The Relationship between Defense Spending and Inflation

Harvey Starr; Francis W. Hoole; Jeffrey A. Hart; John R. Freeman

The Journal of Conflict Resolution, Vol. 28, No. 1 (Mar., 1984), 103-122.

Stable URL:
http://links.jstor.org/sici?sici=0022-0027%28198403%2928%3A1%3C103%3ATRBDSA%3E2.0.CO%3B2-A

The Journal of Conflict Resolution is currently published by Sage Publications, Inc..

The Relationship Between Defense Spending and Inflation

HARVEY STARR
FRANCIS W. HOOLE
JEFFREY A. HART
Department of Political Science
Indiana University

JOHN R. FREEMAN
Department of Political Science
Massachusetts Institute of Technology

The relationship between defense spending and inflation has been of interest to scholars and policymakers throughout much of the post-World War II era. Yet there is no agreement as to the exact nature of the relationship. We attempt to shed some light on this matter by identifying the alternative conceptualizations of the relationship between defense spending and inflation that appear in the literature and subjecting them to empirical examination using data for the 1956-1979 era from four major Western powers. No significant relationship between defense spending and inflation is discovered in the cases of the United States and the United Kingdom, whereas defense spending and inflation are found to be mutually related in the cases of France and the Federal Republic of Germany.

> There is an old joke about the man who drank too much on four different occasions, respectively, of scotch and soda, bourbon and soda, rum and soda, and wine and soda. Because he suffered painful effects on all four occasions, he ascribed, with scientific logic, the common effect to the common cause: "I'll never touch soda again!"
>
> —Leslie Kish (1959: 333)

Inflation is, without question, a central issue for governments throughout the world. In fact, Calleo argues boldly that the "relentless

AUTHOR'S NOTE: This research was supported by a Faculty Research Grant from the Indiana Consortium for Security Studies (INCSS) and financial assistance from the Department of Political Science, Indiana University. We are grateful to John Lovell,

JOURNAL OF CONFLICT RESOLUTION, Vol. 28 No. 1, March 1984 103-122

acceleration of domestic inflation" is one of the major factors that has produced the "present disarray of American policy" (1981: 781). He also asserts that "government policy is the efficient if not the ultimate cause of inflation" (1981: 784). Many would also add that inflation obviously motivates governments to adopt certain policies.

Defense spending is, of course, one of the governmental policies most frequently linked to inflation. Especially since the Vietnam war, defense spending in the United States has been scrutinized as closely as any other governmental activity. Policymakers, analysts, and the citizenry alike have come to realize that security is a more complex issue than simply spending money for defense. For example, Knorr has noted that the "question of national priorities raised by military demands turns on the relation between the expected utility of satisfying these demands . . . and the expected disutility imposed by opportunity costs" (1977: 192).

The complex relationship between defense spending and inflation has been of interest to scholars and policymakers at least since World War II. Although concern with the strength and form of such a relationship is not new, the interest has been taken up with renewed fervor in the United States because of the Reagan administration's policy of attacking inflation yet increasing defense spending to record high levels. For example, MIT economist Thurow, in an article in *the New York Review of Books* (1981), reopened the public debate on the relationship between defense spending and inflation with an attack on the Reagan policy, asserting that the Reagan-backed increase in defense spending would be highly inflationary (for an elaboration of his arguments, see Thurow, 1980). Numerous other analysts have more recently joined the debate.

Yet there is no agreement among economists, political scientists, or policy analysts as to the exact nature of the relationship between defense spending and inflation. We will attempt to shed some light on this matter by identifying the alternative conceptualizations of the relationship between defense spending and inflation that appear in the literature and subjecting them to empirical examination. We investigate the defense spending and inflation relationship in a comparative context by using data from 1956 to 1979 for the United States, the United Kingdom, France, and the Federal Republic of Germany. While several

---

Coordinator of INCSS for his intellectual support as well, and to Nancy Quirk for her assistance during the data collection phase of the project. An earlier draft of this article was delivered at the annual meeting of the International Studies Association, Midwest, St. Louis, November 1982.

studies have examined the trade-off between defense and social welfare spending from a comparative perspective (e.g., Domke et al., 1983; Caputo, 1975; Russett, 1970, 1969; Rimlinger, 1971), little in-depth comparative work has been done on the defense spending and inflation relationship. Yet we will show that there are reasons to believe that the character of the relationship varies across countries. It is also worth noting that there is agreement in the literature that inflation and defense spending are complex phenomena and disagreement over the best way to measure them (e.g., Clayton, 1976; Boulding, 1979; Weidenbaum, 1974). Our research strategy is to use simple measures of defense spending and inflation, a relatively uncomplicated bivariate approach, and a flexible yet rigorous set of statistical techniques. We will not be developing a complete model of inflation in this article. Instead we wish to begin to sort out the direction and extent of the bivariate relationship between defense spending and inflation, as a way of approaching a relatively complex topic. By beginning with simple analytic models, we will be able to comment on the bivariate policy recommendations found in both the academic and the journalistic literatures. We also hope to provide the basis for subsequent work on a more complex model focusing on defense spending and inflation.

PLAUSIBLE BIVARIATE RELATIONSHIPS BETWEEN DEFENSE SPENDING AND INFLATION

There is no widespread agreement about the existence and form of the relationship between defense spending and inflation. While many observers argue that defense spending has a clear and direct causal effect on inflation, three other possibilities exist, and each has its own proponents and supporting rationale. Not only may defense spending affect inflation but inflation may affect defense spending; in addition, each may affect the other in a two-way relationship or there may be no relationship between defense spending and inflation. We briefly review the general arguments below that have been presented for each of these possible relationships.

DEFENSE SPENDING AFFECTS INFLATION

A review of journals in economics and business reveals a common perception that defense spending is and frequently has been used as an

economic instrument—a "macroeconomic tool" (e.g., Business Week: January 19, 1976). The Council of Economic Priorities notes simply that military spending is the largest mechanism available to the federal government for stimulating the economy with purchases (DeGrasse, 1983: 153). Hence policymakers often perceive that defense spending is useful in affecting both recession and inflation. The main assumption is the widespread, fundamental belief that defense spending is inflationary. Several observers (e.g., Calleo, 1981; Steel, 1981) link defense spending to domestic and foreign policies that *overextend,* due to the conscious efforts of those pursuing ambitious policies who are unwilling to tax or to cut back expenditures of a nation's resources in other areas, thus leading inexorably to inflation.

Similar arguments are found in discussions linking war to inflation (e.g., Hamilton, 1977; Stein, 1980; Melman, 1970). Without taxation to cover the costs of warfare, war is found to be clearly inflationary: "Wars and revolutions . . . have been the principal causes of hyperinflation in industrial countries in the last two centuries" (Hamilton, 1977: 18). A Congressional Budget Office report indicates that when the United States rapidly expanded defense expenditures in past war situations (using 1917, 1941, 1950, and 1965 as points of comparison), a substantial increase in inflation followed (Congressional Budget Office, 1983: xi, 5). The average inflation rate for the three-year periods preceding those dates was 3.55%, compared to a 7.3% average inflation rate for the three-year periods subsequent to those dates.

Furthermore, Hamilton and Stein point out that inflation is both much the easiest way to pay for war and a policy preferred to taxation. Resources for defense spending can be provided from increased taxation, cuts in nondefense spending, and/or deficit spending (e.g., see Carnegie Endowment for Internationale Peace, 1981: 2). Thus one alternative is to cut government spending in other areas, such as social services. This is the focus of the literature on the opportunity costs or trade-offs of defense spending. While the results differ somewhat from country to country, several studies demonstrate some trade-off between peacetime defense spending and certain forms of social welfare expenditure, investment, and/or private consumption (e.g., Caputo, 1975; Russett, 1970, 1969; Peroff and Podolak-Warren, 1979; Smith, 1980; Deger and Smith, 1983; DeGrasse, 1983).

More recent studies qualify the earlier findings of peacetime defense spending and trade-offs. Investigating trade-offs in the United States,

the United Kingdom, France, and the Federal Republic of Germany during the 1948-1978 period, Domke et. al., (1983) found that there are no trade-off patterns in the short term (meaning yearly changes in spending levels). Trade-offs are discovered in long-term trends, but they occur only in periods of war or of postwar reconstruction. Russett (1982), looking at the effects of rates of change in military spending on federal health and education expenditures in the United States, found no systematic trade-off.

The view that defense spending is responsible for inflation is also based on arguments that the economic nature of military goods leads to inflation (e.g., Dumas, 1977; Melman, 1978; Thurow, 1981; Franko, 1982). The central point is that defense spending is nonproductive, unlike other forms of economic activity (including other types of government spending). Defense spending, it is further argued, generates no additional purchasing power. The complex economic processes behind this view are summarized by Fallows (1981: 7):

> The first principle is that defense spending is inherently more inflationary than other kinds of government spending. . . . The problem with military spending, simply put, is that it adds to the demand for goods without adding to the supply. . . . Military and non-military spending add to the demand; military spending does not add to supply.

The manner in which the military procures goods and services also is considered to be inflationary. For example, Melman (1978) argues that firms serving the military run their businesses on a cost-maximizing basis and that this becomes a model for increases in costs and prices in the civilian sector as well. Because there are many military needs that can be supplied by only a few firms, heavy and rapid military spending, argues Schultze (1981), can strain the industrial base by leading to bottlenecks and shortages. This, Schultze believes, is the greatest danger of inflation in the Reagan administration's proposed defense budget. The Congressional Budget Office (1983: xiii-xiv) analysis also sees bottlenecks as driving up the costs of certain weapons systems, but concludes that this is "unlikely to spawn widespread inflation." The danger, however, is the adverse affect such bottlenecks will have on productivity in the late 1980s.

A related argument focuses on the short-term effects of switching expenditures from the civilian to the military sectors of the economy

(e.g., see DeGrasse, 1983: Chapters 2-3; Franko, 1982). Defense spending increases the demand for labor, machinery, and capital as supplier firms gear up for increased production. In the short-term, the aggregate supply of labor, machinery, and capital is more or less fixed. Therefore, in the short-term, a rapid increase in defense spending should produce an increase in wages, prices, and rents. Even in the long term, the supply of certain factors (e.g., trained engineers) will not respond quickly to increased demand, and there may be some long-term effects. Also, one can expect those industries in the civilian sector that require the same inputs as firms in the military sector to face severe shortages of supply which they are likely to pass on in the form of sharply higher prices. This is what DeGrasse calls "sectoral inflation." Finally, civilian technological progress is likely to be hindered by the diversion of capital and expertise to the military sector, thus reducing the ability of the civilian sector to offset rising production costs through technological innovation.

It is also argued in the literature that defense spending generates a greater public debt, which is inherently inflationary. DeGrasse (1983), for example, sees the Reagan administration's fiscal policies leading to large federal deficits (due mostly to defense spending), which are expected to exceed the peak deficits of the Vietnam war and thus could fuel inflation. While not anticipating inflation in the short run, the Congressional Budget Office (1983: xv) analysis indicates that in the longer run, as slack disappears from the economy, deficits caused by defense spending could produce more inflation.

The Carnegie report (Carnegie Endowment for International Peace, 1981: 3) also discusses the possibility of financing an increase in defense spending by increases in the deficit. It acknowledges that the societal costs of increasing defense spending in this way include some increase in the rate of inflation. Given the rate of inflation likely to prevail in the early 1980s, it is suggested that this would be a way of financing the increased spending projected by the Carter and Reagan administrations.

In other words, defense spending can lead to inflation through deficit spending if (1) the economy has idle capacity at the time deficits increase and/or (2) deficit spending is attractive as an alternative to cutting back nonmilitary expenditures because of the desire on the part of the federal government to stimulate the economy and its relative unconcern with the possible inflationary consequences.

The effect of increased defense spending on the balance of payments is yet another way in which it can affect inflation. The component of defense spending that is actually spent abroad (e.g., for military personnel and facilities) contributes to payments deficits. The effects of the payment deficit on inflation depends on how big the deficit is and how it is financed. A large deficit can induce downward revaluation of the currency exchange rate and thus make imports more expensive and exports more competitive. The increased cost of imports and the increased price of goods exported, due to increased foreign demand, may result in some increases in the overall rate of inflation. A large deficit, if financed by domestic borrowing can actually be deflationary, to the extent that it diverts capital away from domestic production and reduces aggregate demand. Also, if import controls are introduced to reduce a balance of payments deficit, the end result may be deflation rather than inflation.

Finally, if the country with a large deficit is a key currency country (a country whose currency is widely used by many nations as a means of transacting international business), that country can, for a time, simply continue to run a deficit and justify it in terms of the need for currencies to enhance global liquidity. Eventually, of course, this strategy will have a negative effect on the exchange rate of the key currency country, but, historically, key country currencies have been able to run balance of payment deficits for quite some time before running into this difficulty.

INFLATION AFFECTS DEFENSE SPENDING

Several observers (e.g., Kaufman, 1972; Business Week, January 21, 1980; Capra, 1981) argue that inflation is a powerful factor in rising defense expenditures. As inflation increases, it has an impact on costs and cost-overruns, and it cuts into the purchasing power of the defense dollar. Proponents of a larger defense budget often argue that increases in defense spending are required to compensate for inflation and maintain the targeted level of real defense spending. This is a kind of indexing of defense spending to inflation that creates, for all practical purposes, a causal link between the two as long as it is consistently done over time. There are international elements to this relationship as well. It might be necessary to increase spending for overseas facilities in allied countries to which large states such as the United States have exported

their domestic inflation. In addition, a state may increase defense spending to match an opponent whose own defense spending has increased due to inflation. Thus we must consider the possibility that inflation is a major determinant of increased defense spending. On the other hand, it is conceivable that inflation may stimulate cuts in defense spending as governments use defense spending as an inflation reducing device.

TWO-WAY RELATIONSHIP BETWEEN DEFENSE SPENDING AND INFLATION

If defense spending does have an impact on inflation, then many observers would entertain the prospect that the relationship between defense spending and inflation involves a complex two-way feedback process. Indeed, most of the literature is consistent with the idea of either a one-way relationship wherein defense spending affects inflation or a complex two-way feedback relationship between defense spending and inflation.

NO RELATIONSHIP BETWEEN DEFENSE SPENDING AND INFLATION

Publications by several observers emphasize that defense spending and inflation do not or need not have any meaningful relationship. One view, illustrated by a Merrill Lynch Economics analysis reported in *Forbes* (January 21, 1980), suggests that nondefense policies can and do produce a strong private sector and national economy as a whole, and thus enable the economy to absorb higher defense spending without increased inflation. Such policies include reduced government regulation, cutting spending in other areas such as the social welfare field, tax cuts and growth-oriented tax changes, and policies to take advantage of slack capacity in the economy. One major conclusion of the Carnegie report (Carnegie Endowment for International Peace, 1981: 37) is that the United States would be able to devote additional economic resources to defense with no major impact on inflation, due to economic growth and continued slack in the economy (this would include an increase in defense spending equal to 1% to 1.5% of the GNP). The main

factor in regard to inflation would be how the increased defense spending would be financed. The Congressional Budget Office (1983: xii) similarly notes that a slow recovery and slack in the economy will permit increased defense spending without inflation in the short term.

Along the same lines, Schultze observes (1981: 1): "The United States is fortunate in having an economy, that, with proper policies, can adjust to about as high or low a level of defense spending as the nation and its leaders think is appropriate." He goes on to discuss the special problems that arise over the short run from a rapid increase in defense spending. He also attempts to dispense with the argument that defense spending is inherently inflationary. He argues that defense spending is no more inflationary than any other type of government spending (1981: 2): "In sum, government purchases do not add to market supply in the economic sense of the term. Hence taxes must be levied. But the military nature of the goods is absolutely irrelevant." He also notes that increases in defense expenditure as a percentage of GNP need not be inflationary; they would be inflationary only if those increases came at the expense of investment rather than consumption.

Several publications present evidence that appears to fit together to suggest there may be no meaningful positive relationship between defense spending and inflation. Some sources (e.g., Citibank, 1980; Boulding, 1979) have chronicled the "relentless rise of inflation" since 1965 as well as a basic postwar trend of increasing inflation. Calleo (1981: 782) notes that prices in the United States have risen approximately 177% since 1960. At the same time, other analysts have demonstrated that defense spending in real terms in the United States has been falling. For example, Clayton (1976) examines six different methods of measuring U.S. defense spending: (1) Department of Defense [DoD] method, (2) DoD method plus retirement pay, (3) Census Bureau method, (4) Joint Economic Committee method, (5) DoD Deflator method, and (6) Federal Purchases Deflator method. He concludes that no matter which method is used, defense spending in real terms has been falling.

Additional supporting evidence for the no relationship hypothesis is presented by Boulding (1979). He divides the post-World War I era into four periods: (1) the "depressed 30s," characterized by enormous deflation; (2) World War II, marked by suppressed inflation and huge deficits; (3) the "long boom" of 1948-1969, marked by moderate deficits

and moderate inflation; and (4) the "growing crisis" since 1969, marked by large and increasing deficits and accelerating inflation. Defense spending was negligible in the first of these periods, while in the second it accounted for the budget deficits and inflation. In the third period, after the Korean War, defense spending does not appear to be closely related to government deficits or to inflation. Finally, in the fourth period, one of accelerating inflation, defense spending declined as a percentage of GNP: "It cannot be blamed for the increasing deficit, and it is hard to blame it for the increased rate of inflation" (1979: 94). Moving on to a comparative perspective somewhat similar to our own, Boulding examined data from Japan, West Germany, Italy, France, and Canada, and demonstrated the tenuous relationship between defense spending as a percentage of GNP and the rate of inflation.

In sum, much has been written about the link between defense spending and inflation but little agreement has been reached about how (or whether) government purchases of military goods and services affect and are affected by price changes—as can be seen from the four relationships outlined above. Questions have been raised about the rapidity of the increase in defense spending and the ways in which it is financed. Several recent observers have noted the differential impacts of defense spending in the short and long terms. In addition, many studies recognize the possibility that the character of the relationship varies across countries. For example, the financing of defense spending may have a greater (or lesser) effect on investment, or defense spending may create more severe shortages in particular economies. But, to date, only Boulding's study of some of these issues has been explicitly comparative.[1]

METHODOLOGICAL CONSIDERATIONS

The statistical concept employed in this article is a revision of the one known as "Direct Granger Causality."[2] A variable X is said to "Granger

1. Schultze (1981) and others have not addressed the question of whether certain features of other countries' economies would alter their conclusions about the nature of the relationship between defense spending and inflation. And, while Boulding's study is more comprehensive in considering the sources and impacts of defense spending in countries other than the United States, methodologically his analysis is open to a number of criticisms, the most notable of which is his failure to account for autonomous sources of change in each of his variables. The method we employ takes into account this possibly confounding source of internal change in each variable.

2. Granger's (1969) concept of causation is applicable in longitudinal analysis and its use is widespread in economics and business. The notion of Granger causality has been applied in the study of numerous economic relationships including those between money

cause" another variable Y, if "Y can be better predicted from the past X and Y together than the past of Y alone, other relevant information being used in the prediction" (Pierce, 1977: 11). The Granger approach allows us to ascertain whether defense spending has an impact on inflation, whether inflation has an impact on defense spending, whether there is a two way relationship between defense spending and inflation, or whether there is no relationship between defense spending and inflation.

The Direct Granger approach entails use of the following equations for each country for which we have data:

$$X_t = \sum_{i=1}^{\infty} \pi_{11} X_{t-i} + \sum_{i=1}^{\infty} \pi_{12} Y_{t-i} + u_t \qquad [1]$$

$$Y_t = \sum_{i=1}^{\infty} \pi_{22} Y_{t-i} + \sum_{i=1}^{\infty} \pi_{21} X_{t-i} + v_t \qquad [2]$$

where X is defense spending, Y is inflation and the error terms are represented by u and v.[3] A finite number of lags is chosen for the summations on the right side of the equations, and regression techniques are employed for estimation purposes. The test of the hypothesis that the π_{21} parameters are jointly zero tells us if X Granger causes Y (X

---

and prices, wages and prices, exchange rate and money supply, and money and income (see Feige and Pearce, 1979). Tests for this type of causality also have been employed in recent efforts to construct macroeconomic models of the United States (Sargent, 1979, 1976). Recently, Freeman and Duvall (1983) used the Direct Granger Approach to study the sources and outcomes of state enterprise investment. For an up-to-date treatment of the Granger approach and its relevance in the study of political relationships, see Freeman (1983).

Incidentally, we have reservations about pushing too far the idea of causality found in the Direct Granger approach. We believe that, at a minimum, the Direct Granger approach is useful for providing intriguing correlational evidence that helps us sort out the relationships between defense spending and inflation in the four countries in which we have an interest.

3. One relies on the lagged values of the endogenous variables to capture autonomous (purely endogenous) sources of the variation in X and Y, that is, to take into account the predictive capability of each variable's own history. Multicolinearity could be a problem in that it could render some of the individual π's insignificant. However, in such circumstances as these, the F statistic could still indicate the joint significance of the estimated parameters and in that way detect Granger causal relations (Kmenta, 1971: Chapter 10).

$\longrightarrow$ Y), while a test of the hypothesis that the π_{12} parameters are jointly zero indicates whether Y Granger causes X (X$\longleftarrow$Y). If both null hypotheses are accepted, we conclude that X and Y are Granger independent (X$\longleftarrow\!\!/\!\!\longrightarrow$Y). If both null hypotheses are rejected, we conclude that there is Granger feedback (X$\longleftrightarrow$Y) between X and Y.[4]

Unfortunately, the theoretical literature upon which we are building is not specific about a number of detailed technical matters relating to the application of the Direct Granger method, such as the appropriate lag structure. Of particular importance for our purposes is the idea that, for each country, each equation should be specified and estimated in exactly the same fashion, so that observed results cannot be attributed to different uses of statistical techniques. Accordingly, for detailed technical decisions regarding statistical techniques, we made what we thought were reasonable assumptions and applied them uniformly across equations and countries, with particular attention to the robustness of our conclusions.

To begin with, the Direct Granger method was implemented with five lags on the endogenous variable and five lags on the exogenous variable. The formal development of Granger causality tests assumes that X_t and Y_t are jointly covariance stationary time series. In practice, this assump-

4. There are two main approaches within the Granger tradition. One is the Direct Granger Causality approach that was introduced in the text, and the other is known as the Haugh-Pierce approach. The latter involves use of cross transfer functions within the Box-Jenkins tradition of ARIMA modeling; it recently has been applied to the study of arms races by Majeski and Jones (1981). We decided to employ the Direct Granger Causality approach because recent studies seem to indicate it is the most appropriate approach for assessing time-series relationships. For instance, there now are appearing comparative studies of the formal properties of different causal methods and also comparative experimental evaluations of alternative procedures for assessing Granger causality. Two of the most cited of these are studies by Nelson and Schwert (1983) and Geweke et al. (1983). These two investigations rely on Monte Carlo approaches, with the latter study also focusing on certain statistical properties of different tests. The conclusions of the papers are similar in that they indicate the Direct Granger method either is comparable or superior to competing tests in a number of respects, including statistical power. In other words, we can give greater credence to the Direct Granger test because the Monte Carlo investigations both concluded that the Haugh-Pierce test was inferior to the Direct Granger test in terms of statistical power; that is, the Haugh-Pierce test has a higher probability of failing to reject a null hypothesis that is, in fact, false. It appears to us that the Direct Granger method offers the greatest potential for studies of economic and political relationships. The most serious possible problems with either Granger causality approach would appear to be measurement errors and missing variables. For an overview of many of the relevant issues, see Pierce (1977) and Freeman (1983).

tion is satisfied by procedures such as first differencing; log transformations also are employed for the purpose of ameliorating heteroskedasticity. We decided to follow the same convention. The first difference of the natural logarithm of each variable (total defense spending in current dollars and the consumer price index) was used in the lagged regressions, and the analysis was carried out with an intercept and a trend term for each equation in each country's bivariate system. The logarithmic transform is a variance stabilizing device that preserves Granger causality. The intercept term is included to capture any drift (constant rate of change) in the dependent variables, while the trend term takes into account any (de)acceleration in the same variables. To allow for the possibility of contemporaneous correlation between disturbances in the two equation system, the Zellner GLS procedure for seemingly unrelated equations was employed in fitting each pair of regression equations simultaneously.[5] The residuals from the estimated equations were analyzed for higher order autocorrelation, using Box-Jenkins techniques and the Q statistic.[6] The tests for the joint significance of the the estimated regression parameters, the π_{ij}'s, are based on F statistics.[7] We elected to use the .05 level for all tests of significance.

Annual data were collected from public documents on total defense spending and from the consumer price indexes for the United States, the United Kingdom, France, and the Federal Republic of Germany.[8] The data were available on both variables for all four countries for the 1950-1979 era. The analysis reported here is conducted using data for

5. For an introduction to the estimation of systems of seemingly unrelated equations, see Pindyck and Rubenfeld (1981: 323-324, 331-334). The example of this kind of estimation being used with Direct Granger methods is Cuddington (1980). The SHAZAM computer program was used for the regression analyses reported in the paper. The analysis was done at the Wrubel Computing Center of Indiana University.

6. For an introduction to Box-Jenkins techniques and the Q statistic, see McCleary and Hay (1980). The Box-Jenkins computer program (Pack version) was used for the Box-Jenkins analyses reported in the paper. The work was done at the Wrubel Computing Center of Indiana University. A small sample version of Q is available. But its application alters the values of Q only slightly. For example, the Q for the French defense spending residuals in Table 1 increases only from 21.23 to 21.45.

7. For an introduction to the basic approach underlying these tests, see Wright (1976). The SHAZAM computer program was used for the calculation of the F statistics reported in the paper.

8. The data were collected from the following sources: United Nations (1951-1978), International Monetary Fund (1981), and Stockholm International Peace Research Institute (1980, 1979, 1970). We considered using constant (deflated) dollars rather than

the dependent variables for the 1956-1979 period because of the use of first differences and lagged variables.

EMPIRICAL FINDINGS

The results of the empirical analysis are presented in Table 1. The Q statistics indicate the lack of statistically significant problems of autocorrelation of error terms and the value of the system R^2's suggests reasonable fits for the two equation systems for each country.[9] Furthermore, examination of the autocorrelation functions of the error terms indicates no meaningful violations of the .05 level confidence interval bounds. These diagnostic checks suggest that it is reasonable to employ the F statistic in testing the hypotheses of interest.

A significant F statistic allows us to reject the relevant null hypothesis in Table 1 and infer the existence of the respective hypothesized relationships between defense spending and inflation. As can be seen in Table 1, both F statistics for France and West Germany are significant at the .05 level. This means that the lagged values of inflation jointly have a statistically significant impact on defense spending, and the lagged values of defense spending jointly have a statistically significant impact on inflation. Hence, *for France and for the Federal Republic of Germany, there is Granger feedback ($X \longleftrightarrow Y$) between defense spending and inflation.* As can also be seen in Table 1, both F statistics for the United States and the United Kingdom are insignificant at the .05 level. The lagged values of inflation jointly do not have a statistically significant impact on defense spending, and the lagged values of defense spending jointly do not have a statistically significant impact on inflation. Hence, *for the United States and the United Kingdom, there is*

current dollars for the defense spending variable. We decided not to do so because, among other reasons, of the danger that we might create a statistical artifact in the relationship with inflation. Furthermore, we believe that our manner of operationalizing the variables is consistent with the theoretical arguments upon which we are building. It should be obvious that our findings are constrained by our operational procedures, but that is true for any empirical study. Subsequent consideration of operational procedures is clearly in order.

9. It is acknowledged that it is difficult to interpret the large R^2 values when there are numerous lags of endogenous and exogenous variables and a small number of cases.

TABLE 1
Assessment of Relationships Between Defense Spending and Inflation, 1956-1979

	Null Hypotheses of Relationship Between Defense Spending and Inflation				
	The past history of inflation does not predict *defense spending.*		The past history of defense spending does not predict *inflation.*		
	F (*df* = 5,24)	*Q* (*df* = 20)	*F* (*df* = 5,24)	*Q* (*df* = 20)	*System* R^2
United States	1.41	14.59	.82	14.51	.92
United Kingdom	1.16	14.81	1.92	14.55	.89
France	3.19*	21.23	6.61*	13.39	.95
West Germany	3.81*	18.45	4.87*	18.32	.91

*Significant at the .05 level. A significant F statistic allows rejection of the respective null hypothesis. An F value of 2.62 is needed for significance at the .05 level with 5 and 24 degrees of freedom. A Q value of 31.41 is needed for significance at the .05 level with 20 degrees of freedom. The Zellner GLS procedure for seemingly unrelated equations was employed in fitting each pair of regression equations simultaneously. For the analysis reported in this table, the changes in the natural logarithms of the original series were employed and time trend variables and intercepts were included in the regression equations. Five lags of the dependent variable and five lags of the independent variable were used. The F statistic was calculated under the hypothesis that the coefficients on the five lags of the exogenous variable were jointly zero. The Q statistics were calculated on the residuals using lags of 20. The lack of a significant Q statistic means there is no statistically significant higher order autocorellation of error terms. For completeness, the system R^2 for each country is reported.

Granger independence ($X \leftarrow\!/\!\rightarrow Y$) between defense spending and inflation.

In an attempt to determine if these results were robust, we conducted some additional analyses of our time series data. For example, we wondered whether a trend term was needed in the analysis. Examination of the t tests of the regression coefficients of the time variable indicated statistical significance for five of the eight equations. We decided to treat each equation the same way and leave in the time variable. In addition to using five lagged endogenous and five lagged exogenous variables, we conducted analyses using four by six, five by six, six by six, and six by seven lag structures. In all of these supplementary analyses, the empirical findings were identical to those reported in Table 1.[10] In the spirit of Campbell and Stanley (1963) and Cook and Campbell (1979), we have a

10. We felt that models with fewer lags might have an insufficient number of lags to capture relationships between variables while those with a higher number of lags would seriously reduce our degrees of freedom. The models examined seemed to be reasonable ones, and it is reassuring that they all produce identical substantive results.

bit more faith in our empirical findings and substantive inferences because we tentatively ruled out some potentially confounding factors.

DISCUSSION

What is to be made of results that suggest two-way effects between defense spending and inflation in France and West Germany and no relationship between the same variables in the United States and the United Kingdom? Recall that Domke et al. (1983: 33) studied trade-offs in the same four countries; their research produced differential results across all four countries, and they noted that "our results demonstrate little generality in national allocation patterns."

Clearly the relationship between defense spending and inflation is a complicated one, and our findings suggest that many of the claims found in the literature do not clearly and unambiguously hold up across countries. It should be recalled Schultze argues that the impact of defense spending is mitigated if such spending comes at the expense of consumption rather than investment. Russett (1970: 141-142), in an analysis of American defense spending from 1939 to 1968, notes that "private spending has indeed been the largest alternative use of defense money," with spending on durable goods being most affected by increases in defense spending. Russett observed that, for his data, defense spending, at least during the period Russett analyzed, took the each new dollar of defense spending consists of 42 cents that come from consumption. Investment is also affected by defense spending—72% of the variance is explained. However, each new dollar of defense spending takes only 29 cents from investment. In Schultze's terms, American defense spending, at least during the period Russett analyzed took the less inflationary course by drawing resources from consumption rather than from investment. A similar argument may be made for the defense spending-inflation relationship in the United Kingdom. Russett (1969: 425) noted that "the British were very good at maintaining investment during periods of expanding military demands, though perhaps they were sometimes a little slow to take advantage of a declining arms budget."

In addition, it seems reasonable to conjecture that in the 1950s and 1960s defense spending put a much greater strain on the industrial bases of Germany and France. This showed up in terms of inflation, both in the effect of defense expenditure on investment and in the lack of slack

in the French and German economies compared to those of the United Kingdom and the United States. Recall that the amount of slack in the American economy was a prominent variable in several recent analyses of defense spending and the U.S. economy.

Another important variable, related to the slack in America and Britain and to their ability to spend on defense, is the relationship between the states concerned and the international monetary system. One feature common to the United States and Britain is that both countries historically have had "key currencies." A key currency is not simply a "hard currency" (one that easily and predictably can be converted into others), but is to a certain extent a world currency that is used frequently in international transactions and can affect the global availability of foreign exchange for those transactions. By running a deficit, a key currency country can increase global "liquidity" in a way analogous with the issuance of additional currency by government treasuries in domestic economies.

While Britain's pound sterling is no longer as important as it once was, it was possible for Britain, like the United States, to shift some of the costs of maintaining a large defense establishment by exporting the inflationary effects of defense spending through running balance of payments deficits. After 1956, Britain found itself less and less able to do this. Instead, the British elected to maintain the value of the pound so that it could remain a key currency, by keeping deficits and inflation as low as possible. The negative impact this had on domestic growth and the international competitiveness of British industries is still being felt. Eventually, the British cut back defense spending to more realistic levels. Thus the negligible relationship between defense spending and inflation in Britain seems to be a consequence of a unique and probably ill-advised policy of defending the pound as a key currency during a period of military and economic decline (see Blank, 1978).

The United States used the key currency status of the dollar to export its inflation by running balance of payments deficits in the 1950s and 1960s (for a full development of this argument, see Calleo, 1981). Although the United States has had by far the highest defense spending as a percent of GNP of the countries under study, the special position of the dollar may have allowed the United States not only to use slack in its own economy to absorb possible inflationary effects of defense spending, but to use slack in the world economy as well.[11]

11. We also need to raise the question of whether or not the United States in the 1980s is beginning to resemble the United Kingdom: A declining military power that defends its

Both defense spending and inflation are very complex phenomena. We have shown that during the period of our study there appeared to be a direct two-way relationship between these phenomena in France and the Federal Republic but that no simple and direct relationship existed in the United States and the United Kingdom. It appears that other factors must also be taken into account. We hope that a contribution has been made by the provision of a stimulus for further research on the important defense spending-inflation relationship. Considerable work remains to be done on the theoretical and empirical levels. We encourage other scholars to join in these research efforts.

REFERENCES

BLANK, S. (1978) "Britain," in P. Katzenstein (ed.) Between Power and Plenty. Madison, WI: Univ. of Wisconsin Press.

BOULDING, K. E. (1979) "The war industry," pp. 91-100 in C. C. Walton (ed.) Inflation and National Survival (The Academy of Political Science, Proceedings, Vol. 33, No. 3). New York: Academy of Political Science.

Business Week (1980) "More shocks for the monetary system." January 21, 1980: 86-88.

——— (1976) "The impact of cuts in defense spending." January 19, 1976: 51-52.

CALLEO, D. P. (1981) "Inflation and American power." Foreign Affairs 59: 781-812.

CAMPBELL, D. T. and J. C. STANLEY (1963) Experimental and Quasi-Experimental Designs for Research. Chicago: Rand McNally.

CAPRA, J. R. (1981) "The national defense budget and its economic effects." Federal Reserve Bank of New York Q. Rev. 6: 21-31.

CAPUTO, D. A. (1975) "New perspectives on the public policy implications of defense and welfare expenditures in four modern democracies: 1950-1970." Policy Sciences 6: 423-446.

Carnegie Endowment for International Peace (1981) Challenges for U.S. National Security: Defense Spending and the Economy. New York: author.

Citibank (1980) "Inflation: a global rule-of-thumb." Citibank Monthly Economic Letter (July): 7-10.

CLAYTON, J. L. (1976) "The fiscal limits of the warfare-welfare state: defense and welfare spending in the United States since 1900." Western Pol. Q. 29: 364-383.

---

key currency status at the expense of the domestic economy. A counterargument is that the American economy is still vigorous, that pressure groups will force the Reagan administration to allow the value of the dollar to decline once again, and that the nature of recent increases in defense spending actually will aid U.S. industries in their competition with the Japanese and the Europeans.

Congressional Budget Office (1983) Defense Spending and the Economy. Washington, DC: Government Printing Office.

COOK, T. D. and D. T. CAMPBELL (1979) Quasi-Experiments: Design and Analysis Issues for Field Settings. Chicago: Rand McNally.

CUDDINGTON, J. (1980) "Simultaneous equations tests of the natural rate and other classical hypotheses." J. of Pol. Economy 88: 539-549.

DEGER, S. and R. SMITH (1983) "Military expenditure and growth in less developed countries." J. of Conflict Resolution 27: 335-353.

DeGRASSE, R. W. (1983) Military Expansion and Economic Decline: The Impact of Military Spending on U.S. Economic Performance. Armonk, NY: Council on Economic Priorities/ M.E. Sharpe.

DOMKE, W., R. EICHENBERG, and C. KELLEHER (1983) "The illusion of choice: defense and welfare in advanced industrial democracies, 1948-1978." Amer. Pol. Sci. Rev. 77: 19-35.

DUMAS, L. J. (1977) "Economic conversion, productive efficiency and social welfare." Peace Research Reviews 7: 17-52.

FALLOWS, J. (1981) "Defense, taxes and the budget." Atlantic (August): 7-8.

FEIGE, E. L. and D. K. PEARCE (1979) "The causal relationship between money and income: some caveats for time series analysis." Rev. of Economics sand Statistics 61: 521-533.

Forbes (1980) "Unexpected dividend." January 21: 8.

FRANKO, P. (1982) "The hidden costs of defense spending." University of Notre Dame, Ad Hoc Committee for the Prevention of Nuclear War. (mimeo)

FREEMAN, J. R. (1983) "Granger Causality and time series analysis of political relationships." Amer. J. of Pol. Sci. 27: 327-358.

——— and R. D. DUVALL (1983) "International economic relations and the entrepreneurial state." Econ. Development and Cultural Change (Fall).

GEWEKE, J., R. MEESE and W. T. DENT (1983) "Comparing alternative tests of causality in temporal systems: some analytic results and experimental evidence." J. of Econometrics 21: 161-194.

GRANGER, C. (1969) "Investigating causal relations by econometric models and cross-spectral methods." Econometrica 37: 424-438.

HAMILTON, E. J. (1977) "The role of war in modern inflation." J. of Econ. History 37: 13-19.

International Monetary Fund (1981) International Financial Statistics, Vol. 34. Washington, DC: Author.

KAUFMAN, R. F. (1972) "The Pentagon stokes inflation." The Nation (May 1): 555-558.

KISH, L. (1959) "Some statistical problems in research design." Amer. Soc. Rev. 24: 328-338.

KMENTA, J. (1971) Elements of Econometrics. New York: Macmillan.

KNORR, K. (1977) "Economic interdependence and national security," pp. 1-18 in K. Knorr and F. Trager (eds.) Economic Issues and National Security. Lawrence, KS: Regents Press of Kansas.

MAJESKI, S. J. and D. JONES (1981) "Arms race modelling: causality analysis and model specification." J. of Conflict Resolution 25: 259-288.

McCLEARY, R. and R. A. HAY, Jr. (1980) Applied Time Series Analysis for the Social Sciences. Beverly Hills, CA: Sage.

MELMAN, S. (1978) "Inflation and unemployment as products of war economy." Peace Research Reviews 7: 17-52.
——— (1970) Pentagon Capitalism. New York: McGraw-Hill.
NELSON, C. R. and G. W. SCHWERT (1983) "Tests for predictive relationships between time series variables: a Monte Carlo investigation." J. of the Amer. Stat. Assn. 77: 11-18.
PEROFF, K. and M. PODOLAK-WARREN (1979) "Does spending on defence cut spending on health? A time-series analysis of the U.S. economy 1929-74." British J. of Pol. Sci. 9: 21-39.
PIERCE, D. (1977) "Relationships—and lack thereof—between economic time series, with special reference to money and interest rates." J. of the Amer. Stat. Assn. 72: 11-22.
——— and L. D. HAUGH (1977) "Causality in temporal systems: characterization and a survey." J. of Econometrics 5: 265-293.
PINDYCK, R. S. and D. L. RUBENFELD (1981) Econometric Models and Economic Forecasts. New York: McGraw-Hill.
RIMLINGER, G. V. (1971) Welfare Policy and Industrialization in Europe, America and Russia. New York: John Wiley and Sons.
RUSSETT, B. M. (1982) "Defense expenditures and national well-being." Amer. Pol. Sci. Rev. 76: 767-777.
——— (1970) What Price Vigilance? New Haven: Yale Univ. Press.
——— (1969) "Who pays for defense?" Amer. Pol. Sci. Rev. 63: 412-426.
SARGENT, T. (1979) "Causality, exogeneity, and natural rate models: a reply to C.R. Nelson and B.T. McCullum." Journal of Political Economy 87: 403-409.
——— (1976) "A classical macroeconomic model of the United States." J. of Pol. Economy 84: 207-237.
SCHULTZE, C. L. (1981) "Economic effects of the defense budget." The Brookings Bull. 18: 1-5.
SHEEHAN, R. G. and R. GRIEVES (1982) "Sunspots and cycles: a test of causation." Southern Econ. J. 48: 775-777.
SMITH, R. (1980) "Military expenditure and investment in OECD countries." J. of Comparative Economics.
STEEL, R. (1981) "Containing containment." New Republic (June 13): 11-14.
STEIN, A. A. (1980) The Nation at War. Baltimore, MD: Johns Hopkins Univ. Press.
Stockholm International Peace Research Institute (1980) World Armaments and Disarmament, 1980. London: Taylor and Francis Ltd.
——— (1979) World Armaments and Disarmament, 1978. London: Taylor and Francis Ltd.
——— (1970) SIPRI Yearbook 1968-1969. New York: Humanities Press.
THUROW, L. C. (1981) "How to wreck the economy." New York Rev. of Books (May 14): 3+.
——— (1980) The Zero-Sum Society. New York: Basic Books.
United Nations (1951-1978) UN Statistical Yearbook, 1950-1977 editions. New York: author.
WEIDENBAUM, M. L. (1974) The Economics of Peacetime Defense. New York: Praeger.
WRIGHT, G. C. (1976) "Linear models for evaluating conditional relationships." Amer. J. of Pol. Sci. 20: 349-373.