is possible that the link is not as robust as assumed: in the context of arms race dynamics, Cusack and Ward (1981) found that threat dynamics were empirically insufficient predictors of military spending, while Zinnes (1980, 324) proposed that arms budgets are a historical process resulting more from "complex internal decisions" rather than international hostility. However, doubts about the implications of our own result prompted us to consider two other possibilities. First, we considered the possibility that our divergent results might stem from differences between the military spending data assembled by Nordhaus, Oneal, and Russett and those published SIPRI. The Correlates of War National Military Capabilities data, which Nordhaus, Oneal, and Russett use for the 1950-88 period, use different sources and cover a slightly different set of states. Second, because threat is a difficult concept to measure, considering more than one indicator makes sense. Nordhaus, Oneal, and Russett (2012) weighted the probability of a dispute with every country equally in computing their measure of threat. We estimated an alternative measure weighting the probability of a dispute by the GDP of the country in question, so that threats from states with larger economies contributed more to the measure than threats from smaller powers. For reasons

of space, we present the full results of both these analyses in the appendix. Neither turned up any evidence of a relationship between international threat and military spending.

The random effects models in Table 3 test a third possible explanation for the results concerning threat: this variable explains cross-sectional variation better than it does changes over time. This line of argument finds more support. While the error-correction model we used should capture the long-run equilibrium relationship between the level of military spending and the level of international threat, the fixed effects diminish the importance of cross-sectional variation, as opposed to variation over time within each state. As the last two models in Table indicate, both the long-run multiplier and the coefficient on the level of threat become statistically significant when we remove the fixed effects. It is likely that the effects Nordhaus, Oneal, and Russett (2012) found for international threat stem from large, mostly time-invariant, cross-national differences in the level of military spending and the level of their threat indicator. For instance, major powers like the United States and the Soviet Union had consistently high probabilities of getting involved in a militarized dispute. These states also spent a lot on their military forces compared to other states throughout the sample period. The fixed effects in our model absorb these largely time-invariant cross-national differences. While Nordhaus, Oneal, and Russett (2012, 507-8) also present specifications using fixed effects, their modeling strategy differs from ours, and is not well suited to testing arguments about change over time. For one thing, logging the level of military spending, as they do to produce their dependent variable, might obscure annual changes in military spending. At any rate, our results show that their findings depend on the model one uses.

Conclusion: Reflections and Broader Implications

For theoretical and institutional reasons, the logic leading to military spending increases is different than the logic causing expenditure decreases, and vice versa. Increases and decreases in military spending are not two sides of the same coin. Consequently, some variables that influence military spending do not have the same effects when they are increasing and decreasing. This possibility applies to many independent variables. We have focused on two especially important ones in this paper: economic growth and changes in international threat.

We expected that economic decline and increases in international threat would have greater effects than economic growth and declines in international threat, respectively. In regards to economic growth, we argue military spending is a public good. More spending is not necessarily required to provide the same level of defense when wealth or population grows. Spending that does have to increase to provide the same level of service when population or the economy grow may have a greater claim on the additional resources available from economic growth. Similarly, we argue that increasing threat will have a greater impact on military spending than decreasing threat. The theoretical expectations regarding organizations and individuals in threat environments suggest a ratchet effect.

Our results are mixed: we found the expected effects for economic growth and decline but not for changes in international threat. The results concerning economic growth and decline provide strong support for considering asymmetric effects. We found that the impact of economic decline was between seven and eight times greater than the impact of economic growth. Moreover, models that estimated separate effects for growth and decline perform much better than models that assume symmetric effects, in spite of their greater complexity. Without estimating these separate effects, researchers might erroneously conclude that there was no long-

run relationship between the levels of GDP and military spending. The long-run multiplier linking economic growth and military spending was not statistically significant when we estimated a single, symmetric short-run effect.

Our results concerning GDP and military spending have broader substantive implications as well. Periods of global recession should prompt most states to make large cuts in their military budgets. As the examples depicted in Figure 1 suggest, even relatively small declines in GDP were associated with substantial reductions in military spending. Returning to pre-recession levels of spending takes quite some time after economic growth resumes because the effects of growth are so much smaller than those of recession. This pattern in military spending could have real consequences for the balance of power. The pattern we found is a general tendency, not an iron law. Particularly aggressive states that manage to resist economic pressures to reduce military spending during global recessions might see the balance of power tilt sharply in their favor. This is essentially what happened in Europe during the 1930s, when Depression-driven cuts in military spending magnified the impact of the buildup in Nazi Germany.

In addition, this pattern in military spending could have real consequences for power transitions. One tenet of power transition theory is that states experiencing economic growth will use newly available funds to invest in their militaries. Our findings imply the extent of growth investment in military capabilities is small. Rising economic powers will invest some of their gains into military spending, but any economic downtown will significantly undermine and potentially reverse gains made. Thus, rising economic powers may be less of a security concern than the literature implies. Moreover, the fact that recessions do more to reduce military spending than economic growth does to increase it suggests something interesting about the relationship between economic growth and foreign policy ambition. It might require a sustained

period of largely uninterrupted growth to support the construction of a considerable military force.

While our surprisingly weak results concerning international threat do not support any comparably clear policy implications, it would be a mistake to conclude that international threat is simply unrelated to military spending. There is no shortage of compelling historical evidence that specific concerns about international threats have influenced decisions about military spending and other preparations for war. Moreover, failure to reject the null hypothesis is not evidence that the null hypothesis is true (Gill 1999). Several alternative possibilities are equally compatible with the null results we found. First, states may respond to similar international conditions, as claims about international threat suggest, but not consistently enough to produce a simple relationship in a large, cross-national dataset.

Second, international threat, under certain conditions, may still correlate with spending. For instance, states might respond more consistently to threats emanating from rivals, major powers, or neighboring states. Some types of political regimes or political parties might respond to international conditions more consistently than others. Many other arguments about conditional responses to international conditions are possible. They suggest empirical tests involving either different indicators of threat, or interactive specifications that allow states' responses to international conditions to vary depending on the proposed conditions. Our null results certainly do not rule out these possibilities.

A related but more fundamental problem stems from the fact that “threat” actually exists in the minds of policymakers and other observers. Strictly speaking, it is not an observable feature of the international environment. Threat is certainly related to objective conditions, but the way these conditions map onto policymakers' perceptions might be specific to particular

policymakers, states, or historical periods. Measures of threat in empirical research must necessarily generalize across these unobservable differences in responses, and can thus never be more than rough approximations. Even conditional notions of threat like those suggested in the last paragraph may have trouble coping with this problem. Still, research that focuses on small sets of states or narrower periods of history, where responses to international conditions are reasonably consistent, might find threat to be very important.

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Table 1.
The Effect of Economic Growth and Decline on Military Spending

	Interactive model	Simple model	Baseline model
ΔGDP_{it-1}	0.01*	-0.01	
	(0.004)	(0.01)	
$GROW_{it-1}$	26.15		
	(33.59)		
$\Delta GDP_{it-1} * GROW_{it-1}$	-0.02*		
	(0.01)		
Joint significance test for components of interaction term	F(3, 153) = 3.38*		
ΔMIL_{it-1}	0.51*	0.50*	0.49*
	(0.01)	(0.01)	(0.01)
MIL_{it-1}	-0.13*	-0.13*	-0.05*
	(0.02)	(0.02)	(0.01)
GDP_{it-1}	0.003*	-0.003*	
	(0.001)	(0.001)	
Constant	714.08*	708.54*	681.78*
	(56.76)	(38.22)	(104.27)
Long-run multiplier for *GDP*	0.024*	0.022*	
	(0.003)	(0.003)	
States	154	154	154
Observations	5,600	5,600	5,600
R-squared:			
Within	0.371	0.368	0.303
Between	0.296	0.272	0.498
Overall	0.022	0.021	0.055
BIC	105611.9	105617.7	106150.5
Difference from baseline BIC score	-538.6	-532.8	0

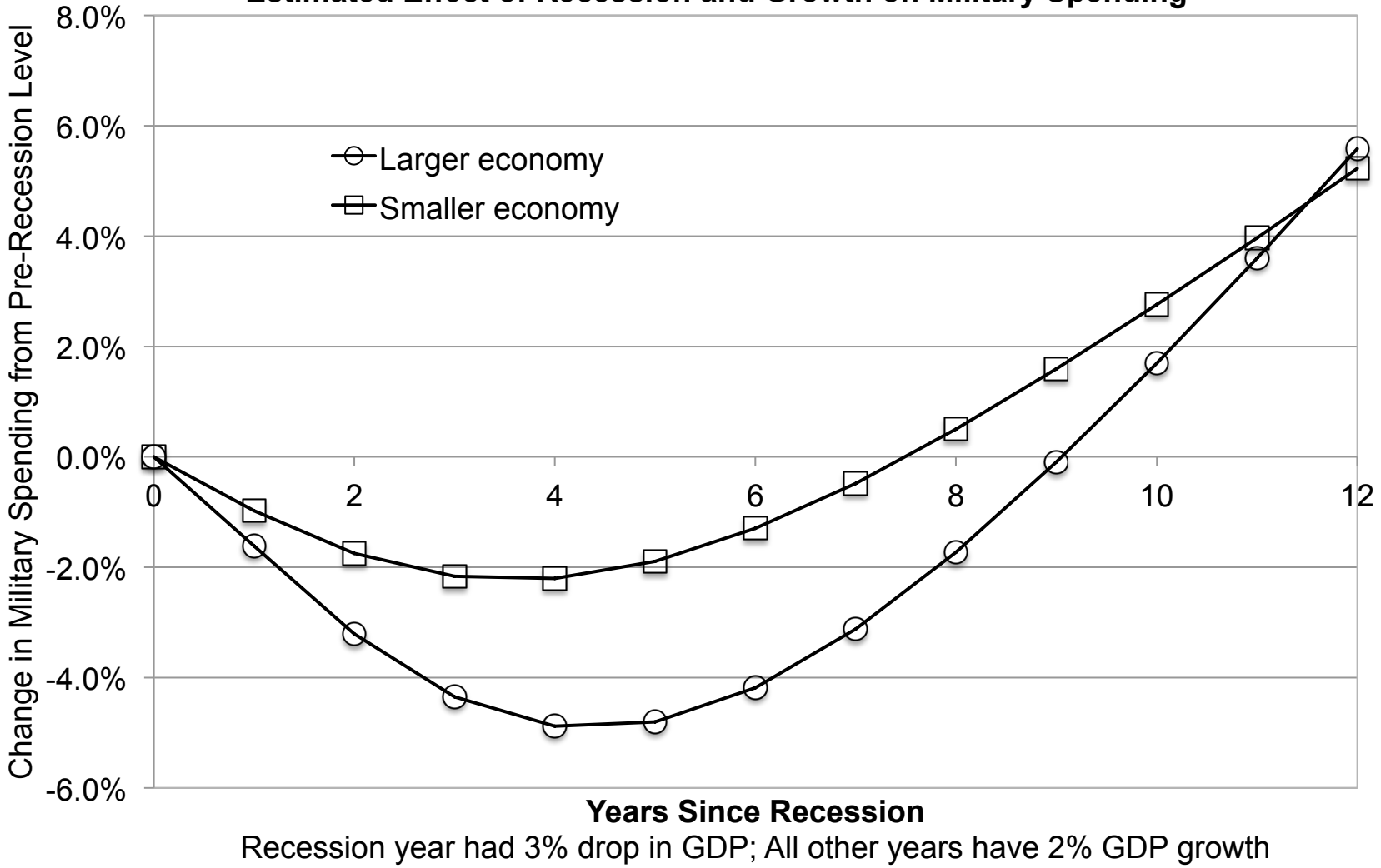
Notes: Asterisks indicate p-values less than 0.05. All models include country fixed effects. Robust standard errors adjusted for clustering on each country are reported in parentheses. We estimated these models and model fit statistics using Stata 14.2.

Table 2.
The Effect of International Threat on Military Spending

	Fixed Effects		Random Effects	
$\Delta THREAT_{it}$	-5.12	-0.06	-5.51	1.59
	(5.35)	(1.17)	(6.42)	(1.30)
$MORETHREAT_{it}$	74.29		38.77	
	(88.69)		(57.75)	
$\Delta THREAT_{it}$ *	10.68		9.29	
$MORETHREAT_{it}$	(13.05)		(12.45)	
Joint significance test for components of interaction term	F(3, 140) = 0.40		F(3, 140) = 1.72	
ΔMIL_{it-1}	0.32*	0.32*	0.28*	0.28*
	(0.02)	(0.02)	(0.01)	(0.01)
MIL_{it-1}	-0.11*	-0.11*	-0.003*	-0.003
	(0.01)	(0.02)	(0.001)	(0.001)
$THREAT_{it-1}$	-4.70	-4.61	0.68*	0.84*
	(3.42)	(3.32)	(0.29)	(0.39)
Constant	2202.74*	2260.93*	-101.26	-78.31
	(809.04)	(875.48)	(89.24)	(66.87)
Long-run multiplier for *THREAT*	-43.23	-42.35	218.64*	260.83*
	(26.39)	(25.55)	(75.40)	(72.30)
States	141	141	141	141
Observations	4,134	4,134	4,134	4,134
R-squared:				
Within	0.16	0.16	0.10	0.10
Between	0.08	0.08	0.44	0.51
Overall	0.004	0.005	0.10	0.10
BIC	78522.5	78508.9	78874.9	78860.3
Difference from BIC score of model with only lag and lagged level of DV	+11.7	-1.9	+27.5	+12.9

Notes: Asterisks indicate p-values less than 0.05. The threat indicator was rescaled for ease of presentation by multiplying it by 1000. Robust standard errors adjusted for clustering on each country are reported in parentheses. We estimated these models and model fit statistics using Stata 14.2.

Figure 1.
Estimated Effect of Recession and Growth on Military Spending



Recession year had 3% drop in GDP; All other years have 2% GDP growth