BENOIT REVISITED: DEFENSE SPENDING AND ECONOMIC GROWTH IN LDCs

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Lisa M. Grobar and
Richard C. Porter

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

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**Department of Economics, The University of Michigan

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ABSTRACT

In the early 1970s, Emile Benoit shocked development economists by presenting positive cross-country correlations between military expenditures and economic growth rates in less developed countries. Skeptics have abounded, and Benoit's research has been much worked over, both conceptually and statistically. This paper reviews this debate. We conclude that Benoit's findings were aberrant: Most studies suggest that military spending does have an adverse impact on economic growth in developing countries, largely through its adverse effect on saving and investment.

RESUME

Au début des années 1970s, Emile Benoit a choqué les économistes du développement avec sa présentation de correlations à transversales positives entre les dépenses militaires et le taux de croissance économique dans les pays en développement. Les sceptiques ont abondé, et les recherches de Benoit ont été examinées dans beaucoup de travaux, aussi bien du point de vue de sa conception que de ses statistiques. Le présent travail passe en revue ce débat. Nous concluons que les résultats de Benoit étaient aberrants: La plupart des études suggère que les dépenses militaires ont un effet clairement négatif sur la croissance économique dans les pays en développement, principalement à cause de son effet négatif sur l'épargne et l'investissement.

... guns kill in more ways than one.[1]

I. INTRODUCTION

In the early 1970s, Emile Benoit shocked development economists by presenting positive cross-country correlations between military expenditures and economic growth rates in less developed countries (LDCs) (Benoit, 1972, 1973, and 1978). Skeptics have abounded, and Benoit's research has been much worked over, both conceptually and statistically. This paper reviews this debate. What is gradually emerging is a consensus that Benoit's findings were aberrant. Higher defense expenditures reduce economic growth, primarily through the reduction of saving rates.

We first review Benoit's arguments and conclusions (Part II). These contain four strands:

1. While Benoit's work has become notorious for its correlations, it begins with a review of the potentially adverse effects that defense expenditures might impose on economic growth. Implicit in this review is a theoretical model of the LDC growth process. This model is explicitly constructed here, and it is shown that Benoit's conclusion — that a one-percentage-point rise in military spending will reduce the GDP growth rate by 0.25 percentage points — is clearly an upper-bound estimate.

2. Benoit then goes on to discuss the potentially favorable growth effects of defense spending. Here, he provides no more than a list — no model, even implicit; and no numbers, even illustrative. Most of the interesting tests of Benoit's work that we will later discuss consist essentially of formalizing the workings of these potentially favorable effects.

3. The concepts of growth and defense to be utilized in the empirical work are Benoit's next concern. The conceptualization is inevitably weak: since Benoit's hypotheses about the possibly favorable influences of military spending are several and vague, it is not clear how to test them. Others have complained about Benoit's definition of external aid. Here, we show that

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1. Whynes (1979), p. 152.

the concept of "the defense burden" is also tricky; it can be captured quantitatively in a number of ways, and the various possible numerical measures may well move in different directions in response to outside forces.

4. Finally, Benoit presents correlations between GDP growth rates and military spending. The correlations are, of course, significantly positive.

Others' correlations and simple single-equation regressions much reduce one's confidence in the positive correlation. But the expected (by most people) significant negative correlation does not emerge. More complex, structural models are clearly needed. Several have appeared — they and their empirical findings are reviewed in Part III of this paper. While the models are still far from ideal and while unanimity does not emerge from the cross-country and time-series econometrics, almost all of this work points to a net negative effect of military spending on the rate of real economic growth. Military spending reduces saving and investment, and thereby reduces growth.

II. BENOIT'S HYPOTHESES, DEFINITIONS AND EVIDENCE

1. The adverse growth effects of defense

Benoit suggests three ways in which defense spending can retard growth. Although the numerical estimates of these adverse effects appear arbitrary, Benoit's thinking is actually quite consistent with a basic variation of a Harrod-Domar model of growth.

Benoit's picture of LDC growth is formed from capital, capital-output ratios, and exogenous growth rates in productivity. There is one policy choice, the decision to withdraw some part of the GDP (Y) for military use. Thus, at any moment the capital stock, K, is apportioned between military production, M, and non-military production, N. The resulting outputs depend upon the capital-output ratio, k. The apportionment of capital between sectors

(i.e. between K_m and K_n) is always made to insure that M is a policy-set fraction, m, of Y.[2] The average productivity of capital in its non-military role grows at a fixed, exogenous rate, p.[3] And a fixed fraction of non-military output, c, is consumed; the rest is invested.

Formally, the model can be written as five equations in five variables (Y, M, N, K, and K_m)[4]:

$$M = mY, \tag{1}$$

$$K_m = kM, \tag{2}$$

$$(K-K_m)e^{pt} = kN, \tag{3}$$

$$Y = M + N, \text{ and} \tag{4}$$

$$\dot{K} = (1-c)N. \tag{5}$$

Equation (1) shows the policy relation of M to Y. Equation (2) indicates how much of the total capital stock (K) must be allocated to the military sector (i.e., to K_m) to implement this military policy. Equation (3) shows the non-military output that is produced by the remaining capital, with the exponential term reflecting the productivity growth there. Equation (4) is the GDP identity. And equation (5) displays the dynamics of the model, whereby net capital formation ($\dot{K}$) consists of a fixed fraction (1-c) of non-military output. Repeated substitutions yield the differential equations,

$$\dot{K}/K = [(1-c)(1-m)]/[km + k(1-m)e^{-pt}], \text{ and} \tag{6}$$

$$\dot{Y}/Y = [(1-c)(1-m) + pk(1-m)e^{-pt}]/[km + k(1-m)e^{-pt}]. \tag{7}$$

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2. The subscripts refer to sectoral allocation (to M or N).

3. The average productivity of capital in its military role does not grow at all.

4. A "dot" over a variable refers to its derivative with respect to time (e.g., $\dot{K} = dK/dt$).

Two things should be noticed about the GDP growth rate of equation (7). One, the growth rate grows at a growing rate, owing to the double force of capital accumulation and productivity growth.[5] And two, the initial GDP growth rate can be written simply as

$$\dot{Y}/Y\ (t=0) = [(1-c+kp)(1-m)]/k. \qquad (8)$$

This, of course, is simply the familiar Harrod-Domar growth rate, with two changes: there is an exogenous productivity growth (p), and the Harrod-Domar rate is proportionately diminished by the relative size of the military allocation (m).

Benoit's picture of LDC growth is a little old-fashioned — it was, after all, conceived in the late 1960s. But it is certainly not pro-military. This can be seen through closer examination of the model and its numerical implications. Increased values of m retard non-military growth in three ways:

a. "Income shift effect" (Benoit, 1973, p. 14). An increase in m requires a once-and-for-all shift of capital from non-military to military production.

b. "Investment effect" (Benoit, 1973, p. 8). A higher value of m not only lowers the entire future path of non-military output but, since a constant fraction of that output represents investment (1-c), it lowers the rate of growth of output.

c. "Productivity effect" (Benoit, 1973, p. 11). By assumption, the capital-output ratio (k) is falling only in the non-military sector (at rate p), so that the productivity-growth force on the GDP growth rate is diminished by the increased weight of the military sector when m rises.

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5. More precisely, the growth rate of GDP grows if

$$m < [1-c]/[1-c+pk],$$

which is satisfied by almost any plausible set of parameter values; and the growth rate of GDP grows at a growing rate until

$$t > \ln[(1-m)/m]/p,$$

which is a long way from now (i.e., t=0) for almost any plausible set of parameter values.

Benoit estimates the size of each of these effects, one at a time, approximately, cumbersomely, and with worry that adding up the estimates may involve "some double counting" (Benoit, 1973, p. 15). But his resulting estimate is exactly that derived from a full application of his implicit model using his parameter values. His parameter values are (Benoit, 1973, pp. 9, 11, 12):[6]

$$m = .024,$$

$$k = 2.8,$$

$$c = .836, \text{ and}$$

$$p = .05 .$$

At these values, the per-annum growth rate of non-military output (N) over 14 years, calculated from the solution to differential equation (7), is 12.50%.[7] An increase in m by one percentage point, from .024 to .034, lowers the growth rate of N to 12.25%. Thus, the estimated impact of military spending is that a one-percentage-point rise in m will lower the non-military output growth rate by 0.25 percentage points (Benoit 1973, p. 15).

Benoit recognizes that this "would be a powerful adverse effect" (Benoit 1973, p. 15) on growth.[8] Critics of Benoit's work generally fail to notice that this theoretical discussion provides strong ammunition against military spending. His model generates high growth rates by ignoring productive factors other than capital, by ignoring diminishing returns, and by assuming high rates

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6. Such a high value of p is incorporated in Benoit's estimates because he uses the median GDP growth rate of his sample LDCs as a proxy for p (Benoit, 1973, p. 26). Actually,

$$p = [\dot{X}/X - \dot{K}/K]/[1 - m],$$

which assures that $p < \dot{X}/X$ unless

$$m > [\dot{K}/K]/[\dot{X}/X].$$

This overestimate of p augments the adverse growth effect of increases in m, as Benoit notes (Benoit, 1973, pp. 12-13).

7. Benoit estimates growth rates over such a short period of time (1951-65) partly because that is the period of his data and partly because the growth rates become incredibly large for longer periods — for these parameter values, it is 23.94% over 50 years.

8. With Benoit's parameters, consumption in AD 2000 would be 63% higher with m = .024 than it would be with m = .034.

of exogenous productivity growth in civilian output. To reach the high cost of military spending that Benoit gets — the 0.25 percentage-point estimate of the preceding paragraph — requires double-digit real GDP growth.[9] Were it not for the larger thrust of his work, Benoit would have been faulted for constructing a model that exaggerates the adverse influence of defense spending on economic growth.

2. The favorable growth effects of defense

Alongside the quantified (albeit largely implicit) model of the adverse effects of defense on growth, Benoit produces no more than a list of ways in which increased defense spending might stimulate economic growth. The list appears in several places in several variants.[10] The evidence for these "growth-stimulative benefits of defense programs is imprecise, anecdotal, and difficult to evaluate" (Benoit, 1978, p. 277). Critics usually argue that these beneficial effects are absent in most LDCs, or if present are small.[11] The following discussion of Benoit's list hints at ways these hypotheses might be tested.

a. Productivity-enhancing byproducts of military training and experience. This externality is particularly generated through the training and discipline of military personnel, who then take these skills with them to the civilian sector after demobilization. This idea suggests looking at the number of personnel involved in defense as well as, or perhaps instead of, military expenditure. Indeed, the turnover rate of military personnel may be the critical variable.

b. Military infrastructure available (at least partly) for civilian use. These quasi-public goods include not only such obvious things as roads and airports but also disaster rehabilitation, mapping, meteorological R&D, etc. The difficulty with testing this is that it is hard to conceive of the data that would meaningfully measure such investments in "infrastructure."

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9. For example, with the more modest (and more realistic) assumption that $p = 0.01$, an increase in m by one percentage point lowers the GDP growth rate by only 0.15 percentage points (i.e., from 6.89% at $m = .024$ to 6.74% at $m = .034$).

10. In Benoit (1973), on p. xxi, pp 3-4, pp. 16-20, pp 85-91, and pp. 169-180 (the India case study); in Benoit (1978), on pp. 277-278.

11. E.g., Ball (1983), p. 508.

c. Military production of close substitutes for civilian goods, which makes it "possible for the civilian economy to devote a higher share of its total output to investment" (Benoit, 1973, p. xxi). Note that a possibly higher share of a necessarily lower output, when the military expands, hardly insures expanded investment. But to the extent that the military produces socially necessary goods and services — e.g., "security" — more cheaply than the private sector would, there may be net resource savings from military expansion. Again, the data for testing are unavailable — e.g., non-military expenditures on "security".

d. A "Keynesian type" of demand creation, promoting a "fuller use of resources than would otherwise have occurred" (Benoit, 1973, p. xxi). No one today, we think, would so naively raise the suggestion that LDC growth rates can be readily elevated by expanded aggregate demand — or that expanded demand, inflation, and growth are so closely and positively related. Certainly, Benoit's own test of this is quite inadequate. He notes that, for his sample of countries, there was a "significant positive simple correlation between the rate of price increase and the rate of growth of real GDP" — once the "hyperinflation countries" were omitted (Benoit, 1973, p. 19). But selectively omitting observations that contribute to negative correlation insures a positive correlation. A macroeconomic, general equilibrium model is essential here.

e. Larger amounts of foreign economic (as well as military) aid directed to LDCs that "maintain unusually high defense burdens" (Benoit, 1973, p. xxi). If defense spending attracts foreign aid, the negative growth effect of defense spending may be more than offset by the positive growth effect of the aid it has "helped to attract" (Benoit, 1973, p. 90). Much of Benoit's book is concerned with aid and its correlations with defense and growth. But little emerges because there is no hypothesis to test. What is needed is a political-economic theory of the relation between military spending and foreign aid.

f. "Essential security required for economic progress" that is provided more fully by increased defense spending (Benoit, 1973, p. 3). Note that this is different from (c) above. Here,

national defense provides something otherwise totally lacking; by (c), national defense provides something otherwise provided more expensively by the private sector. One seemingly appropriate test would be to proxy the unmeasurable "essential security" by the measurable external conflict and to look at the impact of conflict on growth. If such conflict hurts growth and defense expenditures prevent conflict, a favorable effect is indeed located. Unfortunately for this line of testing, Benoit suggests also the idea that there are "conceivable psychological links between defense and growth" whereby "military tension sometimes" leads nations to "work extra hard" (Benoit, 1978, p. 278).

3. The concepts of growth, defense, and aid

Since the main thrust of Benoit's case about the relation of growth and military expenditures is to rest on correlations between the two variables, he naturally devotes some time to making a judicious choice of the precise concepts to be incorporated into these variables.

Actually, the growth rate concept turns out not to be critical. Benoit worries about whether it should be aggregate growth rate or growth rate per capita, GDP or GNP, and with or without military expenditure included. These are not only the logical alternatives but also the only widely available data series that attempt to capture national output and growth. But they all move together so closely that it rarely matters much which is selected.[12]

The choice of the defense burden variable is much more important, both in its conception and in the magnitude of its empirical impact. Unfortunately, Benoit devoted most of his worry to the accuracy and comparability across time and across countries of the military data that emanate from his sample countries.[13] He then took as the defense burden the "real resource expenditures" on defense, as measured by "defense expenditure as a percent of GDP" (Benoit, 1973, pp. 29, 30).

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12. Benoit decided on aggregate real GDP growth rates. He examined GDP growth rates both with the military contribution and without (i.e., the civilian gross domestic output). The correlation between the two growth rates was so high as to make them almost indistinguishable in the subsequent work.

13. This, of course, is a serious worry, but not much can be done about it. The point here is that there are other concerns and that something can be done about these.

This defense-to-GDP variable omits expenditures financed by foreign military grant aid on the grounds that they do not involve "real economic costs for the recipient" (Benoit, 1973, p. 29). But many of the possible favorable effects of defense on growth that Benoit suggested do not depend on resource exhaustion by the military but rather depend on aggregate military spending or on total military presence.

Indeed, many of the arguments about the economic impact of the military on the rest of an LDC economy turn on this very distinction between the volume of domestic resources allocated to the military, the volume of total resources allocated to the military, and the amount of income generated by (or expended on) the military. Here a simple model is developed to display the differences between various measures of the "defense burden" and to show that these different measures cannot be counted upon to be highly inter-correlated. Thus, vague claims that "the military" spurs or retards the civilian sector of the economy may simultaneously be supported and refuted by different measures of military expenditure.

Consider an idealized LDC with given GDP (Y) rationally allocating between non-military goods (N) and military strength (M) so as to maximize its welfare. The nation's welfare function is simply

$$U = M^a N \ , \tag{9}$$

with $a > 0$. Up to some modest limit (M_0), the LDC can purchase military resources at a subsidized price (P_0); P_0 might be as low as zero if military grant aid is available to it. Beyond M_0, the LDC can purchase further military resources at some higher price, P_1, either by exporting output in order to import military equipment at world prices of P_1 or by diverting domestic resources from civilian to military production at a domestic marginal rate of transformation of P_1.

Substituting this budget constraint for N in equation (9) yields the welfare function to be maximized with respect to M alone:

$$U = M^a [Y - P_0 M_0 - P_1(M - M_0)]. \tag{10}$$

The maximization yields the optimal M:

$$M = [aY + a(P_1\text{-}P_0)M_0]/[(1 + a)P_1], \tag{11}$$

which is greater than M_0 if

$$Y > [(P_1 + aP_0)M_0]/a . \tag{12}$$

We will assume that the optimal M is indeed greater than M_0 — that is, that the LDC acquires more M than the subsidized allotment permits.[14]

The actual expenditure on M, which we will call M', is

$$M' = P_0M_0 + P_1(M - M_0), \tag{13}$$

which at the optimal level of M is

$$M' = [aY - (P_1\text{-}P_0)M_0]/[1 + a]. \tag{14}$$

Often, military aid in the form of an opportunity for subsidized purchase is accompanied by loans that permit the postponement of payment. The ultimate payment — whether full or partial, owing to the "softness" of the loans, is irrelevant — may never appear as a military expenditure. In this case, there is a second measure of actual expenditure, which we will call M'':

$$M'' = P_1(M - M_0). \tag{15}$$

At the optimal level of M, this is

$$M'' = [aY - (aP_0 + P_1)M_0]/[1 + a]. \tag{16}$$

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14. $M > M_0$ is more likely the higher is a or the lower is P_1, P_0, or M_0. The condition for $M \geq M_0$ is more modest:

$$Y \geq [(1 + a)P_0M_0]/a .$$

The difference between this inequality and inequality (12) indicates the range of possible solutions at the "kink" in the budget constraint, at the point where $M = M_0$.

Finally, one might calculate the expenditure on M in world prices, which we will call M*:

$$M^* = P_1 M. \tag{17}$$

At the optimal level of M, this is[15]

$$M^* = [aY + a(P_1 - P_0)M_0]/[1 + a]. \tag{18}$$

These four concepts of the "defense burden" —M, M', M'', and M* — are not the same. Moreover, they do not all move in the same direction in response to parameter shifts. Partial derivatives permit the construction of the following table:[16]

	Rise in the Parameter Value		
Effect on	P_0	P_1	M_0
M	–	–	+
M'	+	–	–
M''	–	–	–
M*	–	+	+

For none of these three parameters, P_0, P_1, and M_0, is even the direction of the impact the same for all the measures of military spending.

A similar vagueness permeates the discussion of what concept of foreign economic aid is appropriate in a search for the determinants of the growth rate of GDP. Ideally, Benoit says "aid" should comprise the "widest" measure of "receipts of foreign exchange and goods and services obtained from abroad that are not currently 'requited', in the sense that they do not involve the current surrender of comparable domestic resources in exchange, as would be the

15. For this calculation to be relevant, we must think of P_1 as the world price, not the domestic MRT.

16. Increases in the other two parameters, Y and a, raise military spending by all four measures.

case for normal imports" (Benoit, 1973, p. 35). But, in fact, the variable selected is much less wide. Excluded are:

a. military equipment, on the grounds that "such equipment did not truly substitute for domestic resources that might otherwise have flowed into domestic investment" (Benoit, 1973, p. 35);

b. military transactions receipts, on the grounds that these "require some sacrifice of domestic resources in the form of additional imports required to provide the services" (Benoit, 1973, p. 36); and

c. private investment and multilateral official aid, on the grounds that they do not provide "true offsets against absorption of domestic resources by defense programs" (Benoit, 1973, p. 36).

What Benoit ends up with is bilateral economic aid (grants or loans). Nicole Ball criticized this choice of a particular and partial aid variable as an effort to "stack the deck in favor of the defense burden" as the source of growth (Ball, 1983, p. 510). But the correct criticism concerns neither correlations nor intentions. It is that no formal hypotheses about the aid-military-growth nexus are generated. What aid concept is appropriate is unclear because its role is unclear. Is it seen as a source of growth or is it seen as a correlated proxy for military expenditure (which, in turn, may or may not be a source of growth)?

4. Benoit's correlations

The bombshell is the correlation evidence. For a sample of 44 LDCs, for data of the 1950s and 1960s, a positive correlation appears between the ratio of military spending to GDP and the rate of growth of real GDP. It is this positive correlation that leads Benoit to suggest that the favorable effects of military spending on growth may outweigh the adverse effects.

Variations of samples and variables did not change these positive correlations. The basic correlations were Spearman rank correlations, but simple linear regressions yielded similar results. Data for the 44 LDCs were used for a shorter period, 1960-65. The correlations were calculated for the rate of growth of real GDP and for the rate of growth of real civilian GDP (which equals GDP minus military spending).[17] All variations provided positive correlation coefficients — the values of r ranged from +0.52 to +0.60.[18] Such values are of course significant.

Two kinds of questions are raised by skeptics about these correlation coefficients. Are they robust? And what do they mean? Let us look at the robustness first. By robust is meant that the same results appear even when different countries, different years, different data sources, and different definitions of variables are incorporated. Benoit's results are not robust.

Within Benoit's own sample of 44 LDCs, the significant positive correlations are highly dependent on a few observations. Jordan and Taiwan are particularly critical.[19] In both of his samples, 1950-65 and 1960-65, their military spending exceeded 10% of GDP (with the average for the complete sample being around 3 1/2%) and their real GDP growth rates exceeded 8% (with the average for the complete sample being around 5 1/2%). Omission of these two countries drops the correlation coefficients by approximately one half.[20] To a great extent the Benoit correlations really represent a question about these two countries. A superficial answer to that question might notice that these two also had the largest total net inflow of all external resources as a percentage of GNP.[21] Indeed, the simple correlation between real GDP growth rates and the total net inflow of all external resources (as a percentage of GNP) is +0.50. The

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17. Saadet Deger (1986, pp. 179-180) faults Benoit for incorrectly calculating the growth rate of real civilian GDP. Deger is right that what Benoit says he does (in Benoit, 1978, Table 1) is wrong; but what Benoit actually does is right, as a check of his calculations (in Benoit, 1973) confirms.

18. The slopes ranged from +0.30 to +0.34, suggesting that a one-percentage-point rise in defense (i.e., ratio of military spending to GDP) raises the GDP growth rate by one third of a percentage point.

19. In Benoit, Taiwan is usually called China.

20. From +0.52 to +0.25 for the 1960-65 sample, and from +0.54 to +0.27 for the 1950-65 sample.

21. Benoit (1973), Table 3-12, Column 5, p. 128. The percentage exceeded 18% for each of these two countries; the average for the entire sample was under 5%.

correlation between military spending (as a percentage of GDP) and the inflow of external resources (as a percentage of GNP) is extremely high (+0.79), making it impossible to distinguish the influence of each, separately, on GDP growth through multiple regressions involving the two variables.

Other authors have constructed LDC cross-sections of military spending and GDP growth data, and the resulting correlations are neither positive nor significant. For example, Mary Kaldor's sample of 40 LDCs for 1963-73 produces a correlation coefficient of –0.18 between military burden (i.e., the share of GNP devoted to defense) and the rate of growth (of real GNP per capita).[22] Deger reestimates Benoit's data for 1965-73 and finds a rank correlation coefficient between civilian output growth and military burden of +0.00.[23] Gavin Kennedy amasses data for 48 LDCs from various years of the 1960s and groups them by regions. Although he does not calculate the correlation coefficients, they turn out to be +0.19 for all 38 countries, –0.13 for 12 African countries, +0.28 for 11 Asian countries, and –0.42 for 18 Latin American countries.[24]

There is another sense in which the Benoit results are not robust. Slight changes in the regression formulations dramatically change the estimates of the effect of military spending and the significance of those estimates. Consider regression (1) in Table 1. This is Benoit's basic correlation; it shows that a one-percentage-point rise in the defense burden raises the real GDP growth rate by 0.30 percentage points. As other variables that Benoit considers potentially relevant are added, in regressions (2)-(4), the estimate of the coefficient on defense burden falls and becomes insignificant. Relentless, model-less empiricism says that investment and aid overwhelm defense as a propellant of growth. In any case, the simple correlation does not stand up well to additions of other "independent" variables.

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22. Kaldor (1976), Table 1. Only 23 of Kaldor's countries are the same as those in the Benoit sample (of 44). Jordan and Taiwan are in her sample — although Jordan's growth rate for this period is negative in her sample. Several other countries in the Kaldor sample had high military burdens and low growth rates: Cambodia, Laos, North Vietnam, South Vietnam, Egypt, and Yemen (Aden).

23. Deger (1986), pp. 180, 195.

24. Kennedy (1974), Tables 1, 3-5, pp. 178-189.

Table 1.

Growth Rate Regressions[1]

Independent Variable	Benoit's Symbol	Regression[2] (1)	(2)	(3)	(4)	(5)[6]
constant		4.17* (1.56)	4.18* (1.56)	3.24* (1.42)	0.97 (1.20)	1.12 (1.12)
defense burden[3]	AB	.30* (.07)	.21 (.12)	.23* (.11)	.04 (.10)	-.07 (.10)
external resources[4]	AR	--	.06 (.07)	.06 (.06)	.15* (.06)	.10 (.06)
per capita GNP	Y	--	--	.00* (.00)	.00 (.00)	.00 (.00)
investment[5]	AI	--	--	--	.20* (.05)	.22* (.05)
R^2		.29	.30	.44	.61	.56

Notes:

1. Growth rate of civilian GDP, 1950-65. The data are all from Benoit (1973).
2. Standard errors in parentheses; — indicates variable excluded; * indicates significance at 5%.
3. Military expenditures as a percent of GDP.
4. As a percent of GNP; includes military, private, and multilateral aid as well as bilateral.
5. As a percent of GDP.
6. Regression (5) is the same as (4) but with the Jordan and Taiwan observations removed.

Others have constructed large data sets for LDCs in an effort to uncover the determinants of growth. Military spending is often one of the potential determinants. A recent example regressed annual, four-year, and seven-year rates of growth of real per capita GDP on more than 30 independent variables, with more than 60 countries providing more than 800 annual observations over 1960-1980 (Landau, 1986). The estimated impact of the share of military expenditure in GDP on the GDP growth rate, in the basic regressions, is rarely (and never significantly) positive (pp. 40-43 and 60-61). Later regressions, run with interaction terms among the regressors, did produce positive and sometimes significant coefficients (pp. 54-59).[25]

25. The interaction terms were the product of various regressors and the real per capita GDP level. Such interaction terms were not included if they reduced the significance of the basic estimate of the coefficient (p. 65), as they did for military spending.

among the regressors, did produce positive and sometimes significant coefficients (pp. 54-59).[25] Landau does not speculate why the addition of such interaction terms might cause changes of sign.

Another refinement of Benoit's correlations has been the division of his sample into different types of countries. P.C. Frederiksen and Robert Looney (1983), for example, split Benoit's sample into "resource abundant" and "resource constrained" groups.[26] Basic regressions of the real growth rate of civilian GDP on defense expenditures as a percentage of GDP (and two other independent variables, investment and aid) reveal a significant positive relation in the resource abundant LDCs and a significant negative relation in the resource constrained LDCs. From this, they conclude that, while military spending may make some direct positive contribution to growth, it also has a negative impact on growth in resource constrained countries where it diverts scarce resources from more productive opportunities.

Basudeb Biswas and Rati Ram (1985) re-estimate Benoit's equations for 58 countries over the period, 1960-77, separating the sample into low-income and middle-income LDCs. They regress GDP growth on labor force growth, the share of investment in GDP, and the military burden (the ratio of military spending to GDP), and find that the coefficient on military burden for the low-income group is statistically insignificant. Running the regression for the period, 1970-77, the military burden coefficient is found to be statistically insignificant for both groups.[27]

III. TESTS USING STRUCTURAL MODELS

Going beyond mere correlations, many researchers have built structural models of LDCs that incorporate various direct and indirect linkages between the military variables and growth. Rarely do these efforts offer any support for Benoit's conjecture.

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25. The interaction terms were the product of various regressors and the real per capita GDP level. Such interaction terms were not included if they reduced the significance of the basic estimate of the coefficient (p. 65), as they did for military spending.

26. Of Benoit's 44 countries, seven are removed for lack of data, four are removed as atypical (Burma, Iraq, Syria, and Vietnam), nine are discovered (by cluster analysis) to be resource constrained (Argentina, Brazil, India, Mexico, Morocco, Peru, Philippines, Sudan, and Tanzania), and the other 24 countries fall into the resource abundant category.

27. The model, however, is conceptually suspect (see Porter, 1986).

1. Ricardo Faini, Patricia Annez, and Lance Taylor (1984) test for the effects of military spending on economic performance in the context of a traditional Keynesian model. They hypothesize that, while military spending may have short-run Keynesian stimulative effects, it also has a negative effect on growth owing to the fact that it crowds out investment, straining the "absorptive capacity" of the economy and putting pressure on available supplies of capital, skilled labor, and foreign exchange.

They test this hypothesis by regressing the GDP growth rate on the growth rates of exports and population, on the change in the share of arms spending in GDP over time, on the change in total capital inflows from abroad, on the growth rate of the country's capital stock, and on the level of GDP per capita. They divide their sample of 69 countries into six groups and estimate a regression for each of the six groups (using a "fixed-effects" model, which allows for the estimation of a separate intercept for each country).[28]

They find the coefficients on defense burden to be consistently negative except for the group of developed countries. All negative coefficients on military burden are statistically significant except in the regression on the Asia group.

The second part of the paper tests directly for the effect of military spending on the economic performance of developing countries. They run a series of regressions of the form,[29]

$$X = a_0 + a_1(\log \text{GDP per capita}) + a_2(\log \text{GDP per capita})^2 + a_3(\log \text{population}) + a_4(\log \text{population})^2 + a_5(\text{capital inflow}) + a_6(\text{share of military spending in GDP}), \quad (19)$$

where X is the ratio to GDP of, in turn, investment, imports, industrial production, agricultural production, and tax receipts. The regressions cover the period, 1950-70.

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28. These groups consist of 1) the entire sample, 2) developed countries, 3) developing countries, 4) Latin America, 5) Africa, and 6) Asia.

29. The error terms are left unspecified throughout this review.

The coefficient of defense burden is negative and statistically significant in the regressions where investment and agriculture (as ratios to GDP) are the dependent variables. The coefficient of defense burden is positive and statistically significant only in the regression where the dependent variable is tax receipts.

A final section of the paper explores the time-series relationship between military spending and economic performance for India over the period, 1950-1972. Using OLS estimation, output growth is regressed on export growth, population growth, change in defense burden, and growth in the capital stock. The coefficient on defense burden is found to be positive and significant. In addition, the "X" equations listed above are estimated with the following as dependent variables: the ratios to GDP of investment, imports, agricultural output, industrial output, tertiary sector output, and tax receipts; the growth rate of GDP; and the growth rate of non-defense output. The defense burden coefficient is found to be positive and significant in the investment/GDP regression. When GDP growth is regressed on the defense burden, a negative but statistically insignificant coefficient is found. The authors conclude that while increased defense spending may have led to faster capital accumulation in India, it did not lead to faster growth.

2. David Lim (1983) re-examines Benoit's analysis for a bigger group of LDCs (54) over the period, 1965-73, within the context of a Harrod-Domar capital-centered growth model. He estimates the following equation:

$$\text{Real GDP growth} = a_0 + a_1(\text{incremental output-capital ratio}) + a_2(\text{military spending/total government spending}) + a_3(\text{foreign capital inflow/domestic saving}). \quad (20)$$

The coefficient of the ratio of military spending to total government spending is negative and statistically significant. Lim criticizes Benoit because Benoit does not derive the estimated equations from an explicit conceptual framework. In addition, he claims that the coefficient on defense found in Benoit's regressions overstates the effect of defense spending on growth because it also reflects the impact of foreign capital inflows on growth. He notes that when both

defense spending and capital inflows are included in Benoit's regressions, the estimated values of their coefficients fall substantially.[30]

3. Saadet Deger and Somnath Sen (1983) test the hypothesis that military spending contributes to growth through two types of "spin-off" effects. The first of these is the creation of effective demand for underemployed industrial capital. The second is the contribution of military spending to technological progress that augments the civilian sector's production function.

They test this hypothesis on time-series data for India during 1951-1971. They estimate the following equation for the output of five industries (X_i):

$$X_i = a_{0i} + a_{1i}(\text{real military spending}) + a_{2i}(\text{value added in manufacturing}). \quad (21)$$

They also run these five regressions substituting a one-period-lagged value of the military spending variable. For the ten equations fitted, military spending has a positive, statistically significant coefficient in only one — metal products (with military spending lagged). The coefficients of military spending in all other equations are found to be insignificant.

The authors, recognizing the possible endogeneity of the value added variable, also estimate the equations using instrumental variables and a two-stage CORC procedure. None of the coefficients of lagged military spending is found to be significant.

In an appendix, a system of simultaneous equations is estimated to test for the direct and indirect effects of military spending on growth and to allow for the endogeneity of military spending. This model is described by the following equations:

$$\text{GDP growth} = a_0 + a_1(\text{investment/GDP}) +$$

30. See Table 1, equations (1) and (2). Biswas and Ram (1985) note that Lim's model is essentially a Harrod-Domar identity and cannot uncover structural relationships.

a_2(military spending/GDP) + a_3(GDP) + a_4(population growth) + a_5(net foreign capital transfers); (22)

Investment/GDP = b_0 + b_1(GDP growth) + b_2(change in GDP) + b_3(military spending/GDP) + b_4(net foreign capital transfers); and (23)

Military spending/GDP = c_0 + c_1(GDP) + c_2(D) + c_3(population) + c_4(D_1) + c_5(D_2). (24)

In equation (24), D is the difference between per capita incomes measured at purchasing power parity (PPP) and at official exchange rates, D_1 is a dummy for oil-producing countries, and D_2 is a dummy for countries at war. The variable D attempts to measure the degree of integration of the economy with the rest of the world.

The structural parameters of the model are estimated by three-stage least squares on data for 50 LDCs over the period, 1965-73. Parameter estimates are found that imply a growth impact of military spending of –0.16.[31]

4. Oumar Nabe (1983) looks at the effects of military spending on growth in 26 African countries over the period, 1967-76. He employs the following model:

EDF = a_0 + a_1(military spending), (25)

SDF = b_0 + b_1EDF + b_2(military spending), and (26)

GDPM = c_0 + c_1EDF + c_2SDF + c_3(military spending), (27)

31. This equals $(a_2 + a_1b_3)/(1 - a_1b_1)$.

where EDF is an "economic development factor" (a composite variable reflecting installed electrical capacity, private expenditures and government civilian expenditures), SDF is a "social development factor" (another composite variable incorporating government expenditures on health and education and the number of physicians and teachers in the country, and GDPM is GDP generated by manufacturing.

The structural model is estimated, and military spending is found to reduce manufacturing GDP through the indirect affects of military spending on both SDF and EDF. The model is estimated both on the basis of pooled data and separately for each year. In all cases, military spending is found to reduce the growth in manufacturing output.

5. Saadet Deger (1986) criticizes Benoit's econometric work, arguing that the relationship between military spending and growth is complex and cannot be represented by a single-equation model. The more complex model needed should permit interactions of the military and growth through a) aggregate demand stimulation, b) technological spinoff effects, c) withdrawal of resources from potential investment, and d) creation of new resources.

Deger estimates three structural equations, using data on 50 LDCs with each data point being the national average for the period, 1965-73. The model consists of:

$$\text{GDP growth rate} = a_0 + a_1(\text{saving/GDP}) + a_2(\text{military spending/GDP}) + a_3(\text{1970 per capita GDP at official exchange rates}) + a_4(\text{foreign capital flow/GDP}); \quad (28)$$

$$\text{Saving/GDP} = b_0 + b_1(\text{GDP growth rate}) + b_2(\text{per capita GDP growth}) + b_3(\text{military spending/GDP}) + b_4(\text{inflation rate}) + b_5(\text{foreign capital flow/GDP}); \text{ and} \quad (29)$$

$$\text{Military spending/GDP} = c_0 + c_1(\text{government spending/GDP}) + c_2(\text{per capita GDP}) + c_3(\text{per capita GDP at official exchange rates minus at PPP}) + c_4(\text{war dummy}) + c_5(\text{oil-producer dummy}). \quad (30)$$

He estimates the model using three-stage least squares. In equation (28), he finds that military spending has a positive and significant coefficient. However, in equation (29) military spending has a negative coefficient.

Deger argues that Benoit estimated only equation (28), which represents only the demand and spin-off effects of military spending on growth. Benoit does not take into account the resource effects of military spending on growth through its depression of the savings rate. When this is taken into account, the multiplier effect of military spending on growth is found to be –0.22.[32] The negative impact of military spending on growth through the savings rate outweighs the demand and spin-off effects.

Deger concludes that Benoit's analysis was not wrong, but rather partial. Benoit captured only some of the effects that military spending has on growth and thus was wrongly led to conclude that military spending contributes to economic growth.

6. Saadet Deger and Ron Smith (1983) develop an econometric model to test for the effects of military spending on economic growth. They hypothesize that military spending affects growth through three channels: 1) it may raise aggregate demand and contribute to growth by promoting higher capacity utilization rates; 2) it may accelerate modernization through its influence on administration and social structure; and 3) it may reduce growth by lowering the savings rate.

They employ the following simultaneous equation model to represent these effects:

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32. This equals $(a_1b_3 + a_2)/(1 - a_1b_1 - a_1b_2y)$, where y is per capita income and is evaluated at the sample mean.

$$\text{GDP growth rate} = a_0 + a_1(\text{saving/GDP}) + a_2(\text{military spending/GDP}) + a_3(\text{population growth rate}) + a_4(\text{net external capital flow/GDP}) + a_5(\text{1970 per capita income at official exchange rate}) + a_6(\text{agricultural output growth}); \quad (31)$$

$$\text{Saving/GDP} = b_0 + b_1(\text{GDP growth rate}) + b_2(\text{per capita GDP growth}) + b_3(\text{military spending/GDP}) + b_4(\text{net external capital flow/GDP}) + b_5(\text{inflation rate}); \text{ and} \quad (32)$$

$$\text{Military spending/GDP} = c_0 + c_1(\text{per capita income at the PPP exchange rate minus per capita income at the official rate}) + c_3(\text{population}) + c_4(\text{oil-producer dummy}) + c_5(\text{war dummy}). \quad (33)$$

This model is estimated for 50 LDCs using national averages for the 1965-73 period (by three-stage least squares). The coefficient of military spending in the savings equation is found to be negative and statistically significant. Military spending and saving are both found to have positive and significant coefficients in the growth equation. They use these results to derive a multiplier for military spending on growth of –0.20.[33] Hence, the negative impact of military spending on saving is found to outweigh the positive impact on growth through aggregate demand and the modernization effect.

The authors then test for the sensitivity of their results to the data and sample used. The basic regressions use SIPRI (Stockholm International Peace Research Institute) data on military spending. For 18 African countries and 12 Latin American countries, the growth effect of military spending is found to be more negative when using ACDA (U.S. Arms Control and Disarmament Agency) data.

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33. The same formula as in the previous footnote.

The three-stage least squares estimation of the model is also done on sub-groups within the sample — looking at high income, middle income, and low income countries separately. In all cases, the growth effect of military spending is found to be negative. A number of other changes in the definition of variables and equations are considered, but the military spending influence on growth remains negative in all cases.

7. P.C. Frederiksen and Robert Looney (1983) hypothesize that defense spending is likely to have a more negative impact in poor countries, where high-growth development programs are sacrificed to military spending, than in relatively rich countries. Their sample is split into a "resource abundant" and a "resource constrained" group. Countries are classified as resource abundant if they have relatively high growth in foreign exchange earnings, high import elasticities, low debt-service ratios, low incremental capital-output ratios, high current account deficit/GDP ratios, and large government spending multipliers. Resource constrained countries display the opposite tendencies.

The following regression is run for the two groups for data over the period, 1950-65 (the authors intentionally use Benoit's time frame):

$$\text{Civilian GDP growth rate} = a_0 + a_1(\text{rate of investment}) + a_2(\text{bilateral aid/GDP}) + a_3(\text{defense spending/GDP}). \quad (34)$$

The coefficient of defense spending is +0.22 for the resource abundant group and is –1.22 for the resource constrained group. Both coefficients are statistically significant.

8. Erich Weede (1983) argues that military spending encourages economic growth by contributing to human capital formation. He estimates the following equation for 95 LDCs using data from the period, 1960-1977:

$$\text{GNP growth rate} = a_0 + a_1(\log \text{GNP per capita}) + a_2(\log \text{GNP per capita})^2 + a_3(\text{investment/GNP}) + a_4(\text{primary school enrollment ratio}) + a_5(\text{secondary school} \quad (35)$$

enrollment ratio) + a_6(log military participation ratio).

He finds that the military participation ratio explains about ten percent of the cross-national variance in GNP growth rates. He concludes that military service contributes to human capital formation in that it "teaches discipline and creates a useful habit of obeying orders" (p. 17).

9. Wayne Joerding (1986) suggests that previous researchers may have been in error in that they assumed military spending to be econometrically exogenous with respect to economic growth. He employs the Granger test to data on military spending and growth for 57 LDCs between 1962-77. The hypothesis of Granger non-causality from growth to military spending is rejected by the data, which indicates that there may be some kind of causal relation between growth and military spending. However, he finds that the data do not reject the hypothesis of Granger non-causality from military spending to growth.

He concludes that since Granger non-causality is a necessary condition for strong exogeneity, previous studies using OLS to estimate the effect of military spending on growth in a single-equation model are flawed, since estimation with an independent variable that is endogenous with respect to the dependent variable leads to biased and inconsistent parameter estimates.

IV. CONCLUSIONS

While the studies surveyed here differ widely in method and focus, the empirical results point to similar conclusions regarding the relationship between military spending and economic growth. First, efforts at re-estimating Benoit's correlation coefficients for different samples of LDCs and different time periods all fail to reproduce Benoit's results. In place of Benoit's positive correlations, researchers continually find negative or statistically insignificant correlation coefficients. Benoit's estimates of correlation coefficients for military spending and economic growth are not robust with respect to the sample or time period examined.

Second, researchers who construct more sophisticated structural models relating military spending to growth (and growth to military spending, in some cases) find parameter estimates that imply that economic growth in developing countries is either unaffected by or is diminished by higher levels of military spending.

Furthermore, the models that allow military spending to affect growth through multiple channels, such as those of Deger (1986), Deger and Smith (1983) and Faini, Annez and Taylor (1984), find that while military spending may spur growth through some channels, it retards it through others, and the net effect is negative. The most important negative effect is that higher military spending reduces national saving rates, thereby reducing the rate of capital accumulation.

These more complex models, which do capture interdependence of variables and indirectness of effects, nevertheless need improvement. Almost all fail in two basic ways. One, they provide no explicit motivation for government spending on the military.[34] Such spending typically either is exogenous or is pushed by an exogenous propensity to spend out of the growing national output. Threats to national security, both internal and external, need to be more extensively and carefully incorporated. And two, optimizing behavior with respect to security and growth, either by an abstract LDC "policy maker" or by the actual lobbying interests involved with defense spending, has so far been largely absent from these models.[35]

In short, the existence of positive effects of military spending on economic growth, such as those conjectured by Benoit, still cannot be ruled out. However, the recent econometric evidence points to the conclusion that these positive effects, if they exist, are small relative to the negative effects, and that military spending has an overall adverse impact on economic growth in developing countries.

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34. Not even Benoit suggested that such spending was undertaken in order to augment the growth rate.

35. Such optimizing models will have to be complex. Just considering a single "policy maker" — facing threats to national security, having a desire to grow, and allocating resources between investment and military expenditures — will generate few interesting hypotheses. Such a model, for example, must on the optimized margin display a negative relation between defense spending and growth.

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