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The Peace Dividend: Military Spending Cuts and Economic Growth

Prepared by

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Abstract

Although conventional wisdom suggests that reducing military spending may improve a country's economic growth performance, empirical studies have produced ambiguous results. This paper extends a standard growth model and estimates it using techniques that exploit both cross-section and time-series dimensions of available data to obtain consistent estimates of the growth-retarding effects of military spending via its adverse impact on capital formation and resource allocation. Model simulations suggest that a substantial long-run "Peace Dividend"--in the form of higher capacity output--may result from: (i) markedly lower military expenditure levels achieved in most regions during the late 1980s; and (ii) further military spending cuts that would be possible in the future if a global peace could be secured.

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Summary

Conventional wisdom suggests that reduced levels of military spending are associated with a "Peace Dividend" in the form of stronger economic growth performance. Yet available empirical studies have yielded only partial support for this view.

To unravel the ambiguous empirical findings, this paper estimates an extension of a standard growth model using a panel-data procedure that delivers robust estimates of the effect of military spending on economic growth. The model assumes that high levels of military spending detract from growth both by reducing productive capital formation and by acting more generally to distort resource allocation. In contrast with earlier empirical work, the current panel-data estimates of these adverse effects are statistically significant and sizable.

The recent, marked trend toward lower levels of military spending in many regions of the world augurs well for a future Peace Dividend in terms of a higher growth path of capacity output. The likely quantitative impact of these effects for different geographic regions is simulated. The study finds that the military spending cuts that occurred in most regions in the late 1980s will eventually lead to substantial gains in per capita capacity output, particularly for developing countries in Asia, North Africa, and the Middle East, where military spending ratios were reduced markedly. By contrast, in Eastern Europe and sub-Saharan Africa, where military spending ratios rose in the late 1980s, the output path will eventually be lower than it would have been if military expenditures had remained steady.

The results of a second set of simulations undertaken in this paper suggest that economic growth would be enhanced substantially by deeper cuts in military spending that could become feasible if a generalized international peace were achieved in the future. Furthermore, these Peace Dividend effects, while sizable, may understate the potential gains in economic growth, since a generalized peace would almost certainly result in improvements in other economic determinants of growth. For example, a generalized peace would permit fuller liberalization of trade regimes in a number of developing countries as well as higher expenditures on infrastructure, education, and health.

The major policy implication of this study is that reductions in military spending are potentially attractive elements of macroeconomic adjustment and structural reform programs designed to achieve strong and durable increases in per capita capacity output.

I. Introduction

It is a widely held view that political tensions and associated high levels of military spending detract from the economic growth performance of countries in insecure regions. If this generalization is supported by empirical evidence, then the converse proposition is also likely to be valid: the sustained military spending cuts that would become feasible as a result of improved international security should yield a "Peace Dividend" in the form of higher long-run levels of capacity output.

In an insecure region, so the argument goes, each country must devote a disproportionate share of its endowment of scarce economic resources to "unproductive" military spending. Indeed, in the absence of international cooperation to reduce political tensions, military spending levels can be pushed higher throughout a region as each country tries to outspend its neighbors to ensure its own security, raising military expenditure levels, reducing the availability of productive resources for other domestic uses, and yielding no increase--or even a decrease--in the security of all. It follows that forms of international cooperation that succeed in reducing tensions and thus in lowering military spending would be to the long-run economic benefit of all members of the region.

Interest in the potential size of this Peace Dividend has risen considerably in recent years with the improvements in security that have become evident for both industrial and developing countries with the end of the Cold War and the more recent initiatives aimed at achieving a comprehensive peace in the Middle East. Conversely, it also has unfortunate relevance for two regions--Eastern Europe and sub-Saharan Africa--where the available data indicate that military spending actually showed a rising trend during the latter half of the 1980s.

Is there a Peace Dividend from military spending cuts? If so, how large might it eventually be? Thus far, empirical analyses have had little success in offering a clear answer to this question. The present paper specifies an extended version of a standard growth model which traces the effects of changes in military spending on the growth of per capita capacity output. It implements a technique for obtaining empirical estimates of the model on a panel of time-series cross-section data for a large sample of developed and developing countries. We then undertake simulation experiments with the model to gauge the size of the Peace Dividend--that is, the impact of cuts in military spending on economic growth performance--in a number of major geographic regions of the world. To summarize, the results of our estimation and simulation analyses suggest that these Peace Dividend effects would take some time to emerge, but would eventually be large, especially for countries in regions--such as Eastern Europe, North Africa, and the Middle East--where levels of military spending have traditionally been high.

The view that low levels of military spending are associated with strong growth performance, and vice versa, is usually argued by recourse to casual empiricism. For example, the post-World War II experiences of the Federal Republic of Germany and Japan appear to lend support to the notion that there are positive economic benefits from sustaining low levels of military spending over long periods of time. The strict post-war limits on military expenditures that were imposed on these countries--combined with the Allies' effective guarantee of their security--allowed the Federal Republic of Germany and Japan to devote relatively large proportions of their total factor endowments to productive capital formation, thereby contributing to their impressive economic growth performance during the succeeding five decades. Such general but striking observations have left most economists with a strong presumption that, on average, a country that has a relatively low ratio of military expenditure to GDP is likely to display relatively strong secular economic growth performance.

Yet not all military spending is unambiguously counterproductive, or even unproductive, in an economic sense. It is often argued, for example, that in developing countries expenditure on military training may contribute to improving the educational level and discipline of the labor force and may act as a stabilizing influence in the society. Likewise, it has been argued (see, for example, Thompson (1974)) that military expenditure can be economically productive to the extent that it enhances the state of national security and improves the enforcement of private property rights, thereby encouraging private investment and growth. Capital expenditure on the military can also have productive uses: a number of developing countries that are former colonies of industrial nations still benefit from extensive transport networks that were built primarily for military purposes.

These counter-examples suggest that the question of whether and to what extent military spending is economically unproductive cannot be resolved by recourse to historical generalizations. The models to be estimated should be designed in such a manner that they can help to answer quantitative questions. How unproductive is military spending? How large might the Peace Dividend be? Furthermore, the estimation procedures to answer these questions must be carefully designed to exploit the limited availability of data and to overcome certain identification problems.

The difficulties of isolating this relationship are compounded by the fact that the basic linkage between military spending and the growth of capacity output may be obscured in empirical studies by opposing effects. In the short run, military expenditures can stimulate aggregate domestic demand and boost employment, while in the long run heavy military spending may tend to depress productive fixed and human capital formation and to aggravate distortions in resource allocation, thereby depressing the growth path of capacity output. If both these factors operate simultaneously, the negative long-run growth effects could easily be concealed in empirical studies by positive short-run effects of the demand stimulus from increased military spending, particularly when--as has often been the case in this area--econometric studies are based mainly on cross-country analyses covering relatively short time periods.

Given these considerations, it is not surprising that the existing empirical literature yields ambiguous results, not only on the magnitude of the impact of military expenditure on long-term economic growth, but even on whether the effect is positive or negative. In order to unravel the contradictory empirical findings it is essential to use an estimation procedure that can deliver robust estimates of the broad order of magnitude of the effect of changes in the level of military spending on growth performance.

Even if cuts in military spending do improve growth performance substantially, these effects are likely to appear with a long lag; thus the beneficial effects from large military spending cuts may be hard to disentangle from other factors that influence economic growth. Nevertheless, if national governments are to be convinced that it is to their economic advantage to stockpile fewer guns in order to make room for more investment in productive capital, they need to be presented with robust quantified estimates of the costs that military spending imposes on the economic welfare of their citizens and to have convincing evidence of the improvements in living standards that can result over the long run from military spending cuts. Such a quantification is attempted in this paper.

Throughout this paper we define the *military spending ratio*, m, as the ratio of total military spending to GDP. The data on the military spending ratio used here are those published annually by the Stockholm International Peace Research Institute (SIPRI). 1/ We define the "Peace Dividend" narrowly as the percentage difference between the level of real per capita capacity output resulting from a given sustained reduction in the military spending ratio, and the baseline path of capacity output that would have prevailed in the absence of such a reduction.

To quantify the effect of military spending on growth and give an idea of the possible size of the Peace Dividend defined in this narrow sense, we extend the empirical analysis of Solow (1956) and Swan (1956) that we undertook previously (Knight, Loayza, and Villanueva (1993)) to incorporate the possible effects of military spending on the growth path of per capita capacity output. Specifically, this paper extends our earlier analysis in two ways. First, we expand the basic neoclassical growth equation to include, in addition to the investment ratio and other factors considered in

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1/ Appendix IA provides definitions and sources for all data used in this study. A detailed discussion and analysis of the SIPRI data on military spending, as well as that provided by other sources, is given in Hewitt (1992, 1993). Based on his detailed analysis, Hewitt concludes that SIPRI data are to be preferred to other sources for empirical work of the sort we undertake here.

our earlier paper, the military spending ratio as an additional determinant of capacity output. Second, we also specify an explicit investment function in which the ratio of investment to GDP is determined by several factors, including the fraction of GDP that is devoted to military spending. The resulting two-equation growth model is first estimated by the "standard" cross-sectional technique that has been widely used in empirical analyses of economic growth. We then re-estimate the model on our 79-country pooled time-series cross-section sample using an econometric technique--described in our earlier paper--that yields consistent and efficient estimates on panel data. We use these estimates to gauge the direction and magnitude of the effects of military spending on both the level of fixed investment and the growth of real per capita output. Next, we employ simulation experiments with the estimated model to obtain an idea of the potential magnitudes of the Peace Dividend effects that might result from military spending cuts both in the industrial countries and in developing countries in major geographic regions of the world: Asia, Eastern Europe, the Middle East, North Africa, sub-Saharan Africa, and the Western Hemisphere.

The rest of this paper is organized as follows. Section II briefly reviews recent trends in military expenditures and the empirical literature on the relationship between military spending and economic growth. Section III outlines our extension of the standard empirical growth model and the estimation technique used. Section IV presents and compares standard cross-section estimates of the effect of military spending on investment and economic growth with the results of our panel-data estimation. Section V describes simple simulation experiments that help to indicate the rough order of magnitude of the longer-run Peace Dividend from military spending cuts. We first simulate the long-run effects that will eventually become visible as a result of the developments in military spending that have already taken place in various geographic regions during the latter half of the decade of the 1980s. We then simulate the potential effects of further declines in military spending that might be expected to occur in the future in various regions if a lasting global peace could be secured. Section VI summarizes and concludes.

II. Data and Empirical Research on Military Spending

1. Recent trends in military spending

The descriptive literature on recent trends in military expenditures (see Hewitt (1993) and the primary data sources cited there) indicates the large extent to which the world's productive resources have been devoted to the military throughout the period since the Second World War. 1/ On average during the period 1972-90, for example, over 5 percent of world

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1/ Our paper makes use of the data on military expenditures presented in Hewitt (1992, 1993), which are based mainly on statistics published by SIPRI. Hewitt's data cover 124 industrial and developing countries.

resources as measured by the combined GDP of the 124 countries considered by Hewitt (1993), were devoted to military spending. A second striking feature brought to light by Hewitt's analysis of the data is that world military spending has been declining in recent years. When he compares the ratios for the mid-1980s with those for 1990, Hewitt finds that total military expenditures of all countries in his sample fell sharply, from 5.6 percent of their combined GDP in 1985 to 4.3 percent five years later.

A closer analysis of Hewitt's data shows important differences in military spending across country groupings as well as over time. Table 1 summarizes the main patterns of military expenditure for industrial countries and for developing countries in various geographic regions. The entries in this table represent weighted averages of national military spending ratios, where the weights are each country's share of the regional total GDP level measured in U.S. dollars using official exchange rates. Table 1 presents these averages for nine country groupings: the full sample of 124 countries; a group of 22 industrial countries; and 102 developing countries subdivided into six regional groups--Asia, Eastern Europe, Middle East, North Africa, sub-Saharan Africa and Western Hemisphere. This table also regroups these regional data into two time periods. Period I extends over 1972-85; it covers roughly the years when the Cold War was still at its height and when initiatives toward improved security in the Middle East had not yet borne fruit. Period II covers 1986-90, which Hewitt characterizes as a period of diminishing tensions associated with the gradual end of the Cold War and somewhat improved security conditions in Asia, the Middle East, and North Africa.

The data in Table 1 yield several broad observations. First, in both periods military spending ratios varied widely between the industrial and developing country groups, and among developing countries in different geographic regions. For example, among the developing country groups during Period I military spending ratios ranged from a high of over 11 percent of GDP for countries in Eastern Europe to only just over 2 percent for the Western Hemisphere; in Period II the range of variation among regions was just as pronounced (from just over 14 percent to under 2 percent) with the same ordinal ranking of ratios among regions. These striking differences in military spending ratios correspond broadly to what one would expect given the different levels of security across regions. For example, in both periods countries in Eastern Europe and the Middle East had the highest military spending ratios, reflecting the failure to achieve comprehensive improvements in security in those regions. Next in ranking were Asia and North Africa, followed by sub-Saharan Africa. Finally, the very low ratio for Western Hemisphere countries in both periods reflects the low incidence of major armed conflicts in this region.

A second striking feature of the data reported by Hewitt is that for the industrial countries and for developing countries in all geographic regions but two, weighted average military spending ratios *fell*, in some cases quite sharply, between Period I and Period II. This feature is the most striking in North Africa and Asia. For the group of Middle East

Table 1. Ratios of Military Spending to GDP for Various Country Groups and Time Periods 1/

	Period Weighted Averages, in Percent 2/		
	Full Period (1972-90)	Period I (1972-85)	Period II (1986-90)
Full Sample	5.10	5.19	4.84
Industrial Countries	3.90	3.97	3.70
Developing Countries	5.20	5.54	4.26
Regional Groupings:			
Asia	5.70	6.35	3.88
Eastern Europe	12.40	11.75	14.22
Middle East	10.00	10.36	9.06
North Africa	7.20	8.12	4.60
Sub-Saharan Africa	3.20	3.12	3.42
Western Hemisphere	2.10	21.6	1.94

Source: Hewitt (1992).

1/ See Appendix IB for lists of countries included in each grouping for Hewitt's sample.
2/ The weights are each country's share in the group GDP measured in U.S. dollars using official exchange rates.

countries, where military spending initially absorbed over 10 percent of GDP, the weighted average ratio also fell markedly in the latter half of the 1980s. The industrial countries had a modest decline in military spending during the late 1980s associated with the end of the Cold War. Developing countries in the Western Hemisphere region, which already had very low levels relative to other developing regions, experienced only very small further reductions. An unfortunate contrast with these trends was evident in Eastern Europe and sub-Saharan Africa, where ongoing internal and regional tensions caused weighted average military spending ratios to *rise* by 2.5 and 0.3 percentage points, respectively, in 1986-90. Despite the adverse trends in these two regions, it is noteworthy that the weighted average military spending ratio for the whole group of developing countries fell by considerably more than it did in the industrial countries. Whereas the weighted average ratio of developing countries had been nearly 1.6 percentage points higher than that of the industrial countries in Period I, in Period II it fell to a level only 0.6 percentage points higher.

2. The empirical relationship between military spending and growth

Estimation of the empirical relationship between output growth and military spending is complicated by the fact that it has both short-run and long-run components, which may act in opposite directions. In the short run, as with increases in other types of government expenditure, a rise in military spending on final goods and services may increase aggregate domestic demand, thereby exerting a short-run stimulative Keynesian impact on the growth rate by inducing a rise in capacity utilization--that is, it raises the growth of current output *relative to* that of capacity output. 1/ The short-run multiplier effect of military spending on actual output is likely to be larger the smaller is the import content of spending on military goods. Thus the stimulative short-run effects are likely to be largest in countries that have domestic military hardware-producing industries.

These short-run stimulative effects, however, do not necessarily lead to higher levels of capital formation and capacity output. Indeed, over the longer term increases in military spending are likely to exert a negative effect on capacity output. There are two channels by which a sustained rise in military expenditure might be expected to depress a country's secular growth performance. The first results from the likelihood that a rise in military expenditure, other things equal, will exert a negative impact on the rate of investment in (public and private) productive fixed capital. This occurs because of well-known crowding-out effects: an increase in military spending must be financed either by raising current taxes or by borrowing (future taxes). In either case, it will lower the expected after-tax return on productive fixed capital while simultaneously reducing the flow of (domestic plus foreign) savings that is available to finance productive fixed capital formation in the domestic economy. This channel is likely to be particularly important in the case of net-debtor developing countries. Since such countries are faced with external financing

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1/ Hewitt (1992) hypothesizes that military expenditures can have a net positive or negative impact on economic growth depending on the alternative use of the funds. He argues that specific military expenditures on general-use public infrastructure and promotion of research, as well as demobilization of trained personnel contribute to economic growth; however, military spending is an inefficient means to enhance growth compared to private investment expenditure or government expenditure on social infrastructure and education. In the context of developing countries, Hewitt contends that the justification for military expenditures must be from national security grounds, since the economic benefits are limited.

constraints, a rise in military spending--to the extent that it is not associated with larger net capital inflows to finance a higher external current account deficit--can be expected to crowd out capital investment and/or private consumption. 1/

A second channel by which military expenditures may affect the growth path of capacity output is through their direct impact on the efficiency of resource allocation. Since military expenditures are not governed by market processes, they tend to create distortions in relative prices that result in a dead-weight loss to total productive capacity. In addition, they may exert negative externalities on capacity output. There are several ways in which these inefficiencies directly affect the growth rate. First, a higher dead-weight loss to domestic production results from either an increase in contemporaneous taxes or higher borrowing to finance higher military spending; borrowing from the banking system often leads to higher inflation, which distorts resource allocation. 2/ Second, research and development activities may concentrate on military progress at the expense of technological advances in economically-productive areas. Third, policies implemented to support a military program are often detrimental to efficient resource allocation and market growth: examples are trade restrictions, nationalization of military equipment producers, military procurement preferences for certain firms and industries, and compulsory military service. Finally, rent-seeking activities grow around the military because of its non-competitive allocation of resources. In this way, *over and above* their depressing effect on the level of investment, military expenditures may exert a direct adverse impact on the economy's productive efficiency.

These considerations suggest that the net effect of a rise in military expenditure on a country's growth rate and its steady state level of capacity output is likely to be negative. Therefore, one would expect to find evidence of this negative impact in longer-run economic data both across countries and over time. However, it is obviously difficult to disentangle empirically the potential positive short-run effect of the demand stimulus associated with an increase in military spending from the depressing effect of high military spending on the longer-run growth path of capacity output, particularly if the estimation work fails to exploit both the time-series and cross-section dimensions of the data. The striking ambiguity of past econometric results in the face of strong casual evidence

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1/ Hewitt (1992) notes that higher military expenditures may be financed through higher external borrowing, lower private consumption, lower private investment, and lower expenditures on other government programs, including productive ones such as education and health services, public infrastructure, and the police and judicial systems. In general, the likely consequences would be lower current consumption and investment levels and lower future growth, the exact mix being dependent on the particular financing channel.

2/ See Tommasi (1995) and de Gregorio (1991).

on the long-run economic benefits of lowering military expenditure suggests that weaknesses in the econometric techniques used to test these hypotheses may be a problem.

Thus it is not surprising that a number of past attempts to subject the military spending-growth relationship to empirical testing--Benoit (1973, 1978) and Frederiksen and Looney (1982)--appeared to uncover empirical support for the thesis that military expenditures were not detrimental to growth. Benoit (1978), using data for 44 developing countries over 1950-65, finds a positive association between military spending and growth of civilian per capita output. In contrast, Rothschild (1977) on the basis of rank correlations on growth, exports, and military spending for 14 OECD countries during 1956-69, concludes that higher military spending is associated with lower exports and lower economic growth. Deger and Smith (1983) find that the direct impact of military expenditures on growth is positive, while the effect on savings is negative; in their view the net impact of military expenditures on growth is negative because the negative indirect effect on savings outweighs the positive direct impact. Biswas and Ram (1986) conclude that military expenditures neither help nor hinder economic growth. Aschauer (1989) finds that government expenditure on infrastructure in the United States has a positive effect on growth, while military capital expenditures have virtually no impact. Some other studies have obtained a negative, but weak empirical relationship between military spending and economic growth. 1/

III. Model and Empirical Methodology

Since the available data on military activity indicate that the fraction of GDP devoted to the military varies widely both across countries and over time, this section exploits these two dimensions of the data to overcome some of the shortcomings of past empirical work and obtain robust estimates of the effect of military expenditures on investment and economic growth. 2/ For this purpose, we employ an econometric technique that was proposed in our earlier paper (Knight, Loayza, and Villanueva (1993)) to deal with time-series cross-section data.

Our regression equation for the rate of economic growth is based on the Mankiw, Romer; and Weil (1992) version of the model of Solow (1956) and Swan (1956). This growth equation is derived by linearizing the transition path of output per capita around its steady-state level. 3/ The resulting

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1/ See Chan (1985) for a selected bibliography.

2/ In this paper, the term investment, by itself, refers to physical capital investment. When we refer to human capital investment, we say so explicitly.

3/ For details of this derivation, see Knight, Loayza, and Villanueva (1993). The growth effects that we discuss in this paper apply to the transition to the steady state.

equation specifies output growth as a function of initial output and variables that condition for the economy's steady state. The conditioning variables that we include are the ratio of investment to GDP; the rate of population growth; a proxy for the degree of openness of the economy to international trade (i.e., an index of the degree of restrictiveness of its system of tariff and non-tariff barriers to international trade); the widely used Barro-Lee (1993) proxy for the incidence of wars; 1/ the ratio of military spending to GDP; and a dummy variable that catches any otherwise unspecified country-specific effects. In accordance with the Solow-Swan model we assume that the conditioning variables are exogenous with respect to output growth; in particular, the ratio of military expenditures to GDP is assumed to be unaffected by the rate of output growth. 2/

Equation (1) specifies the rate of growth of z_t, defined as the natural logarithm of the level of capacity output per capita:

$$z_{i,t}-z_{i,t-1} = \theta_n \ln(n_{i,t}+g+\delta)+\theta_k \ln(sk_{i,t})+\theta_m \ln(m_{i,t})+\theta_h \ln(sh_i)+\theta_f \ln(f_i) +\theta_w \ln(w_i)+\gamma z_{i,t-1}+\xi_t+\mu_i+\epsilon_{i,t} \qquad (1)$$

where ln indicates a natural logarithm; the indices i and t represent the country and time period, respectively; n is the average population growth rate; g is the technological growth rate, δ is the rate of depreciation of the stock of physical capital, and $g+\delta$ is assumed to be equal to 0.05 3/; sk is the ratio of physical capital investment to GDP; m is the ratio of military expenditures to GDP; sh is a proxy for the ratio of human capital investment to GDP; f is a proxy for the degree of restrictiveness of the economy's international trade system; w is the Barro-Lee proxy variable; ξ_t represents time-specific factors; μ_i represents country-specific factors; and ϵ is a white-noise error term.

1/ The Barro-Lee proxy variable for the incidence of wars is defined for each country as the number of war-years as a fraction of total years in the period 1960-85. See Barro and Lee (1993).

2/ There are three differences between the growth equation specified in this paper and the one used in our 1993 paper. First, in this paper we do not include the ratio of government fixed investment to GDP as an explanatory variable, since we found it to be statistically insignificant in our previous study. Second, and more important, we now include as a regressor the ratio of military expenditures to GDP. Finally, to isolate the effect of military expenditures on the allocation of productive resources, we control for the incidence of wars on economic growth by including the above-mentioned Barro-Lee proxy.

3/ The assumption that $g+\delta=0.05$ follows Mankiw, Romer, and Weil (1992). We found that although changes in this number affect the estimated θ_n, they do not significantly affect the other estimated coefficients.

In order to allow for the indirect effect of military spending on growth via its impact on productive investment, we extend the model of our earlier paper to include a second equation which specifies the ratio of investment in fixed capital as a function of the rate of investment in human capital, *sh*; the restrictiveness of the trade system, *f*; the Barro-Lee dummy, *w*; and the military spending ratio, *m*. The investment equation is:

$$\ln(sk_{i,t}) = \eta_n \ln(n_{i,t} + g + \delta) + \eta_m \ln(m_{i,t}) + \eta_h \ln(sh_i) + \eta_f \ln(f_i) + \eta_w \ln(w_i) + \xi_t + \mu_i + \varepsilon_{i,t} \quad (2)$$

As already noted, we use Hewitt's annual data on the ratios of military expenditure for all the countries in our sample. However, owing to limitations on the availability of data for some countries on the other variables that enter into equations (1) and (2), our estimation sample is a subset of the countries covered by Hewitt. The countries excluded from our sample are those in Eastern Europe (including the countries of the former Soviet Union and the former Democratic Republic of Germany), and countries for which complete data were not available for other variables in the model. The latter include several developing countries in Asia, sub-Saharan Africa and the Western Hemisphere. Consistent with other empirical studies of long-term economic growth, we also exclude from the estimation sample a few countries--mostly in the Middle East and North Africa--whose main source of GDP comes from the extraction of petroleum reserves. The list of countries and data sources for the variables used to estimate our model are presented in Appendix IA and B.

Our estimation sample covers 79 countries; the sample period is 1971-1985. The countries and regions included in our sample, together with the simple and weighted means and standard deviations for their ratios of military spending to GDP over 1971-85 and 1986-90 are presented in Table 2. For comparison with Hewitt's data in Table 1, the weighted average means for each of the country groups on the same definition as Hewitt's, as well as the changes in these weighted means from Period I to Period II are reported in Table 2 and Appendix IC. A close comparison of the weighted averages for each of the country groups in our sample with those for the full group of 124 countries discussed by Hewitt shows that, for the regions we include, our sample has characteristics that are quite similar to those highlighted in the more comprehensive Hewitt sample. In particular, the magnitudes of the declines in the weighted average military spending ratios in each region are quite similar in the two samples. The exception is sub-Saharan Africa, where the country coverage of our sample is much less comprehensive than Hewitt's owing to the unavailability of data on the other variables in

Table 2. 79-Country Sample: Ratios of Military Spending to GDP for Various Country Groups and Time Periods 1/

	Period averages, in percent			Comparison of changes (Period II minus Period I)	
	Full Period (1972-90)	Period I (1972-85)	Period II (1986-90)	Our 79-Country Sample	Hewitt's Sample
Full Sample					
Weighted Average	3.80	3.89	3.59	-0.30	-0.35
Simple Average	3.35	3.44	3.08	-0.36	...
(Standard deviation)	(0.21)	(0.12)	(0.21)	...	...
Industrial Countries					
Weighted Average	3.90	3.99	3.71	-0.28	-0.27
Simple Average	3.01	3.07	2.85	-0.22	...
(Standard deviation)	(0.13)	(0.07)	(0.12)	...	...
Developing Countries					
Weighted Average	3.10	3.14	2.80	-0.34	-1.28
Simple Average	3.48	3.58	3.17	-0.41	...
(Standard deviation)	(0.26)	(0.16)	(0.24)	...	...
Regional Groupings					
Asian Developing					
Weighted Average	3.90	3.94	3.75	-0.19	-2.47
Simple Average	3.66	3.64	3.71	0.07	...
(Standard deviation)	(0.28)	(0.28)	(0.33)	...	...
Middle East					
Weighted Average	6.80	6.93	6.49	-0.44	-1.30
Simple Average	10.70	11.24	9.21	-2.03	...
(Standard deviation)	(1.35)	(1.07)	(0.82)	...	...
North Africa					
Weighted Average	6.50	7.59	3.38	-4.21	-3.52
Simple Average	6.06	6.72	4.19	-2.53	...
(Standard deviation)	(2.27)	(2.29)	(0.48)	...	...
Sub-Saharan Africa					
Weighted Average	2.70	2.83	2.52	-0.31	0.30
Simple Average	2.70	2.75	2.58	-0.17	...
(Standard deviation)	(0.24)	(0.26)	(0.12)	...	...
Western Hemisphere					
Weighted Average	2.20	2.28	1.80	-0.48	-0.22
Simple Average	2.43	2.49	2.26	-0.23	...
(Standard deviation)	(0.40)	(0.44)	(0.25)	...	...

Source: Hewitt (1992).

1/ See Appendix I.B. for lists of countries included in each grouping for both Hewitt's and our sample.

equations (1) and (2). 1/ These broad similarities between the sample we use for estimation and Hewitt's data give us a degree of confidence that although our estimating sample has a less comprehensive country coverage it nevertheless retains broadly similar characteristics.

To construct the panel data set, we work with non-overlapping intervals of five years each. We have cross-sectional data covering output growth and several other variables in three separate five-year time periods: 1971-75, 1976-80, and 1981-85. Since data for all variables are available for 79 countries, this gives us a relatively large panel-data sample of 79 x 3 = 237 observations on the dependent variables in equations (1) and (2). We measure the growth of per capita output over a 5-year interval, rather than a single year. This procedure provides a simple way of averaging out short-run cyclical variations in the rate of capacity utilization, thereby helping to ensure that this variable approximates output growth at the average rate of capacity utilization in each five-year time period for each country in the sample. 2/ Similarly, the data for the investment ratio *sk* are averaged over the same 5-year intervals. Thus some variables are indexed by both time, t, and country, i; these are the variables *z*, *h*, *sk*, *m* and *sh*, for which panel data are available. The remaining variables *f* and *w*, for which we have only cross-sectional data, are indexed only by country. The observations for the level of per capita output that are used to obtain the growth rate for each 5-year interval correspond exactly to the years 1970, 1975, 1980, and 1985. For the rest of the panel variables--*n*, *sh*, *m*--observations correspond to the averages over the five year intervals 1971-75, 1976-80, 1981-85. For the cross-sectional variables--*sh*, *f*, *w*--observations for each country correspond to averages over the whole 15-year period (1971-85) under consideration or, in a few cases, that portion of it for which data are available.

The fact that panel data are available for most of the variables of interest allows us to account for both time-specific and country-specific effects. Country-specific effects are especially important in the present analysis. There are a host of factors that are peculiar to each country (e.g., government policies, resource endowments, social institutions, and cultural traits) and these may well be correlated with the regressors considered in the model. Failure to account for them would lead to inconsistent estimates of the parameters. We control for the time-specific effects by removing the time means from each variable. To account for the country-specific effects, we use the methodology proposed by Chamberlain (1982, 1984), commonly known as the Π-matrix technique. Given that the

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1/ As a result of these differences in coverage, our data show a small decline in military spending ratios in these countries, while Hewitt's more comprehensive data show a small rise.

2/ This follows the technique used by Phillips (1958) to ensure that his estimated relation between the rate of change of nominal wages and the level of the unemployment rate was approximately a phase line.

growth regression contains a lagged dependent variable, the fixed-effects "within" estimator that is commonly used to control for specific effects would yield inconsistent estimates.

A detailed exposition on the application of the Π-matrix technique to growth regressions estimated using panel data is presented in our earlier paper (Knight, Loayza, and Villanueva (1993)). Basically, the application has two steps. First, we replace the country-specific factor $\mu_{i,t}$ by its linear predictor $E^{*}(\mu_{i,t})$ plus an error term in the regression equation for each time period. The linear predictor is a linear function of the regressors for all time periods. This yields a system of reduced-form regression equations, with one equation for each time period. Second, we estimate the reduced-form parameters in the system and, from them, obtain the structural parameter estimates through a minimum distance estimation procedure. Chamberlain (1982) shows that this procedure results in consistent and asymptotically efficient estimates.

IV. Estimation Results

This section presents the estimation results for our two-equation growth model. To illustrate the difficulties (discussed in Section II) that may have arisen in past empirical work on the impact of military spending on growth, we first employ a standard estimation procedure that is widely in use in empirical research in growth economics. Specifically, we obtain standard "cross-section" estimates of equations (1) and (2) using the data on output growth for our 79-country sample averaged over the *whole period* 1971-85 and average levels for each country of the values of the right-hand variables over the same period. Next, we re-estimate the model on our sample of panel data observations using our proposed econometric approach, and compare the parameter estimates obtained using the two alternative estimation methods.

1. Standard cross-section estimation

Table 3 reports the estimation results for a standard cross-section regression of the investment equation (equation 2). To account for geopolitical and developmental differences across regions we consider two regional dummy variables in our cross-country regressions, one for Africa and the other for the developing countries in the Western Hemisphere. It can be seen from Table 3 that the standard cross-section regression estimates are not very enlightening. Only the proxy for investment in human capital and the dummy variable for Africa exert positive and statistically significant effects on physical capital investment. In particular, the cross-section regressions cannot identify a significant relationship, whether positive or negative, running from the level of military spending to the rate of investment in productive fixed capital. When Barro and Lee's proxy for the incidence of wars is added to the regression equation, the parameter estimates change only slightly; as expected, it exerts a negative effect on investment, and the effect is statistically significant at the 10 percent level. Except for this aspect, the standard cross-section regression estimates do not yield a robust empirical investment equation.

Table 3. Standard Cross-Section Regressions for the Ratio of Investment to GDP

No. of Countries	79	79
VARIABLE	COEFFICIENT (T-RATIO)	COEFFICIENT (T-RATIO)
ln(n+0.05)	-0.1400 (-0.79)	-0.1478 (-0.89)
ln(sh)	0.0702 (3.47)	0.0664 (3.43)
ln(f)	-0.0895 (-0.36)	-0.0985 (-0.41)
ln(m)	0.0401 (0.54)	0.0809 (1.01)
w		-0.5190 (-1.51)
constant	2.1726 (4.16)	2.1620 (4.31)
AFRICA 1/	-0.4054 (-2.10)	0.3723 (-1.89)
WESTERN HEMISPHERE	-0.1736 (-1.37)	-0.1362 (-1.05)
Adjusted R^2	0.463	0.483

1/ "Africa" is defined as countries in the North and sub-Saharan African regions.

Similarly, Table 4 reports standard cross-section estimates of the growth equation (equation 1). We find that only the investment ratio, the proxy variable for international trade restrictions, and the dummy variable for the developing countries in the Western Hemisphere enter significantly with the expected signs. It is interesting to note that in the cross-sectional regression the estimated coefficient of military spending has a *positive* and statistically insignificant estimated effect on growth. Note also that when the military spending ratio is included in the cross-section regression for equaticn 1 the coefficient estimates for the other variables change very little. The same results are obtained when the Barro-Lee proxy for the incidence of wars is included. These rather inconclusive cross-sectional results broadly correspond to the ambiguous estimation results that are found in the past empirical work cited in Section II.

Table 4. Standard Cross-Section Regressions for the Growth Rate

No. of Countries	79	79	79
VARIABLE	COEFFICIENT (T-RATIO)	COEFFICIENT (T-RATIO)	COEFFICIENT (T-RATIO)
z_{t-1}	-0.0057 (-1.17)	-0.0055 (-1.17)	-0.0057 (-1.19)
$\ln(n+0.05)$	0.0103 (1.51)	0.0091 (1.37)	0.0088 (1.28)
$\ln(sk)$	0.0112 (2.73)	0.0110 (2.68)	0.0107 (2.57)
$\ln(sh)$	0.0013 (0.86)	0.0012 (0.87)	0.0012 (0.89)
$\ln(f)$	-0.0189 (-2.12)	-0.0181 (-2.12)	-0.0184 (-2.11)
$\ln(m)$		0.0023 (0.69)	0.0026 (0.72)
w			-0.0043 (-0.50)
constant	0.0537 (1.79)	0.0471 (1.70)	0.0489 (1.74)
AFRICA 1/	-0.0079 (-1.09)	-0.0072 (-2.98)	-0.0070 (-0.95)
WESTERN HEMISPHERE	-0.0139 (-2.78)	-0.0128 (-2.48)	-0.0125 (-2.30)
Adjusted R^2	0.244	0.241	0.231

1/ "Africa" is defined as countries in the North and sub-Saharan African regions.

2. Panel data estimation

We now contrast these standard results with our panel data estimates of the investment and growth equations. Table 5 reports the panel data estimates for the investment equation. In contrast to the standard cross-section results, in our panel regressions *all the variables now enter with the expected sign and are significant at the 5 percent level*. The inclusion of the Barro-Lee proxy does not importantly modify the parameter estimates but, as expected, it affects investment in a negative and significant way. Population growth and human capital investment have positive effects on physical capital investment, while a more restrictive trade system has a negative impact. Most interesting for our purposes--and consistent with our priors--the panel data estimates reveal that a rise in the ratio of military spending has a *statistically significant negative impact* on investment. Thus our results for equation 2 are consistent with the hypothesis that a rise in military spending does indeed lead to crowding out of investment in productive fixed capital.

Table 5. Panel Regressions for the Investment to GDP Ratio

No. of Countries	79	79	79
VARIABLE	COEFFICIENT (T-RATIO)	COEFFICIENT (T-RATIO)	COEFFICIENT (T-RATIO)
$\ln(n+0.05)$	0.5081 (3.37)	0.6506 (4.65)	0.6950 (4.74)
$\ln(sh)$	0.2707 (2.99)	0.2511 (2.99)	0.2294 (2.99)
$\ln(f)$	-0.1225 (-2.03)	-0.0947 (-1.69)	-0.0766 (-1.52)
$\ln(m)$		-0.0742 (-1.98)	-0.0754 (-2.14)
w			-1.3232 (-6.78)
Wald test for uncorrelated effects (p-value)	5.46 (0.1410)	38.57 (0.0000)	65.85 (0.0000)

Table 6 reports our panel-data estimates of the growth equation. First note that the lagged value of per capita output is significant and negatively related to the growth rate. This is the standard result in the empirical growth literature, known as "conditional convergence." Our results imply, however, that the growth rate of population is not a significant determinant of output growth. This is somewhat surprising in the light of previous studies which find a negative relationship on the basis of data from 1960 to 1985. Investments in physical capital and human capital both exert a positive effect on growth, and trade restrictions have a negative influence.

When we include the military spending ratio as an explanatory variable in our panel data regression, we find that it has a negative and significant effect on growth. It implies that, in addition to crowding out physical investment (as reported in Table 5), a rise in military spending *also* exerts an independent direct negative impact on economic growth. This is true even

Table 6. Panel Regressions for the Growth Rate

No. of countries	79	79	79
VARIABLE	COEFFICIENT (T-RATIO)	COEFFICIENT (T-RATIO)	COEFFICIENT (T-RATIO)
z_{t-1}	-0.0989 (-3.83)	-0.6656 (-2.96)	-0.0262 (-1.27)
$\ln(n+0.05)$	0.00003 (.003)	0.0064 (0.48)	-0.0004 (-0.03)
$\ln(sk)$	0.0227 (3.65)	0.0225 (3.94)	0.0165 (2.92)
$\ln(sh)$	0.0603 (3.73)	0.0404 (2.99)	0.0158 (1.32)
$\ln(f)$	-0.0286 (-4.35)	-0.0204 (-3.39)	-0.0091 (-1.63)
$\ln(m)$		-0.0081 (-2.67)	-0.0060 (-2.06)
w			-0.0132 (-1.51)
Wald test for uncorrelated effects (p-value)	28.19 (0.0000)	51.61 (0.0000)	55.59 (0.0000)

though we are controlling for human capital investment, population growth, and trade restrictions. The panel data estimation results of the growth equation that are reported in Table 6 are therefore consistent with the view that a rise in military spending adversely affects the growth performance of the economy.

A further important result of our empirical work is that inclusion of the military spending ratio reduces the absolute size of the estimated coefficients of physical investment, human investment, and trade restrictions in the growth equation. This follows from the fact that military expenditures are generally negatively correlated with both types of investment, and positively correlated with the intensity of trade restrictions. 1/ Given that both human capital investment and the openness of the trade system have a significant positive impact on output growth, their negative correlation with military expenditures indicates the possibility of other channels through which military spending adversely affects growth; namely, through crowding out human capital investment and fostering the adoption of various types of trade restrictions. 2/ Due to the lack of panel data on the proxies for human capital investment and trade restrictions, we cannot run separate regressions explaining the variables *sh* and *f*, and thus we are unable to quantify such effects.

As expected, the Barro-Lee proxy for the incidence of wars exerts a direct negative and significant effect on economic growth. The inclusion of this variable in the panel estimates also alters the magnitude of the estimated coefficients of the other regressors. In fact, all such coefficients decrease in absolute size, reflecting the fact that levels of both physical and human capital are negatively correlated with the incidence of military conflict, whereas the incidence of military conflict is positively correlated with intensification of trade restrictions and thus with increases in military expenditures.

V. The Peace Dividend: Simulation Experiments

As mentioned in section II, the ending of the Cold War in Europe and the other improvements in international security that occurred in the latter half of the 1980s were associated with significant reductions in military spending in a number of major geographic regions. The panel data estimation results presented in the preceding section suggest that such cuts--if sustained over time--would eventually yield a Peace Dividend in the form of a higher level of capacity GDP. In addition, the ongoing peace process in the Middle East raises the prospect that substantial further cuts in military spending could take place in this region in future years. Thus it is interesting to use our empirical estimates of the quantitative impact of military expenditures on investment and growth obtained in the preceding section to assess the timing and rough order of magnitude of the Peace Dividend effects that might occur in each region.

1/ We refer to partial correlations; that is, the correlation between military expenditures and a given variable, with other variables held constant.

2/ The positive correlation between military spending and trade restrictions is particularly strong in developing nations. Given that most of these countries import military armaments from industrial countries, they are more exposed to balance of payments problems. Partly for this reason, developing countries also tend to operate more restrictive trade regimes.

1. Simulated long-run effects of the changes in military spending that took place in the late 1980s

As a first step, we run simulations to see what our model has to say about the likely long-run effects of the major changes in military spending ratios that took place in a number of regions during the late 1980s. As the data in Table 1 above make clear, the improvements in international security that became evident during the 1980s permitted governments in all but two geographic regions to achieve reductions in their military spending ratios. For example, when the average ratio of military spending to GDP for the period 1972-85 is compared to the average for 1986-90, it is evident that between these two subperiods military expenditure declined as a percentage of GDP in all regions except Eastern Europe and sub-Saharan Africa. Although the ratio fell only modestly in the industrial countries (from 4 percent to 3.7 percent) it declined sharply in a number of regions of the developing world. The largest reduction occurred in North Africa, from 8.1 percent in 1972-85 to 4.6 percent in 1986-90; followed by Asia (6.3 percent to 3.9 percent); the Middle East (10.4 percent to 9.1 percent); and the Western Hemisphere (2.2 percent to 1.9 percent). By contrast, there was a relatively large *rise* in the military spending ratio in Eastern Europe (11.8 percent to 14.2 percent) and a modest rise (3.1 percent to 3.4 percent) in sub-Saharan Africa.

While our estimation results indicate that the effects of these changes may eventually be substantial, the estimated lags also suggest that they will take time to appear. For this reason, the salutary impact of the military spending cuts that took place in the late 1980s may not be easy to isolate empirically from other factors that influence output growth rates over the longer term. The simulation experiments provide a useful gauge of the timing and size of these effects. Thus our first set of simulations analyzes the output effect in each region covered by our study if the actual changes in military spending ratios that occurred over 1986-90 were to be sustained over the long run.

We undertake these simulations for the industrial countries and for each of the groups of developing countries in the six regions analyzed by Hewitt and described in Section II: Asia, Eastern Europe, the Middle East, North Africa, sub-Saharan Africa, and the Western Hemisphere. The exogenous shock that generates each simulation is the change in the military spending ratio that took place in each region during the second half of the 1980s. Specifically, we take the difference between Hewitt's weighted average military spending ratio for Period I (1972-85) and the corresponding ratio for Period II (1986-90) for each country group in Table 1. The levels and the resulting changes are reprinted in the first three lines of Table 7.

Table 7. The Peace Dividend: Simulated Long-Run Effects of Changes in Military Spending Ratios in the Late 1980s on Capacity Output 1/

	Country Groups						
	Industrial Countries	Developing Countries					
		Asia	Eastern Europe	Middle East	North Africa	Sub-Saharan Africa	Western Hemisphere
	(In percent of GDP)						
1. Average Military Spending Ratio, 1972-1985 2/	3.97	6.35	11.75	10.34	8.13	3.12	2.16
2. Average Military Spending Ratio, 1986-1990 2/	3.70	3.88	14.22	9.06	4.60	3.42	1.94
3. Change in Military Spending Ratio *(2 minus 1)*	-0.27	-2.47	2.47	-1.28	-3.53	0.30	-0.22
4. Associated Change in Ratio of Investment to GDP 3/	0.14	0.66	-0.48	0.25	0.70	-0.11	0.15
Time Horizon (Years)	Simulated Minus Baseline Growth Rates of Per Capita GDP						
	(In percent per annum)						
1	0.010	0.071	-0.028	0.019	0.082	-0.013	0.015
5	0.049	0.339	-0.131	0.091	0.391	-0.063	0.073
10	0.043	0.297	-0.115	0.079	0.343	-0.055	0.064
25	0.029	0.199	-0.077	0.053	0.230	-0.037	0.043
50	0.015	0.103	-0.040	0.027	0.119	-0.019	0.022
∞	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Time Horizon (Years)	Simulated Minus Baseline Levels of Per Capita GDP						
	(In percent of baseline GDP)						
1	0.0	0.1	-0.0	0.0	0.1	-0.0	0.0
5	0.1	1.0	-0.4	0.3	1.2	-0.2	0.2
10	0.4	2.6	-1.0	0.7	3.0	-0.5	0.6
25	0.9	6.2	-2.4	1.7	7.2	-1.2	1.3
50	1.4	9.8	-3.8	2.6	11.3	-1.8	2.1
∞	2.0	13.6	-5.3	3.6	15.7	-2.3	2.9

1/ The simulation exercise is based on the parameter estimates given in Table 5, column 4, and Table 6, column 4. Details on how the simulations were performed are given in Appendix II.

2/ Derived from data in Hewitt (1992).

3/ The change in investment ratio is produced by the total change in military spending ratio with respect to the baseline military spending ratio (average during 1972-85).

In these simulation experiments we assume for simplicity that the change in the average military spending ratio in each region is spread over the whole period 1986-90, 1/ and that after reaching its new level in 1990 the military ratio remains constant thereafter. The stylized paths of the changes in military spending ratios that occurred in each region during the late 1980s are illustrated by the solid lines in the top panels of Figure 1. The numerical parameters of the model are our panel estimates from Tables 5 and 6.

To implement the simulation we first substitute equation (2) into equation (1) to obtain the reduced-form relationship between the military spending ratio and the growth path. From this reduced-form equation we obtain the deviation of the simulated growth path for each region owing to the change in the military spending ratio from the path that would have prevailed if this exogenous change had not occurred (for a detailed explanation see Appendix II). Note that since ours is a long-run model the simulations trace the dynamic effects of this change on regional levels of *capacity* output. We are not interested in the short-run Keynesian multiplier effects of military spending cuts, since these affect actual output *relative to* capacity output.

Table 7 and Figure 1 (solid lines) summarize the simulation results for each of the seven regions. Line 4 indicates the change in the investment ratio that results from the shift in the military spending ratio in each region. For example, in the Asian developing and North African countries, which had the biggest cuts in their military spending ratios over 1986-90, the resulting increase in investment is nearly 0.7 percent of GDP; in the Middle East investment rises by 0.25 percent of GDP; in the industrial countries and the developing countries of the Western Hemisphere the rise is about 0.15 percentage points.

The middle panel in Table 7 shows the difference between the simulated *growth rates* of capacity output per capita and their baseline paths that will eventually result from the changes in military spending levels that actually occurred in the late 1980s. The lower panel shows the percentage difference in the *levels* of capacity output per capita in each region relative to their baseline paths.

In our model, a one-shot increase in the military spending ratio causes a permanent rise in the level of GDP as a result of a transitory rise in the growth rate: since our first set of simulations assumes that military spending ratios are held constant at their new levels from 1990 onward, the growth rates of per capita output in each region gradually decelerate again until they return to their baseline levels. As a result, the percentage

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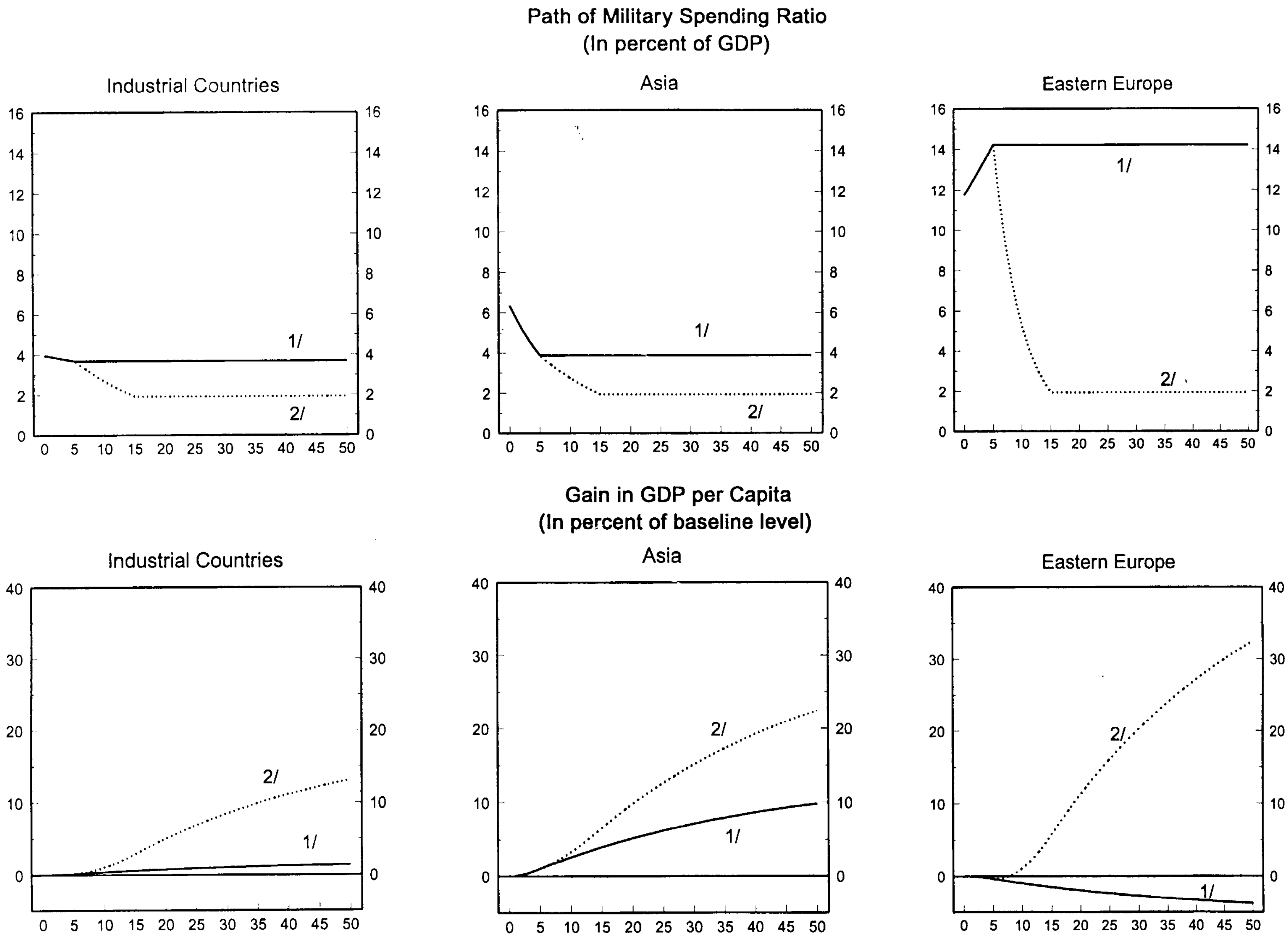
1/ Specifically, we assume that the natural logarithm of the military spending ratio declines linearly over this period.

Figure 1. Various Country Groups: Simulated Long-run Effects of Actual Past Changes in Military Spending (solid line) and Possible Future Reductions (dotted line)

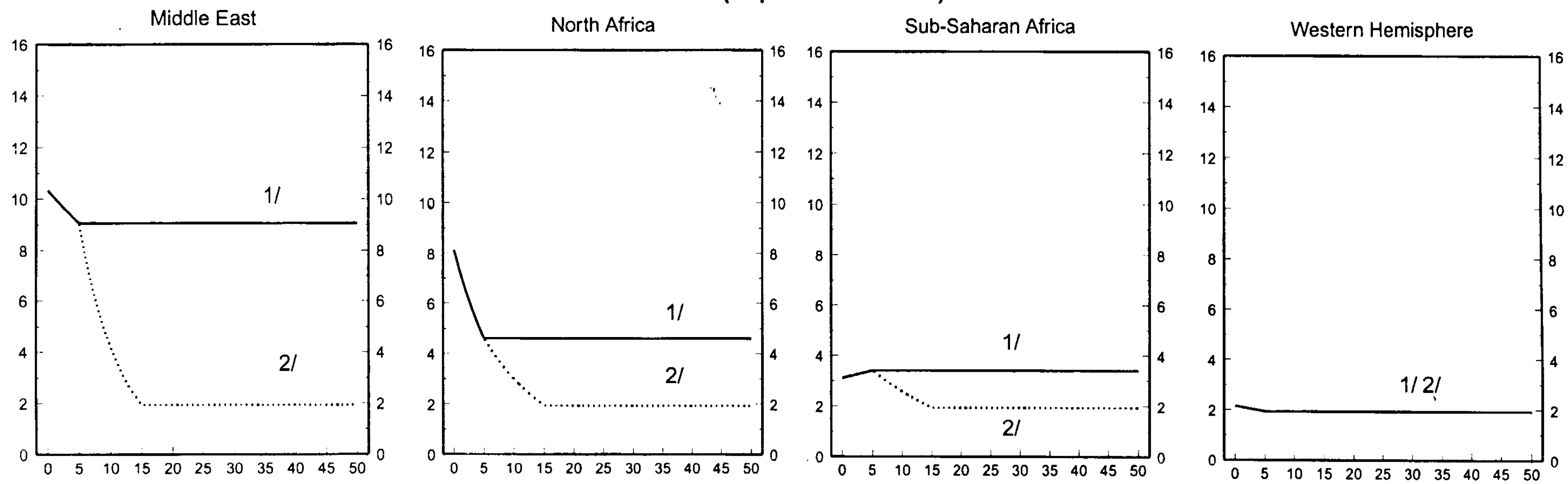


1/ If military spending falls from 1972-85 to 1986-90 average over five years.

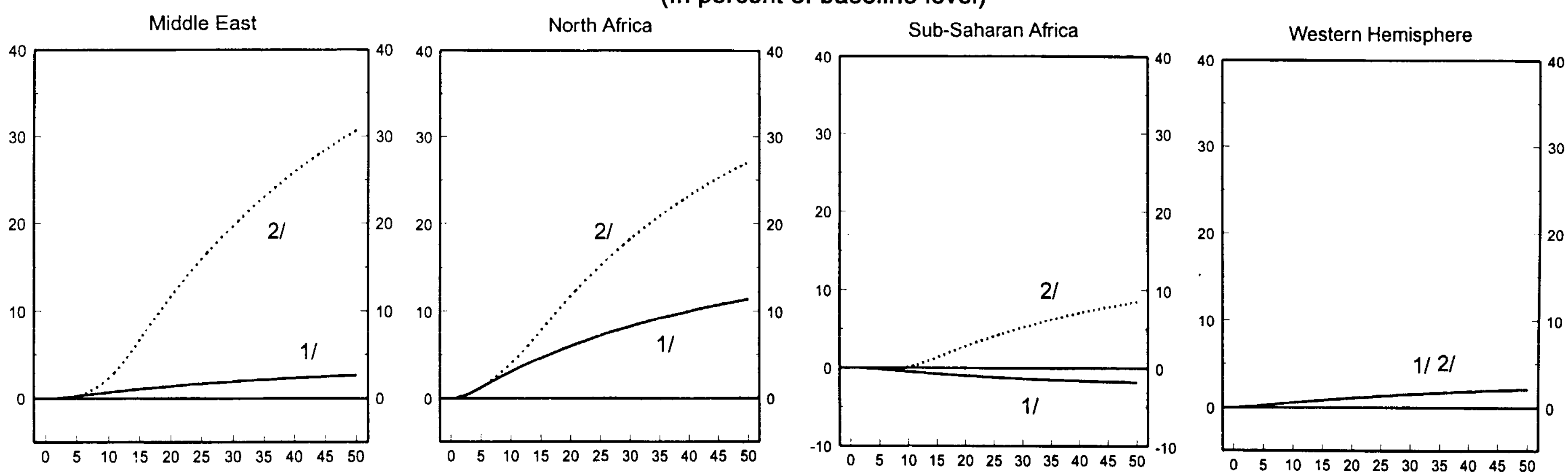
2/ Assuming regions decrease military spending from 1972-85 average to that of the Western Hemisphere in the period 1986-90 over 15 years.

Figure 1 (cont'd). Various Country Groups: Simulated Long-run Effects of Actual Past Changes in Military Spending (solid line) and Possible Future Reductions (dotted line)

Path of Military Spending Ratio
(In percent of GDP)



Gain in GDP per Capita
(In percent of baseline level)



1/ If military spending falls from 1972-85 to 1986-90 average over five years.

2/ Assuming regions decrease military spending from 1972-85 average to that of the Western Hemisphere in the period 1986-90 over 15 years.

deviation in the levels of per capita GDP (shown in the lower bottom panel of Table 7 and the solid lines in the lower panel of Figure 1) continue to rise at decreasing rates until the new levels are reached in each region.

Obviously, the geographic regions that experienced the largest reductions in military spending ratios in the late 1980s are the ones that will eventually benefit from the largest gains in capacity output per worker. As indicated in the middle panel of Table 7, these past cuts are projected to result in modest but persistent gains in annual growth rates. For example, in the cases of Asia and North Africa, where military spending cuts were largest, the gains in annual growth rates reach a maximum that is about 0.3 percent per year higher than the baseline growth rate; the effects are of course smaller for other country groups, particularly the industrial countries and the developing countries in the Western Hemisphere.

Owing to the dynamic properties of the growth model these modest deviations in growth rates persist for quite a long time, and as a result their ultimate effects on the *levels* of capacity output per worker are substantial. For example, our simulations indicate that in the long run the changes in military spending ratios of the late 1980s would--if sustained--result in a gain in the capacity level of per capita output in North Africa of nearly 16 percent relative to the baseline level that would have prevailed in the absence of such cuts; for Asia, output would eventually be nearly 14 percent higher; and for the Middle East it would be 3.6 percent higher.

These results suggest that the long-run Peace Dividend from the military spending cuts that have already taken place in several regions during the late 1980s will eventually cumulate to large effects on the levels of capacity output. Even for the industrial countries and Western Hemisphere countries, where the military spending cuts during the latter half of the 1980s were modest (from their relatively low initial levels), per capita output levels would eventually be 2.0 percent and 2.9 percent, respectively, above the baseline paths. By contrast, because of the rise in military spending ratios that occurred in Eastern Europe and sub-Saharan Africa during the latter half of the 1980s, per capita GDP in these regions would be *lower* by some 5.3 percent and 2.3 percent, respectively, in the long run.

2. <u>Simulated effects of a generalized peace in all regions</u>

Our second set of simulation experiments looks at the long-run gains in capacity output that might result from *future* large military spending cuts that might be associated with the achievement of a generalized peace in all geographic regions of the world. Specifically, we pose the following questions. If global peace were achieved, by how much might military spending ratios decline? What might be the size of the stimulus to productive investment? How soon might the resulting Peace Dividend exert positive effects on the growth paths of capacity output in various geographic regions? How large might these effects ultimately be? These are, of course, highly speculative questions. Even if there was a sustained improvement in global security, it is not clear how large the resulting cuts in military spending ratios would actually be, since most countries would probably still wish to maintain at least some minimal level of military preparedness.

We have already emphasized that--reflecting the differing levels of political tensions and risks of military conflict in different parts of the world--there has been a wide regional variation in ratios of military spending to GDP throughout the period for which comparable data are available. In particular, as seen in Table 1, developing countries in the Western Hemisphere have maintained the lowest average military spending ratios of any region (around 2 percent) over a long period of time. Since the Western Hemisphere developing countries have avoided major armed conflicts throughout this period, it is plausible to assume that the average military spending ratio already observed for this region can be taken as a simple approximation of the minimum level that could be attained in other regions if a lasting world peace were achieved.

Thus our second set of simulations assumes that the military spending ratio in *each* region declines steadily over a 10-year period from its regional average level over 1986-90 to the (1986-90) average level observed for the Western Hemisphere developing countries--that is, just under 2 percent of GDP. We then simulate the effects of these reductions in military spending on the growth paths of per capita capacity output for each of the regions, and compare them to the baseline paths that would have been traced out if military spending ratios had remained at the average levels observed over 1972-1985. Thus this second set of simulations includes *both* the effects of the changes in military spending that occurred in 1986-90 (relative to the average levels for 1972-85) *and* the additional effects that would eventually result from a generalized international peace. The results are summarized in Table 8 and Figure 1 (dotted lines).

In our model, these large further reductions in military spending ratios would act as a strong stimulus to productive investment in all regions. The fourth line of Table 8 shows that the resulting increases in investment ratios would be especially striking for Eastern Europe (4.9 percent of GDP) and the Middle East (3.3 percent of GDP), the regions that--since they currently have high levels of military spending--stand to gain the most from reducing them to the minimum level associated with a generalized peace.

The dotted lines in the upper panels in Figure 1 show the hypothetical downward paths of military spending for each region over the next 10 years. The dotted lines in the lower panels represent the percentage deviation of each region's per capita capacity output from the baseline path over a fifty year period starting from 1986. As the simulations indicate, the further gradual declines in military spending in all regions that would be associated with a lasting improvement in international security would exert

Table 8. The Peace Dividend: Simulated Effects of Decreasing Regional Military Spending Ratios from their 1972-85 Average Levels to the 1986-90 Level for Western Hemisphere Developing Countries 1/

	Country Groups						
	Industrial	Developing Countries					
	Countries	Asia	Eastern Europe	Middle East	North Africa	Sub-Saharan Africa	Western Hemisphere
	(In percent of GDP)						
1. Average Military Spending Ratio, 1972-1985 2/	3.97	6.35	11.75	10.34	8.13	3.12	2.16
2. "Minimum" Military Spending Ratio 2/	1.94	1.94	1.94	1.94	1.94	1.94	1.94
3. Change in Military Spending Ratio *(2 minus 1)*	-2.03	-4.41	-9.81	-8.40	-6.19	-1.18	-0.22
4. Associated Change in Ratio of Investment to GDP 3/	1.50	1.63	4.90	3.30	1.81	0.58	0.15
Time Horizon (Years)	Simulated Minus Baseline Growth Rates of Per Capita GDP						
	(In percent per annum)						
1	0.010	0.071	-0.028	0.019	0.082	-0.013	0.015
5	0.049	0.339	-0.131	0.091	0.391	-0.063	0.073
10	0.265	0.535	0.570	0.609	0.639	0.140	0.064
25	0.348	0.542	0.908	0.815	0.657	0.243	0.043
50	0.179	0.279	0.467	0.420	0.338	0.125	0.022
∞	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Time Horizon (Years)	Simulated Minus Baseline Levels of Per Capita GDP						
	(In percent of baseline GDP)						
1	0.0	0.1	-0.0	0.0	0.1	-0.0	0.0
5	0.1	1.0	-0.4	0.3	1.2	-0.2	0.2
10	1.1	3.3	1.1	2.3	3.9	0.1	0.6
25	6.9	12.6	16.1	16.0	15.2	4.1	1.3
50	13.2	22.4	32.4	30.7	27.0	8.5	2.1
∞	19.8	32.7	49.7	46.2	39.6	13.1	2.9

1/ The simulation exercise is based on the parameter estimates given in Table 5, column 4, and Table 6, column 4. Details on how the simulations were performed are given in Appendix II.

2/ Derived from data in Hewitt (1992). Line 2 is the 1986-90 average military spending ratio of developing countries in the Western Hemisphere.

3/ The change in investment ratio is produced by the total change in military spending ratio with respect to the baseline military spending ratio (average during 1972-85).

very marked stimulative effects on the growth paths of per capita output in all regions (except Western Hemisphere, where there is assumed to be no *further* fall in military spending after 1990).

The simulated transitory effects on growth rates are much larger than in the first simulation. For example, in Eastern Europe where--on our assumptions--the total decline in the military spending ratio would be the largest (on the order of 4.9 percent of GDP), the rate of growth of per capita GDP would rise to a maximum where it was 0.9 percent per annum higher than in the baseline simulation. In the Middle East, Asia and North Africa, growth rates would reach a maximum that was more that 0.6 percent a year higher from years 10 to 25 of the simulation.

As a result of these differences in growth rates, the ultimate effects on the levels of capacity output would vary widely across regions, but would generally be large. When all lagged effects had worked their way through, the output levels for Eastern Europe and the Middle East would be 50 percent and 46 percent higher, respectively, than they would have been if the reductions in military spending had not occurred. In the developing countries of Asia and North Africa the long-run gain would be 30 to 40 percent, and in sub-Saharan Africa over 10 percent. For industrial countries, capacity output per capita would eventually be higher by 20 percent. This second set of simulations, therefore, suggests that military spending cuts of a size that might plausibly be expected to occur in each region if a comprehensive global peace were achieved would exert large positive Peace Dividend effects on capacity output in most geographic regions.

VI. Summary and Conclusion

There are a number of good reasons for expecting that military spending cuts associated with improved international security would be likely to enhance long-run economic growth performance. Thus it is surprising that the empirical literature, taken as a whole, yields an ambiguous answer to the question whether military spending cuts have a positive impact on growth. The present paper was motivated by our suspicion that the ambiguous results of past studies may reflect weaknesses in estimation methodology, particularly the failure to exploit both the cross-section and time-series dimensions of available data using appropriate econometric techniques.

To unravel the contradictory empirical findings, we estimate an extension of a standard growth model that includes an investment equation and a growth equation, both of which are functions of the military spending ratio as well as other determinants. We estimate the model on panel data for a large sample of industrial and developing countries.

In contrast to standard cross-section estimates which give no clear significant results, the panel estimates of both the investment and the growth equations are robust in the sense that all variables enter significantly with the expected sign. The empirical results provide a clear answer to the question whether military expenditure is economically unproductive. Our answer is in the affirmative. When the military spending ratio is added to a growth equation that already includes the determinants suggested by standard theory the direct effect of higher military spending on per capita output growth is unambiguously negative and large. The indirect impact of military spending on economic growth, via its negative impact on productive investment, is also found to be statistically significant. Thus our empirical estimates clearly indicate that high levels of military expenditure detract from economic growth both because they reduce productive fixed capital formation and because they act more generally to distort resource allocation.

Using simulations with the estimated model we quantify the likely size of the Peace Dividend that would result over the long run from sustained cuts in military spending ratios. We find that the improved security conditions and associated military spending cuts in most regions in the late 1980s will lead--provided they are sustained--to substantial gains in capacity output over the long run. On the other hand, the unsettled security conditions and the associated increases in military spending in Eastern Europe and sub-Saharan Africa in the late 1980s have further weakened the already low rates of growth of per capita output in these regions. These simulated effects are large enough in themselves to justify our belief that there will be a substantial Peace Dividend from the cuts in military spending that have already taken place in most regions.

Deeper cuts in military spending that would be made possible by a generalized peace would result in an even larger Peace Dividend. Specifically, we find that a generalized improvement in security that allowed military spending ratios in all regions to fall to the levels actually observed in the Western Hemisphere in recent years would result in very large long-run gains in capacity output in most regions. For example, in Eastern Europe and the Middle East--where military spending ratios have been high in the past--the salutary effects of military spending cuts on investment and growth could increase capacity output in the very long run by nearly 50 percent relative to the levels that would have prevailed if military spending ratios had remained fixed at the high average levels that were prevalent in these regions over 1972-85. The Peace Dividend effects for other regions, though less spectacular than in these cases, are still very large in the long run.

It is also relevant to note that these simulation results may actually tend to *understate* the positive output-growth effects of enhanced international security. First, a sustained global peace might eventually reduce the world military spending ratio by more than our simulations assumed. Universal peace, after all, would be the classic example of a public good. Furthermore, although our simulations explicitly assume that all determinants of investment and growth other than military spending would remain unchanged even if a generalized peace were achieved, it is likely that there would be positive synergies in the evolution of productive technology. Since improved security would allow a greater proportion of research and development expenditures to be devoted to nonmilitary goals, it would stimulate market-oriented technological innovation, thus enhancing the growth of total factor productivity.

Over the long run, improvements in international security would almost certainly result in improvements in the other economic variables that are significant determinants of economic growth. As political tensions subsided, more and more countries would be able to concentrate on improving economic performance by dismantling barriers to free international exchange of goods, services, and financial assets. In this way, a generalized peace would foster economic interdependence, more open trading systems, and associated specialization gains. For analogous reasons, a better international security situation would also allow national education programs to concentrate on productive skills, and participation in the educational systems could rise markedly in a number of populous countries where political insecurity has long limited educational opportunities.

Given these considerations, the key policy implication of this study is straightforward: The Peace Dividend from military spending cuts is likely to be very substantial over the longer term. Thus reductions in military spending should be viewed as attractive structural policy elements of macroeconomic packages designed to enhance the growth path of capacity output.

Data Sources and Definitions, and Sample of Countries

A. Data sources:

The basic data used in this study are annual observations. The following variables were taken from Summers and Heston (1991), Penn World Tables:

z : Natural logarithm of real GDP per worker.

sk : Ratio of real investment to real GDP (five-year average).

n : Growth rate of number of workers (five-year average).

The following variable was taken from Mankiw, Romer and Weil (1992):

sh : Percent of working-age population enrolled in secondary schools (average for the period 1960-85).

Data on tariffs were taken from Lee (1993):

f : Import-share-weighted average of tariffs on intermediate and capital goods (from various years in the early 1980s).

Data on military expenditures were provided by Daniel Hewitt, who collected the data from the 1992 Yearbook of the Stockholm International Peace Research Institute (SIPRI):

m : Ratio of SIPRI military expenditures to GDP (data are annual for 1971-1990).

Data on the incidence of wars was provided by Barro and Lee (1993):

w : Ratio of years spent in international wars to the total number of years in the period 1960-1985.

B. List of Countries included in Hewitt's 124-Country Sample, and in our 79-Country Panel Data Set used for Estimation.

(Countries from Hewitt's sample that are included in our panel data estimation are marked with an asterisk).

1. Industrial Countries

Canada *
U.S.A. *
Japan *
Austria *
Belgium *
Italy *
Luxembourg
Netherlands *
Norway *
Portugal *

Denmark *
Finland *
France *
Germany, Federal Republic of *
Greece *
Ireland *
Singapore *
Spain *
Sweden *
Switzerland *
United Kingdom *
Australia *

2. Developing countries

Algeria *
Angola
Argentina *
Bahrain
Bangladesh *

Benin *
Bolivia *
Botswana
Brazil *
Bulgaria

Burkina Faso *
Burundi *
Cameroon *
Central African Republic *
Chad

China
Chile *
Colombia *
Congo *
Costa Rica *

Cote d'Ivoire
Cuba
Cyprus
Czechoslovakia
Dominican Republic

Ecuador *
Egypt *
El Salvador *
Ethiopia *
Fiji

Mozambique
Myanmar
Nepal *
Nicaragua *
Niger

Gabon
German Democratic Republic
Ghana *
Guatemala *
Guinea-Bissau

Guyana
Haiti *
Honduras
Hungary
India *

Indonesia *
Iran
Iraq
Israel
Jamaica *

Jordan *
Kenya *
Korea *
Kuwait
Lebanon

Liberia
Libya
Madagascar *
Malawi *
Malaysia *

Mali
Mauritania
Mauritius *
Mexico *
Morocco *

Sudan *
Swaziland
Syrian AR *
Taiwan, Province of China
Tanzania *

Nigeria *
Oman
Pakistan *
Panama
Paraguay *

Philippines *
Peru *
Poland
Romania
Rwanda *

Saudi Arabia
Senegal *
Sierra Leone *
Somalia *
South Africa
Sri Lanka *

Thailand *
Togo
Trinidad and Tobago *
Tunisia *
Turkey *

Uganda *
United Arab Emirates
U.S.S.R
Uruguay *
Venezuela *

Yemen AR
Yemen PDR
Yugoslavia
Zaire *
Zambia *
Zimbabwe *

C. Comparison of Hewitt's and Our Data on Military-Spending-to GDP Ratios for Various Country Groups and Time Periods

	Period Weighted Averages in Percent 1/					
	Full Period (1972-90)		Period I (1972-85)		Period II (1986-90)	
	Hewitt	Our Sample	Hewitt	Our Sample	Hewitt	Our Sample
Full Sample	5.10	3.80	5.19	3.89	4.84	3.59
Industrial Countries	3.90	3.90	3.97	3.99	3.70	3.71
Developing Countries	5.20	3.10	5.54	3.14	4.26	2.80
Regional Groupings:						
Asia	5.70	3.90	6.35	3.94	3.88	3.75
Eastern Europe	12.40	--	11.75	--	14.22	--
Middle East	10.00	6.80	10.36	6.93	9.06	6.49
North Africa	7.20	6.50	8.12	7.59	4.60	3.38
sub-Saharan Africa	3.20	2.70	3.12	2.83	3.42	2.52
Western Hemisphere	2.10	2.20	2.16	2.28	1.94	1.80

Source: Hewitt (1992).

1/ The weights are each country's share in the group GDP measured in U.S. dollars using official exchange rates.

Simulation Exercise

There are three elements that determine the gains in GDP over time for a given reduction in the ratio of military spending to GDP (M/GDP = m). First, the effect of m on the ratio of investment to GDP, and the latter's effect on per capita GDP growth; second, the direct effect of m on per capita GDP growth; and third, the effect of the current per capita GDP on its growth rate (the convergence effect.) From equations 1 and 2, the percentage gain in per capita GDP (Δz_t) for a given percentage change in the military spending ratio ($\Delta\ln(m)$) is given by

$$\Delta z_t = (\theta_m + \theta_k \eta_m)\Delta \ln m$$

$$\Delta z_{t+1} = [(1+\gamma)+1](\theta_m + \theta_k \eta_m)\Delta \ln m$$

$$\Delta z_{t+1} = \left[\sum_{i=0}^{j} (1+\gamma)^i\right](\theta_m + \theta_k \eta_m)\Delta \ln m$$

$$\vdots$$

$$\Delta z_\infty = \left[\frac{-1}{\gamma}\right](\theta_m + \theta_k \eta_m)\Delta \ln m \qquad (for\ -1<\gamma<0)$$

The estimates for θ_m, θ_k, and γ are taken from Table 6, column 4; and the estimate for η_m, from Table 5, column 4.

$\Delta\ln(m)$ for each group of countries is computed as follows:

$$\Delta \ln m = \ln(Average\ M/GDP(1986\text{-}1990)) - \ln(Average\ M/GDP(1972\text{-}1985))$$

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