The Effects of the National Security Environment on Military Expenditures, 1950-2000

William Nordhaus, John R. Oneal, and Bruce Russett

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We have interesting results showing that nations' security environments, as estimated by a liberal and realist model of dyadic conflict, help explain their military expenditures. That the external threat would influence national defense spending seems obvious, but our examination of 165 countries for the post-World War II period indicates that the probability of a fatal militarized dispute assessed ex ante is more important than are any of the post hoc variables included in a common sense model of defense spending: the actual incidence rate of nations' involvement in serious interstate conflict, the severity of these conflicts measured in combatant fatalities, or the military expenditures of friends and foes. Social science does well in comparison to common sense. The economic size of countries is the predominant influence on expenditures, and we are not sure that we have properly taken this important factor into account. So, in addition to our interesting results, we have a puzzle with which we hope for help.

We have three objectives today: provide an external test of the validity of the widely accepted liberal and realist model of dyadic conflict; offer insight into the determinants of national military expenditures; and examine the military expenditures of a few prominent countries in light of our theoretical analysis.

The Liberal and Realist Model of Dyadic Conflict

Research on the causes of war has advanced rapidly in the last fifteen years through the analysis of pairs of states (or dyads) observed through time (Polachek, JCR 1980; Bremer, JCR 1992). Using dyadic analyses directly addresses the central question of interest to scientists and policy makers alike: which states are prone to interstate conflict. And it does so while avoiding the ecological fallacy that was inherent in early studies at the systemic level. At the same time, the examination of dyad-years allows for consideration of inherently relational influences, such as alliances and other diplomatic agreements or the balance of power—influences difficult to incorporate in the time series of individual states. Moreover, dyadic analyses can include not only variables measured at the national level, such as regime type, but also characteristics of the national culture or even individual leaders. At the other end of the spectrum, they can also incorporate measures from the systemic level of analysis, such as the concentration of national capabilities among the major powers or the power of the leading state.

Our dyadic model of nations' security environments incorporates elements from the two major schools of international relations that are amenable to social scientific

investigation: the liberal or Kantian, in which the character of states' political regimes and their economic relations reflect their affinities and interests and the realist school with its emphasis on the absolute and relative power of nations, their alliances, and geographic proximity. We also control for each dyad's historical experience of violent conflict, measured as the number of years of peace since its last dispute. We report in Table 1 the results of a logistic regression analysis of fatal Militarized Interstate Disputes, 1885-2000. We have over 469,000 dyad-years. The robust standard errors are adjusted for clustering by dyad.

The following conclusions can be drawn: 1) two democracies are very peaceful, two autocracies less so, and mixed pairs fight a lot; 2) economic interdependence reduces conflict; 3) a preponderance of power, not a balance, increases the prospects for peace. Indeed, a consensus seems to have formed in the empirical literature regarding this question, debated since Thucydides. 4) Large states are prone to fight, presumably because their interests are global and their capabilities for defending and promoting them are substantial. 5) Contrary to realist theory, the pacific benefit of alliances is slight. This is surprising: few would expect that good economic relations are more conducive of peace than explicit security agreements. Interestingly our recent simultaneous estimates indicate that the value of such agreements is primarily indirect, through their promotion of trade. 6) Conflict is likely for states that are geographically proximate, and 7) for those that have fought recently.

Based on analyses we have reported elsewhere, we can also say with confidence that the power of the leading state—the so-called hegemon—does not influence conflict propensities in the international system at large; and cultural differences—as indicated by a supposed clash of civilizations—are relatively unimportant.

There are important limitations to this line of research. All the variables included in the model tend to vary slowly over time, so these analyses do much better in identifying the "dangerous dyads" than when those states will actually go to war (Glick and Taylor, Rev. Ec. & Stat. forthcoming). Or, to use Kenneth Waltz's (*Man, the State, and War* 1954) terms, we have good evidence regarding the permissive causes of war, but have little to say about proximate ones. Nicholas Sambanis (JCR 2004) notes that research on the causes of civil wars suffers from the same deficiency.

If the liberal and realist model captures the probability of serious interstate conflict, we should be able to use these predictions to help explain national military expenditures. To do this, we converted the dyadic-year estimates of the probability of a fatal dispute into state-year data. We did this by calculating the annual probability that a state would be involved in a fatal dispute with at least one other country. Thus,

$$p\_fatal_{i,t} = 1-[(1-p\_fatal_{i1,t})*(1-p\_fatal_{i2,t})* \ldots *(1-p\_fatal_{ij,t})]$$

From now on, I will mean this state-year variable when I refer to the probability of a fatal militarized dispute.

We use this variable—our estimate of the severity of the threat in the national security environment— in a series of regression analyses to help explain military expenditures. We consider the experience of a large sample of countries over the post-World War II period. We have approximately 6000 cases in most tests, or an average of 37 years for 165 countries. Before looking at the evidence, however, we must consider

whether interstate conflict is endogenous to national defense spending or, rather, the nature of this endogeneity.

To assess the danger that our analyses of the influence of serious interstate conflict on military expenditures would be biased by the reciprocal effect, we added the logarithm of the higher and lower military expenditures for each dyad-year to our model of dyadic conflict. Consistent with the preponderance theory, peace proved most likely when there is an imbalance of military expenditures. Increased national defense spending has, therefore, an indeterminate effect, across all cases, on the threat environment: if it heightens the military imbalance in a dyad, the risk of war goes down; if it moves the two states toward equality in expenditures, the risk goes up. This finding goes a long way toward eliminating the danger that the reciprocal effect of military expenditures on the probability of interstate conflict will bias the analyses we report below.

Explaining National Military Expenditures

In all our tests, we control for the influence of national size on defense spending. The reason is obvious: military expenditures are limited by a state's ability to pay for security. Large states spend more on their armed forces than do small states. Thus, the first estimates we report are for the following specification:

$$milex_{i,t} = f(\text{real GDP}_{i,t}, p\_fatal_{i,t}) \qquad (1)$$

To calculate the association of economic size and the threat environment with military expenditures for our pooled cross-sectional and time-series data, we use the correlated panel-corrected, standard errors model recommended by Beck and Katz (APSR 1995). With unbalanced panels, this is a Prais-Winsten estimator. Use of PCSE is consistent with the assumption that the disturbances across panels are heteroskedastic and contemporaneously correlated. The estimator is a conservative alternative to feasible generalized least squares. We correct for a strong first-order autoregressive process; rho was computed with a regression using lags. All our calculations were done using Stata 8.

As can be seen in the first column of Table 2, the probability that a state will be involved in a fatal dispute is not highly correlated with defense spending in this simple specification. The estimated coefficient of p_fatal is positive, as expected, but not statistically significant. On the other hand, national military expenditures are closely associated with countries' real gross domestic products. In Tables 2 and 3, * indicates $p<.05$, **$p<.01$, ***$p<.001$; two-tailed tests.

The lack of statistical significance for our estimate of the probability of a fatal dispute is easily explained. P_fatal is a prospective measure of a country's security environment. The liberal and realist model provides an estimate for year t based on conditions in year t-1. We incorporated a lag in the dyadic model of fatal disputes to make sure that, in evaluating the influences of democracy and trade or power and alliances, our analyses excluded any reciprocal effects of a conflict on them. National military expenditures, on the other hand, are only retrospectively given. We know on January 1 of a new year how much a state spent over the previous twelve months. This makes clear that defense spending is a function not only of the security environment,

estimated probabilistically ex ante, but also the realization of threats experienced as actual conflict post hoc.[1]

The probability of a fatal dispute estimated with our dyadic model is a measure of the anticipated financial requirements for fielding a military that is adequate to support a state's objectives and policies. States may favor the status quo or be revisionist in their relations with other countries. Often, perhaps generally, their policies reflect a combination of the two objectives. When states are conservative and seek to maintain the status quo, p_fatal is a better measure of the anticipated cost of deterring aggression, than the cost of actually defending territory. Of course, states often do not desire to maintain the status quo in their relations with others. Instead they may use their military capabilities proactively to promote their interests. This can be done either by means of coercive diplomacy (George, *Forceful Persuasion: Coercive Diplomacy as an Alternative to War* 1991) or by actual force of arms. States should prefer coercive diplomacy, just as they prefer deterrence, because the cost—in human life especially—is generally less. In explaining national military expenditures, then, we need to consider not just the risk of conflict that nations anticipate but the costs they actually incur when deterrence fails or coercive diplomacy proves inadequate.

We consider the influence of actual conflict on defense expenditures using two variables. The first is a measure of the incidence rate of fatal disputes for each country in each year. We started by calculating the fraction of a state's dyadic relations that were marked by a fatal militarized dispute. Thus,

$$\text{fatal\_rate}_{i,t} = \#\text{ of dyads}_{ij,t}\text{ w/ a fatal dispute / total \# of dyads}_{ij,t}$$

Then we created a variable comparable in construction to p_fatal in the following manner:

$$\text{actual\_fatal\_rate}_{i,t} = 1-((1-\text{fatal\_rate}_{i,t})\text{\^{}number of other states } j_t)$$

We could have simply used the incidence of fatal disputes (fatal_rate) itself. The advantage of using the more complex variable (actual_fatal_rate) is that the coefficient estimated in the analyses below is directly comparable to that of p_fatal, our ex ante measure of the threat in the national security environment. We also ran tests in which we simply substituted a binary indicator of whether state i experienced a fatal dispute with any state in year t. The results were consistent with those we report. Naturally we expect that states that are known post hoc to have experienced a higher incidence of interstate conflict will have spent more on their armed forces.

In addition to the number of fatal disputes in which a country is involved, we expect that national military expenditures will reflect the severity of those conflicts. Therefore, the second gauge of the financial demands of the military conflict that states actually experience in a year is a count of the fatalities a country suffered in conflicts with all other states that year, normalized by the population of the country. Thus,

$$\text{fatalities}_{i,t} = \sum \text{fatalities}_{ij,t} / \text{population}_{i,t}$$

[1] The probability of a fatal dispute should be more closely correlated with budget requests or appropriations than actual expenditures, but these data are not generally available.

We expect that states will spend more on the military in years when they experience a large number of casualities in combat relative to the nation's total population. In short, military expenditures should be a function of the number and severity of interstate disputes a country experiences in a year.

We also control for the influence of the military expenditures of other states, both friends and foes. Alliances and more informal international agreements often carry commitments for support in particular circumstances, which can manifest itself as greater spending by states on their armed forces. The contemporaneous expenditures of potentially hostile powers, on the other hand, may be taken by national leaders as evidence of heightened threat that necessitates a greater commitment of resources to the military. Arms races have long been explained as an action-reaction cycle. Consequently, we constructed two measures of the military expenditures of other states. One is the logarithm of the sum of the current spending of friends. The other is the log of the total spending of adversaries in a year. We identified a state's friends and its foes using Signorino and Ritter's (ISQ 1999) statistical measure (S) of the similarity of two states alliance portfolios. Following Bueno de Mesquita (*The War Trap* 1981), we assume that countries that have the same allies (and the same non-allies) have similar or complementary foreign policies and security interests.

Using Signorino's S, we ranked all states j according to the similarity of their alliance portfolio with state i in year t. Those states above the median in each year were considered friends; all states below, were considered foes. We then summed the military expenditures of friends and foes and took the logarithm. Thus, the two measures designed to capture the influence of other states' contemporaneous military expenditures are defined as follows:

$friends\_MX_{i,t} = \ln (\sum milex_{k,t})$, where k is any country whose alliance portfolio is more similar to i's portfolio than the median for all countries relative to i in year t

$foes\_MX_{i,t} = \ln (\sum milex_{l,t})$, where l is any country whose alliance portfolio is less similar to i's portfolio than the median for all countries relative to i in year t

In addition to capturing the influence of alliance commitments for coordinated expenditures with friends and the consequences of arms races with potential foes, the logarithms of friends' and foes' military spending is also a way of controlling for the transmission of military conflict through these channels. A state may be required or consider it prudent to spend more money on its armed forces when either a friendly country or a hostile power is involved in a military conflict, even if the dispute does not entail for state i combat that produces fatalities among its armed forces.

To summarize, we expect national military expenditures to be a function of policy makers' ex ante estimates of the armed forces necessary for security given the environment in which they expect to operate. They will normally seek to deter some adversaries from resorting to military force and to promote their interests at less cost by coercive diplomacy; but states are not always successful in achieving their objectives merely by the threat or show of force. As Engels observed, battle is to power what cash is to credit. Sometimes deterrence fails, and the military must defend the country or its

strategic interests; and states may chose to force compliance with their demands if threats are insufficient. Thus, national military expenditures should reflect both ex ante and post hoc influences.

To show that actual involvement in interstate conflict and the spending of friends and foes do affect states' defense spending, we next estimate what might be called the common sense or naïve model of military expenditures:

$$milex_{i,t} = f(\text{real } GDP_{i,t}, \text{actual\_fatal\_rate}_{i,t}, \text{fatalities}_{i,t}, \text{friends\_MX}_{i,t}, \text{foes\_MX}_{i,t}) \quad (2)$$

As seen in the second column of Table 2, three of the four estimated coefficients for the variables representing the post hoc influences are statistically significant. Not surprisingly, states that experience a greater number of fatal disputes do spend more on their armed forces; and the more severe these conflicts are, as indicated by the number of deaths among its combatants, the greater those expenditures. The current spending of potential adversaries, too, positively affects states' military budgets; but the estimated coefficient for the log of friends' expenditures is not statistically significant, though its sign is positive. Arms races with foes are apparently more influential on national military expenditures than are obligations entailed by treaties or diplomatic commitments. It may also be that the alliances do not have a uniform effect: small states may free-ride on the efforts of larger allies as well as act in concert with them.

In the third column of Table 2, we combine the ex ante influence of the security environment, derived from the liberal and realist model of fatal disputes, while controlling for the post hoc effects of states' actual involvement in interstate conflict and the influences of the military expenditures of friends and foes:

$$milex_{i,t} = f(\text{real } GDP_{i,t}, p\_fatal_{i,t}, \text{actual\_fatal\_rate}_{i,t}, \text{fatalities}_{i,t}, \text{friends\_MX}_{i,t}, \text{foes\_MX}_{i,t}) \quad (3)$$

The results reported in column 3 indicate that the probability of serious interstate conflict does contribute to explaining national military expenditures. The probability of a fatal dispute is now statistically significant at the .03 level. Again economic size is the predominant influence. Defense spending is also affected by states' involvement in interstate conflicts, the severity of those disputes, and the military expenditures of potential rivals.

In the last column of Table 2, we show that, surprisingly, the probability of a civil war does not significantly influence national defense expenditures. We used data on the threat of domestic conflict made publicly available by Nick Sambanis (JCR 2004). Sambanis estimates the same models of domestic conflict using a dozen different datasets, including one he has assembled, Nils Petter Gleditsch's collection of events, and the civil war data published by the Correlates of War project (2000). Sambanis notes that there is a "remarkable degree of disagreement" on how to code civil wars; but nevertheless, "overall, civil war models seem to be good at identifying countries with long-term proclivities to civil war" (p. 855). In column 4, we report results using the COW data because it uses the highest threshold of violence in identifying its cases. These serious events should be most likely to influence military expenditures, but neither

it nor either of the alternative measures of the prevalence of civil conflict is associated with greater spending.

Thus far, we have commented only on the statistical significance of our findings, when of course it is their substantive importance that is ultimately of concern. We'll return to this issue, but first let's consider the robustness of the results reported in column 3.

In the first column of Table 3, we report a dynamic model that includes the lagged value of the dependent variable and, in column 2, an estimate of equation 3 to which fixed country effects have been added. The coefficients of the dynamic model with the lagged dependent variable again are estimated with correlated, panel-corrected standard errors, and both it and the fixed effects model include a correction for an AR1 process. In both, p_fatal is quite significant ($p < .001$ with a lagged dependent variable; $p < .008$ with fixed effects). Indeed, the severity of the security environment is more robustly related to national military expenditures than is the actual incidence rate of fatal disputes or the influence of arms races with potential adversaries or the expenditures of allies.

As before, these analyses include all states for which data are available; but we want to be sure that our tests capture the experience of large states. Certainly our results would be less interesting if they only applied to small countries. We considered two subsets of cases: the time series of the largest 40 countries in 1980 and fourteen major and regional powers: the United States, Canada, Mexico, Brazil, Great Britain, France, Spain, Germany, Italy, the USSR/Russia, China, Japan, India, and Indonesia. In the second two columns of Table 3, we limit the analyses to the big fourteen. Then, the threat environment is associated with military spending in the dynamic analysis ($p < .03$) but not in the fixed effects model ($p < .70$). P_fatal does better, however, in these analyses than do the measures of actual conflict or the military expenditures of friends and foes. The only significant coefficient for these four variables is for the fatalities suffered, in the dynamic model.

Next we address the substantive importance of the determinants of military expenditures. We consider two measures. The first is the effect of a change of two standard deviations, given the coefficients from the PCSE estimation in column 3, Table 2, which includes all 165 countries. The second is the standardized coefficient from a simple OLS regression using the same specification. As seen in Table 4, the probability of a fatal dispute is more influential by the first measure than is any other variable except economic size, of course, and foes' military expenditures. It is more influential than all but GDP in the OLS estimation. Nevertheless, the absolute change in defense spending associated with a 40 percentage point move in the prospectively estimated probability of a fatal dispute is small: only $1m, when national military expenditures are about $300m according to either the mean or median. The results of the dynamic model that incorporates the lagged dependent variable give a larger long-term effect: $7m, or about 2% of mean military expenditures. If the analysis is limited to the major and regional powers, the importance of the security environment is larger in absolute terms but still small relative to defense budgets or the size of their national economies. Still, a dramatic systemic change such as the end of the Cold War will affect many states' budgets simultaneously over many years. Thus, the cumulative effect is appreciable.

To summarize, the security threat estimated by the liberal and realist model does supplement the information provided by factors that common sense suggests should

influence military expenditures: the actual incidence rate of countries' involvement in serious interstate conflict, the fatalitites their combatants suffer, and the military expenditures of friends and foes. In addition, p_fatal is correlated, reasonably robustly, with national defense spending, while the probability of a civil war is not. Still, the absolute effects of all the theoretical variables except GDP are small—at least in these estimates.

It may be that we are not taking the effect of economic size into proper account. The effect of an increase in the security threat is apt to be conditional on the economic size of the country. We have tested this possibility by including an interaction term in our model of military expenditures: the product of the probability of a fatal dispute and the nation's economic size. This increases the influence of the security environment on spending, but still the results seem understated. Making the effect of the external threat conditional on size is not as easy as it first seems though, because the effect of GDP is apt to be contingent on a state's membership in an alliance. Then, as Mancur Olson (*The Logic of Collective Action* 1971) suggested, the small tend to exploit the large.

The Military Expenditures of Key States in Light of our Theoretical Analysis

It is interesting to compare states' actual military expenditures to the theoretically predicted. Because we carefully modeled the security environment in the liberal and realist model, and control in the milex eqn for several post hoc influences, the significance of the lagged dependent variable in models 5 and 7 seems to indicate the importance of domestic influences: bureaucratic inertia or governmental policies. It could be the efforts of a junta to secure its position or the political influence of a military-industrial complex.

In the following graphs, we plot the actual military expenditures of the United States, Britain, Japan, the USSR/Russia, and China versus the predicted values from equation 3. Of course, our confidence in the data on defense spending is much greater for the Western powers than for Russia and China.

Table 1: Logistic Estimates of the Probability of a Fatal Militarized Interstate Dispute by Dyad, 1885-2000

Number of obs = 469,029
Wald chi2 (13) = 1854.05
Prob > chi2 = 0.0000
Log pseudo-likelihood = -4137.8 Pseudo R2 = 0.3799

	Coefficient	Robust Std. Error	z	p > |z|
Lower democracy score	-.124	.0174	7.09	0.000
Higher democracy score	.0441	.0110	4.00	0.000
Lower bilateral trade / GDP	74.2	20.0	-3.71	0.000
Contiguity	1.02	.220	4.65	0.000
Distance a-b (ln)	-.463	.088	-5.27	0.000
Higher probability of winning	-1.34	.40	3.32	0.001
Allies	-.147	.168	-0.88	0.381
Larger GDP (ln)	4.63	1.62	2.87	0.004
System size	-.454	.049	-9.27	0.000
Years of Peace	-.637	.034	-18.73	0.000
Constant	1.23	.72	1.70	0.089

Table 2: Effects of the National Security Environment on MILEX

Prais-Winsten regression, correlated panels corrected standard errors (PCSEs)

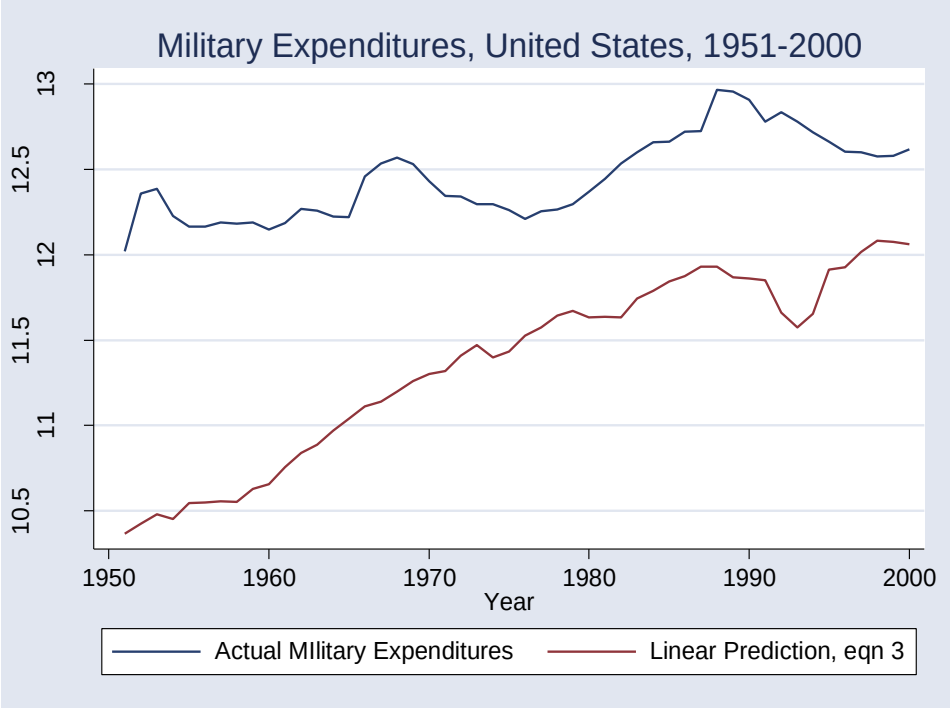
	(1)	(2)	(3)	(4)
P fatal	.1065		.1742*	
	(.0760)		(.0787)	
P civil war				.0463
				(.0402)
Real GDP (ln)	1.1201***	1.1485***	1.1385***	1.1191***
	(.0273)	(.0230)	(.0246)	(.0402)
Fatalities		50.5678*	45.9922*	37.3426*
		(21.0575)	(20.1235)	(18.5040)
Actual Fatal Rate		.0671**	.0699**	.0416
		(.0245)	(.0240)	(.0255)
Friends MX (ln)		.0158	.0192	.0134
		(.0137)	(.0138)	(.0130)
Foes MX (ln)		.1908**	.1975***	.1531*
		(.0613)	(.0609)	(.0635)
Constant	-5.840***	-8.830***	-8.8994***	-8.0120***
	(.2865)	(.8994)	(.9056)	(.9367)
N	6172	6172	6172	5287
N-Groups	165	165	165	149
R-Squared	0.4863	0.5457	0.5230	0.5546
Wald chi2	1688.61	2524.05	2168.99	1702.06

Table 3: Effects of the National Security Environment on MILEX

	LDV	FE	LDV	FE
	(5)	(6)	(7)	(8)
P fatal	.1237***	.1524**	.1356*	.0314
	(.0389)	(.0576)	(.0612)	(.0817)
Real gdp (ln)	.0718***	.4078***	.0564**	.4966***
	(.0102)	(.0398)	(.0185)	(.1352)
Fatalities	33.4049*	50.1880**	600.8852**	-400.3391
	(15.8449)	(18.4967)	(231.9108)	(302.0076)
Actual fatal rate	.0320	. 0321	-.0013	-.0133
	(.0209)	(.0210)	(.0288)	(.0251)
Friends' milex (ln)	-.0084	-.0052	-.0023	.0362
	(.006)	(.0089)	(.0154)	(.0300)
Foes' milex (ln)	.0368	.0179	.0306	.0622
	(.0220)	(.0296)	(.0267)	(.0583)
Lagged milex	.9372***		.9468***	
	(.0083)		(.0109)	
Constant	-.7544*	1.5723***	-.6420	1.5084***
	(.3316)	(.0549)	(.4423)	(.1277)
N	5945	6007	679	679
N-Groups	165	165	14	14
R-squared	0.9789	0.7671	0.9813	0.5466

Table 4: Substantive Effects of Determinants of National Military Expenditures

	β*2*std.dev.	Beta
P of fatal dispute	**.070**	**.087**
Real GDP (ln)	**4.190**	**.858**
Actual fatal rate	**.037**	**.067**
Fatalities / population	**.059**	**.036**
Friends' milex (ln)	**.047**	**.012**
Foes' milex (ln)	**.137**	**.059**


Military Expenditures, United States, 1951-2000
10.5
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11.5
12
12.5
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1950
1960
1970
1980
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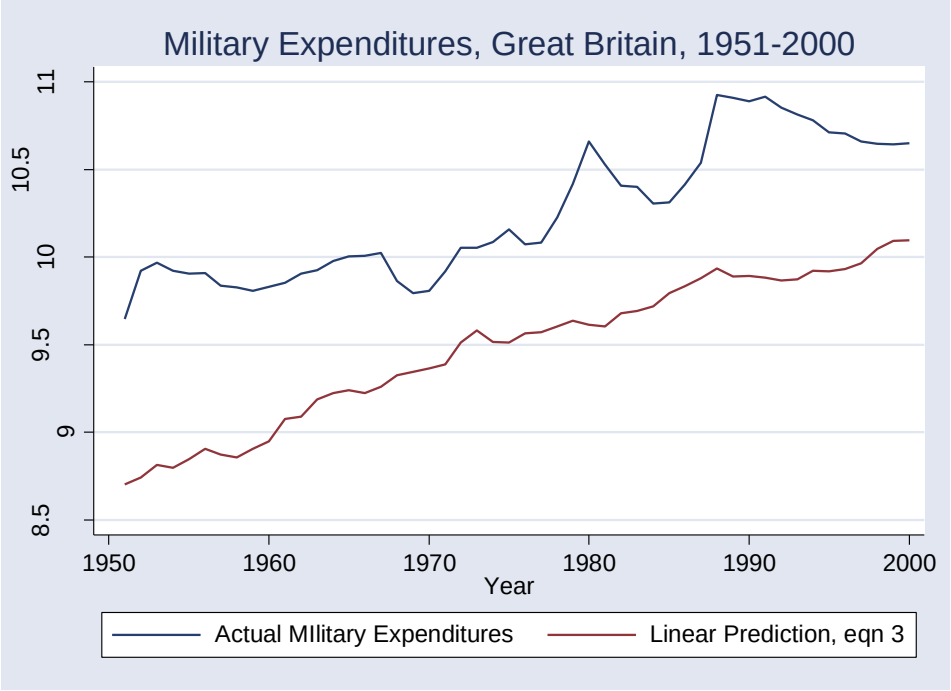
2000
Year
Actual MIlitary Expenditures
Linear Prediction, eqn 3


Military Expenditures, Great Britain, 1951-2000
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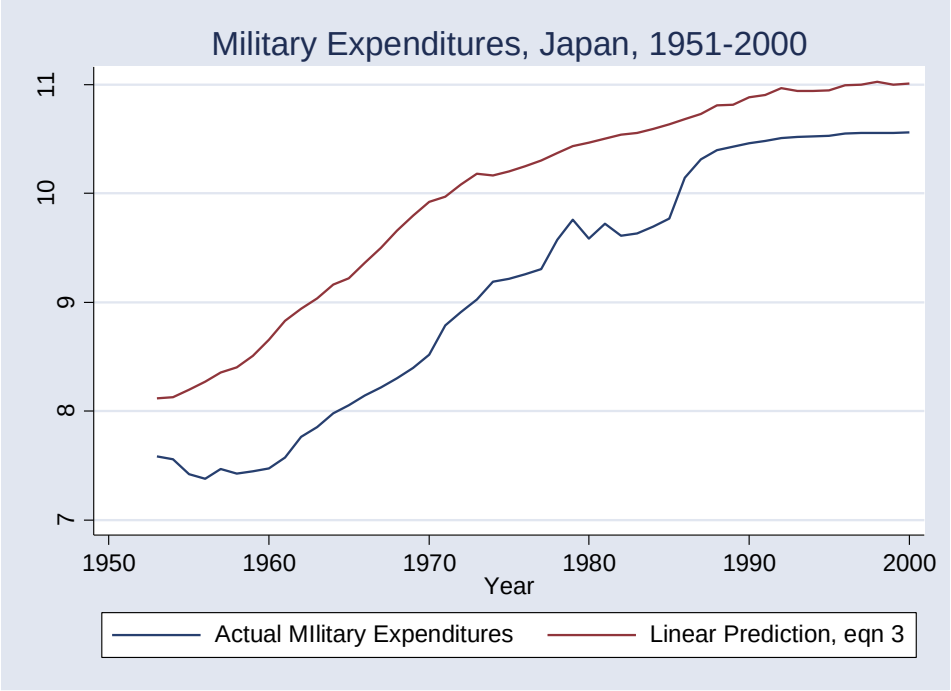
Actual MIlitary Expenditures
Linear Prediction, eqn 3


Military Expenditures, Japan, 1951-2000
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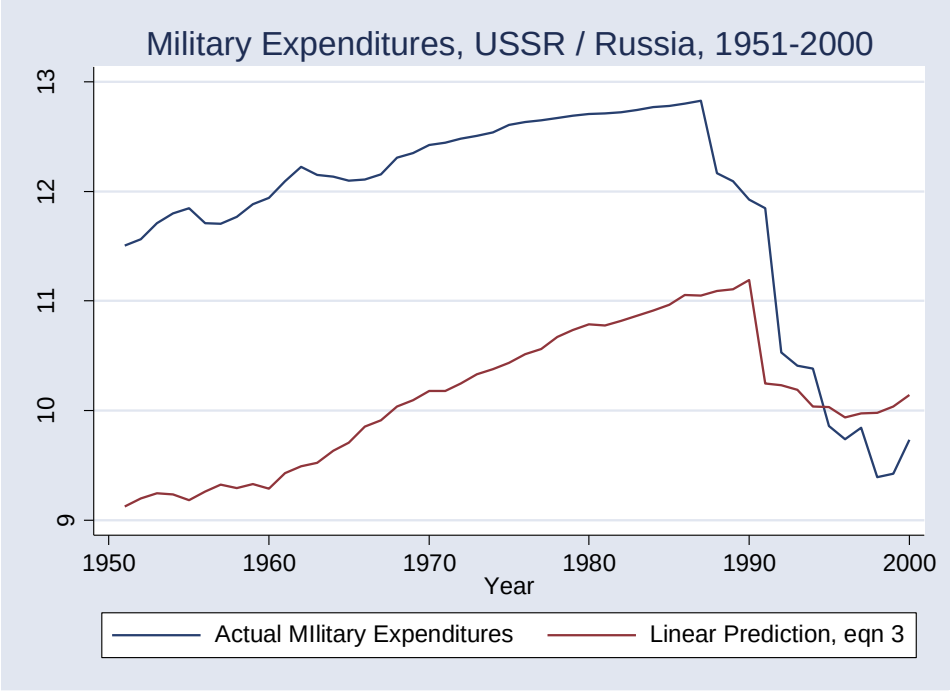
Actual MIlitary Expenditures
Linear Prediction, eqn 3


Military Expenditures, USSR / Russia, 1951-2000
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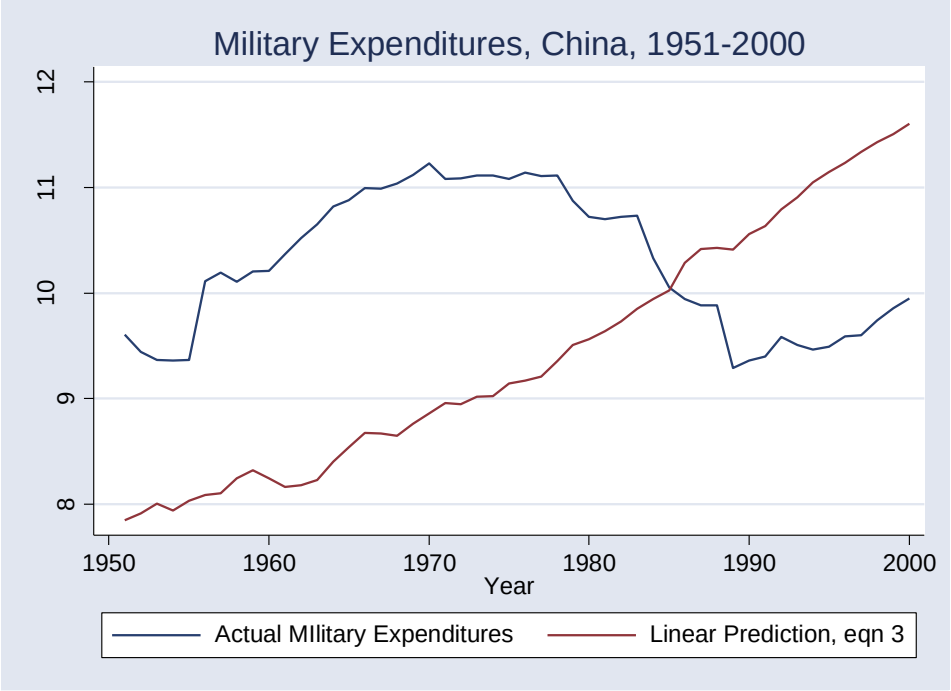
Actual MIlitary Expenditures
Linear Prediction, eqn 3


Military Expenditures, China, 1951-2000
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Actual MIlitary Expenditures
Linear Prediction, eqn 3