Lost Productivity and Defense Burden of the Southern Cone of Latin America

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Defense burdens of Latin American countries have mostly declined over the past two decades. The decline in defense spending took place as countries moved gradually away from military to civilian democratic regimes. But the process of decline has not been uniform, it has essentially varied with the degree of civilian control that each country acquired over its armed forces. In the Southern Cone (SC) of Latin America, the group of five countries - Argentina, Bolivia, Chile, Paraguay and Peru - spent, on average, from 3% to 6% of their gross national product on military outlays during the 1970's and 1980's. By one estimate,[1] Chile spent the most (6.4%), followed by Peru (3.5%), Bolivia (3.1%), Argentina (2.9%), and Paraguay (2.8%). But if we consider the size of the country and compare per capita expenditure, their ordering becomes different. For example, Argentina spent annually $154, Chile $112, Peru $87, and Bolivia and Paraguay about $30 each.[2] Interestingly, the levels of their defense expenditure also fluctuated widely over the two decades. At one point, namely 1980-81, the five countries together spent over $11 billion in one year, but, on average, their annual spending has been close to $8 billion. This paper tries to detect and quantify the *hidden costs*, if any, of military expenditures for each of the five countries in the Southern Cone of Latin America. We define the *hidden costs* in terms of reduction related to total factor productivity when there is a substitution of military for nonmilitary expenditures. We believe that if we can uncover such *hidden costs* and measure the loss of factor productivity in the economy, we should be able to show that a potential reservoir of 'peace dividend' did exist, and that it could be tapped when resources are shifted from the military to the civilian sector. Our analysis shows that there is an

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[1] Our estimates of military expenditures are provided by Thomas Scheetz of Argentine Business University and Lincoln University College.

[2] All values are measured in 1990 US$ unless specified otherwise.

economic argument for a shift from the military to the nonmilitary sector.

In section 1, we highlight briefly a comparative record of aggregate military expenditures of the five Southern Cone countries; in section 2, we describe our methodology and in section 3, we provide some estimates. The implications of the statistical results are discussed in section 4.

1. Was Military Expenditure Contagious? Some Numbers

A comparison of aggregate real military expenditures (MILEX), measured in 1990 US$, of the five Southern Cone countries over two decades is given in Table 1. Per capita military expenditures (PMIL) are shown in Table 2, and shares of military expenditures as percentage of GDP (MILS) in Table 3.

Table 1. Aggregate Military Expenditure of Southern Cone Countries, 1971-1990
(Millions of 1990 US$)

	Mean	Mean	Mean (Rank)	Standard Deviation (Coefficient of Var)	Minimum	Maximum
	1971-80	1981-90	1971-90	1971-90	1971-90	1971-90
Argentina	4832.5	3841.8	4337.1 (1)	1993.9 (0.46)	2069.1	7716.6
Bolivia	178.9	143.4	161.1 (4)	60.3 (0.37)	61.3	345.7
Chile	1088.7	1474.9	1281.8 (3)	267.7 (0.21)	783.2	1619.9
Paraguay	68.2	131.0	99.6 (5)	35.4 (0.36)	52.1	154.0
Peru	1562.9	1424.6	1493.8 (2)	510.2 (0.34)	812.0	2742.5
SC total	7731.2	7015.7	7373.5	2461.5 (0.33)	4488.0	11135.4

Table 2. Per Capita Military Expenditure and GDP of Southern Cone Countries, 1971-1990

	Per Capita Military Expenditure			Per capita GDP		
(Mean Values)	1971-80	1981-90	1971-90 (Rank)	1971-90	1971-90	1971-90(Rank)
Argentina	180.6	127.7	154.2 (1)	5834.4	4734.1	5284.3 (1)
Bolivia	35.3	22.7	29.0 (5)	992.4	813.8	903.1 (5)
Chile	104.0	120.9	112.4 (2)	1673.5	1849.0	1761.3 (3)
Paraguay	24.8	35.2	30.0 (4)	937.5	1201.7	1069.6 (4)
Peru	100.3	74.0	87.1 (3)	2612.6	2358.6	2485.6 (2)
SC total	127.1	98.2	112.6	3653.5	3076.4	3364.9

Table 3. Ratio (%) of Military Expenditure to GDP of Southern Cone Countries, 1971-1990
(Millions of 1990 US$)

	Mean 1971-80	Mean 1981-90	Mean (Rank) 1971-90	Standard Deviation (Coefficient of Var) 1971-90	Minimum 1971-90	Maximum 1971-90
Argentina	3.1	2.6	2.9 (4)	1.1 (0.38)	1.4	4.9
Bolivia	3.5	2.7	3.1 (3)	1.0 (0.32)	1.6	6.3
Chile	6.2	6.6	6.4 (1)	1.1 (0.17)	4.7	8.3
Paraguay	2.7	2.9	2.8 (5)	0.5 (0.31)	1.9	3.7
Peru	3.8	3.1	3.5 (2)	1.1 (0.31)	1.9	6.5
SC total	3.5	3.1	3.3	0.9 (0.27)	2.0	4.9

A careful reading of these tables underscores the following:

(1) Respective ranks of the five countries change strikingly when judged by aggregate military expenditures, per capita military expenditures and by the ratios of their military expenditures to GDP. The cases of two countries, Argentina and Chile engaged in arms races, are particularly noteworthy. (a) Argentina which ranks first by MILEX and PMIL falls to the fourth position when judged by MILS. (b) Chile which ranks third by MILEX, and second by PMIL ranks first when judged by MILS. Chile may be viewed as having a top rank in terms of defense burden. Here one may pause and raise an interesting question: can a small country like Chile afford to use such a high proportion (over 6%) of its productive resources for its military?

(2) The transition to a democratic civilian regime in Argentina, Bolivia and Peru took place in the early 1980's, but in Chile and Paraguay not until the end of 1980's. Simultaneously, in the 1980's, Argentina, Bolivia and Peru reduced both their aggregate and their per capita military expenditures as well as their GDP shares of military expenditures from high levels reached in the 1970's, but military expenditures in both Chile and Paraguay went up during this period. At the same time, levels of per capita GDP of Argentina, Bolivia and Peru were lower in the 1980's. Levels of per capita GDP of Chile and Paraguay were higher in the corresponding period (Table2). Thus by the economic history experienced by these two groups of countries one may tend to conclude rather simplistically that the economies of the Southern Cone countries during the two decades of 1970's and 1980's were basically driven by their military sectors.

(3) Total military expenditure of the five countries together was lower in the !980's than in the 1970's on each of the three counts, MILEX, PMIL and MILS. Their overall defense burden fell during the 1980's. We also note simultaneously that per capita real GDP of the Southern Cone fell from $3653 in the 1970's to $3076 in the 1980's - a significant fall by almost 16%. Annual movements in the levels of MILEX, PMIL and MILS of the Southern Cone as a whole are shown respectively in Figures 1-3.

(4) The contagious aspect of military expenditures across Southern Cone countries is reflected in Figures 4-6, where the statistics (MILEX, PMIL, MILS) are plotted separately for each country. The aggregate military expenditures of Argentina, Bolivia and Peru seemed to have moved together.[3] The correlation coefficient between MILEX of Argentina and Bolivia is 0.74, between Argentina and Peru, 0.66, and between Bolivia and Peru, 0.44. Similarly, the correlation coefficient between MILEX of CHILE and Paraguay is 0.74. Both Chile and Paraguay were under military regimes during the period under study. Analogous patterns can be detected in the movements of MILS of Argentina, Bolivia and Peru. Also, two negative relationships between MILS of Argentina and Paraguay (r = - 0.31), and between Paraguay and Bolivia (r= - 0.39) are noteworthy. An overall emerging pattern points to a substantial degree of contagion in the movements of military expenditures of the five countries analogous to an action-reaction model of Richardson (1960). The underlying pattern indicates that possibly a strong and mutually beneficial contagion towards a further reduction in military spending in Latin America can be, and ought to be, implemented.

[3] This not surprising in the light of the fact that a transition to democratic civilian regime can be dated approximately in 1981 for Peru, 1983 for Bolivia and 1984 for Argentina. Similarly, democratic transition is dated in 1989 for Paraguay and 1990 for Chile.

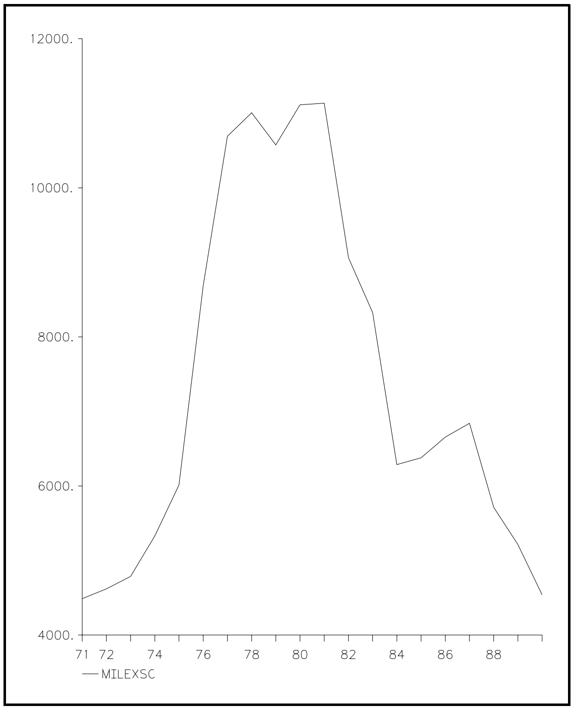

Figure 1. Military Expenditure SC, mill US$ 1971-90

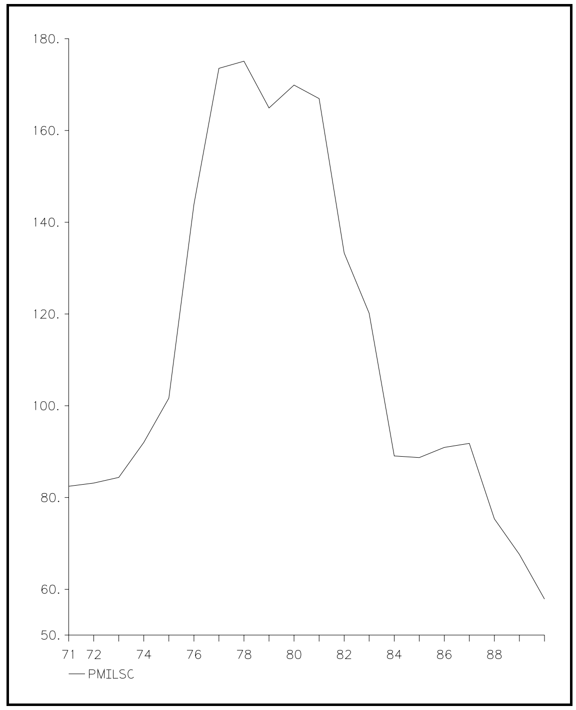

Figure 2. Per capita Military Expenditure SC, 1971-90

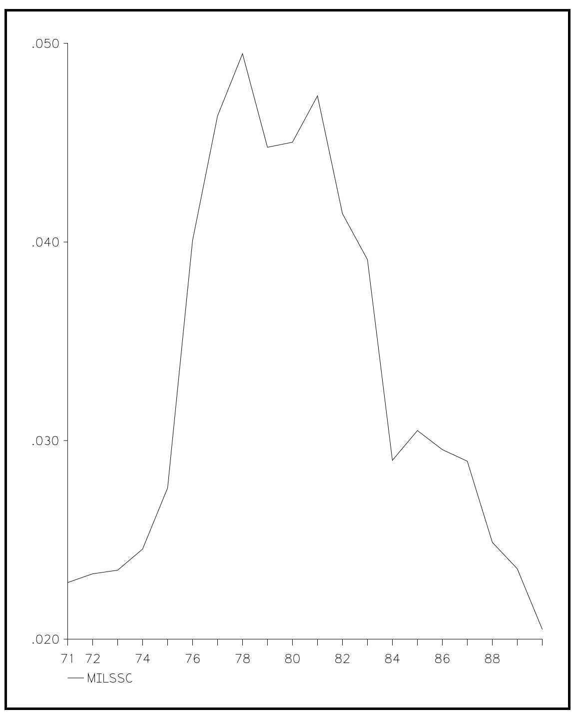

Figure 3. Ratio of Military Expenditure to GDP, SC, 1971-90

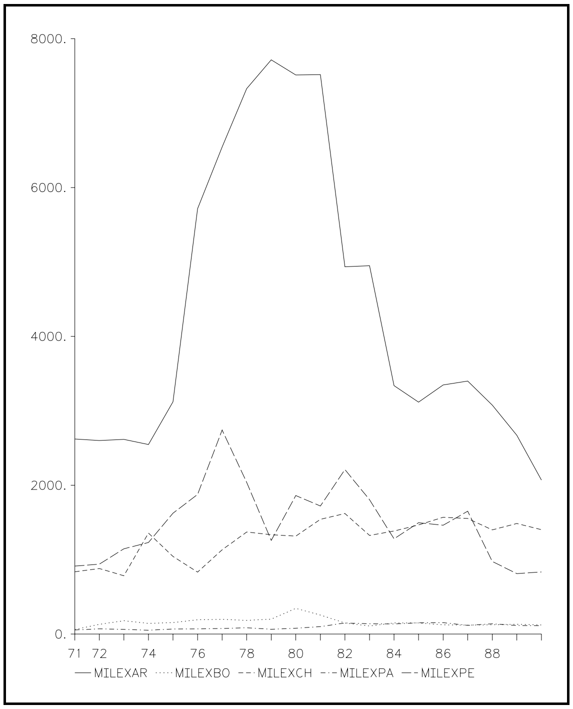

Figure 4. Military expenditure in Five Countries, 1971-90

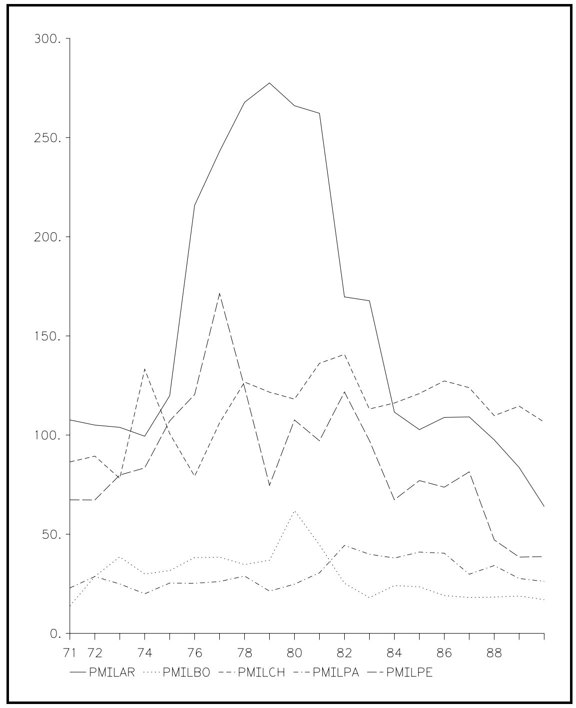

Figure 5. Per capita Military Expenditure in Five Countries, 1971-90

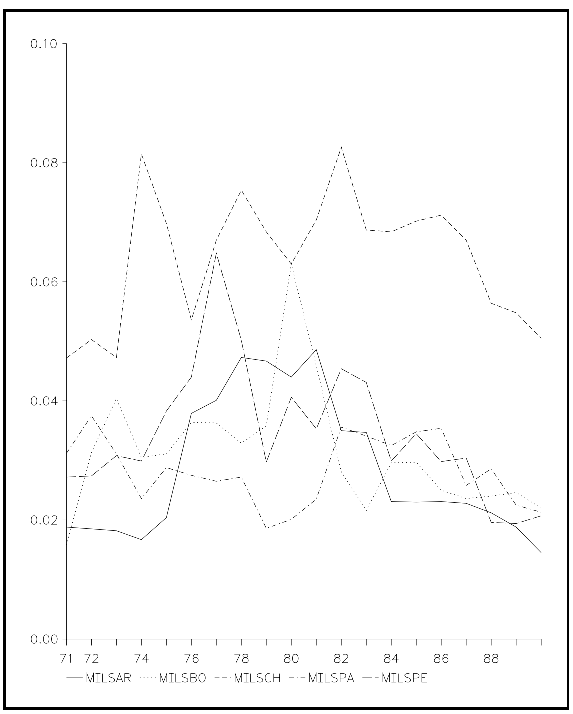

Figure 6. Ratio of Military Expenditure to GDP in Five Countries, 1971-90

2. Methodological Specification

A burgeoning literature on the impact of military expenditure on economic growth is now available. Rati Ram's (1993) discussion of the conceptual linkage between military spending, productivity and social well being is well known. Dunne (1996) presents an excellent annotated survey of existing quantitative literature on the linkage between military expenditure and economic growth. Not surprisingly the evidence available so far is quite conflicting and is generally conditioned by the methodological underpinnings of each study. More recently, Marwah, Klein and Scheetz (1999) have presented a substantive model-based analysis of the impact of military expenditure on Guatemala's economy. Some further evidence on the subject is presented in Marwah, Klein and Scheetz (2000) from Bolivia's economy. It is shown in both cases that how a small reduction in military expenditures leads to improved performance of the economy. The Guatemala results are derived by constructing a small simultaneous equations model. The impact of reduction in military spending is particularly realized in terms of higher economic growth, higher consumer spending, lower inflation, an improved trade balance and stronger currency. The model has twelve equations that incorporate both the demand side and supply side effects. The results for Bolivia for lack of full data are based on an analysis of the production function alone - a single equation from the supply side.

In this paper, macroeconomic analysis of the impact of military expenditures on productivity for each of the five Southern Cone countries is done within the analytical framework of a multi-factor technological production function of the type we developed in the Bolivian case. In this context we must remember that from the expenditure side of the national income accounting data we can split GDP into two broad, but distinct, components, military and nonmilitary, but we do not have corresponding sectoral data on capital and labor. Nonetheless, by making some simple but realistic assumptions we can derive an aggregate production function that incorporates a ratio of military (or nonmilitary) expenditures to GDP as a separate input factor. We can then estimate and examine the effect of this ratio, particularly of military expenditure to GDP, on total factor productivity. The methodology is briefly explained below.

Let total output (GDP) depend on two inputs, capital (K) and labor (L), and an exponential factor, A(T), that accounts for shifts over time in total factor productivity. That is,

$$(1) \qquad GDP = F\,(K, L, A(T))\ .$$

We may parametrize (1) as a transcendental production function that belongs to the genre of Cobb-Douglas functions.[4] In this function, the production technology is specified in more general terms than those confined to the strict Cobb-Douglas case. It allows for both non-unitary elasticity of substitution between the factor inputs, capital and labor, and their elasticities of production to be non-constant. The transcendental function can be further augmented by a ratio of military expenditure to GDP, (MILEX/GDP), in order to show the "competing" inputs of (civilian) nonmilitary activities and military activities, allowing for the fact that separate data, across countries of the Southern Cone, are not generally available in detailed form to estimate their two separate production functions. We do, however, have estimates of military expenditure in constant prices, for each country in the Southern Cone.

Assuming that production technology is homogeneous of degree one in the factor inputs, capital and labor, and exponential dynamic shifts can be approximated by a polynomial in time up to a third degree, the general function including a random term μ is proposed as,

$$(2) \qquad \frac{GDP}{L} = A \left(\frac{MILEX}{GDP}\right)^{\alpha-1} \left(\frac{K}{L}\right)^{\beta} e^{\gamma\left(\frac{K}{L}\right) + \sum_{i=1}^{3} \delta_i T^{i}}\, \mu .$$

In (2), output per worker (average productivity, AP) is invariant with respect to identical scale changes in K and in L by virtue of a homogeneity condition of constant returns to scale. The elasticity of output per worker with respect to factor intensity ($AP(\eta_{K/L})$) depends upon the

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[4] See Intriligator et al. (1997, p.297).

capital-labor ratio. In other words, the rate of growth of labor productivity also depends upon the growth rate of factor intensity, the same capital-labor ratio. Similarly, the partial production elasticities of both capital (η_K) and labor (η_L) instead of being constant are functions of the capital-labor ratio.[5]

Total factor productivity (TFP), defined as output per unit of total factor inputs, is given in (2) by

$$(3) \qquad TFP = \frac{GDP}{K^{\beta} L^{1-\beta} e^{\gamma(\frac{K}{L})}} = A \left(\frac{MILEX}{GDP}\right)^{\alpha-1} e^{\sum_{i=1}^{3} \delta_i T^i}.$$

Besides being subject to nonlinear dynamic shifts over time, both AP and TFP are shown respectively in (2) and (3) to depend upon the military share of GDP. It may be noted that GDP includes military expenditure, and total employment includes military employment. The key question is whether AP and TFP *in fact, and to what extent*, depend on the distribution of GDP between military and nonmilitary expenditures, that is to say, whether there are any productivity interactions between military and civilian expenditures? The answer depends upon the value of the parameter α that must be determined statistically in (2). For α-1 measures the elasticity of (or shifts in) output per worker as well as the elasticity of total factor productivity with respect to MILS, the share of the military sector in GDP, that is,

$$(4) \qquad AP_{(\eta_{mils})} = \frac{\partial AP}{\partial MILS} \times \frac{MILS}{AP} = (\alpha - 1), \quad and$$

$$(5) \qquad TFP_{(\eta_{mils})} = \frac{\partial TFP}{\partial MILS} \times \frac{MILS}{TFP} = (\alpha - 1).$$

If α = 1, labor productivity and total factor productivity remain unchanged even when the distribution of GDP into military and nonmilitary sectors changes. If α < 1, an increase in the share of the military sector has a negative

[5] These elasticities are: $(\eta_K) = \beta + \gamma K/L$; $(\eta_L) = 1 - \beta - \gamma K/L$; $(AP(\eta_{K/L})) = \beta + \gamma K/L$, where AP = GDP/L.

effect on productivity. This would imply that nonmilitary expenditures are more productive than military expenditures. If $\alpha > 1$, the military share has a positive effect on productivity. In this way the data could show either positive or negative effects, and the estimation of α from the data shows which way the effect can be expected to go.

In spite of the fact that data are not generally detailed enough to estimate statistical series of two types of factor inputs, military and nonmilitary, it is possible to devise a surrogate function from share statistics, that show how changes in the distribution of military and nonmilitary expenditures can influence productivity, measured in the usual sense. The strict transcendental specification does not show any such difference in productivity outcomes; so the tool for the present study is the augmented form of the transcendental specification, which is going to be used in the estimation to see what light it sheds on productivity.[6]

To sum up, while estimating a production function for each country of the Southern Cone we test the null hypothesis, H_0: α-1 = 0, against the alternative, H_1: α-1 … 0. We then use the estimated values of α to compute the productivity loss (or gain !) of each country that may be attributed to its military sector. Thus equation (2) forms the ultimate focus of our analysis. It is estimated after transforming it in the logarithmic form.

3. Empirical Evidence

Data Sources: reliable data on military expenditures are very difficult to obtain. In our analysis we used the time series data on military shares, MILS, which were provided by Thomas Scheetz. These data series have been compiled by his team in the context of a larger project and are undoubtedly the best available data for the five countries under study. Macroeconomic data series on GDP, gross fixed investment and labor force were taken from Macroeconomic Data

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[6] For derivation of a surrogate term, MILEX/GDP, in (2) , see Appendix A.

System (MEDS) maintained by Douglas Walker and his team in the Social Policy Analysis Division at the United Nations. They were made available by Douglas Walker. However, these long term, and consistently constructed, data series of Gross World Product, Population and Labor force are available only up to the early 1990's in the MSPA *Handbook of World Development Statistics*. This forces us to terminate our sample period early in the 1990's.

The statistical analysis is based on 22 annual observations for 1970-1991 unless specified otherwise. Allowing for potential errors of measurement in the data, the equations are estimated by the 'instrumental variable' technique (Table 4). A number of instrumental variables were drawn for each country from a small macro-econometric model under construction. The corresponding estimates by 'ordinary least squares' method are listed in Appendix B Table 1. In the case of instrumental variable estimation the standard errors of regression coefficients are heteroskedastic-consistent. In presenting the results the major test statistics have been summarized with each equation. The numbers within parentheses below the coefficients are | t-ratios |. Specifically, in the context of 'ordinary least squares' estimates, the property of *serial independence* of the residuals is tested by the Breusch-Godfrey LM(.) (BG-LM) test and the Durbin-Watson d test; homoscedasticity, by the Breusch-Pagan (BP-het) test or White-het test; *normality*, by Jarque-Bera (J-B) test; and *specification*, by Ramsey's RESET test. The ρ-value is risk involved in rejecting a stated null hypothesis. The definitions of the variables are summarized in the Appendix B.

Table 4. Statistical Equations: 'Instrumental variable' Estimation

$$lnAP = lnA + (\alpha-1)\,lnMILS + \beta\ln(\frac{K}{L}) + \gamma(\frac{K}{L}) + \delta_1 T + \delta_2 T^2 + \delta_3 T^3 + \varepsilon D + \ln\mu.$$

Sample: 1970-1991, N=22

Regressors	Argentina	Bolivia	Chile	Paraguay[a]	Peru
Constant	10.654 (71.12)	6.803 (64.79)	7.730 (21.17)	7.499 (669.69)	9.744 (22.06)
ln MILS	-0.048 (4.62)	-0.013 (1.64)	-0.043 (1.80)	-0.173 (5.07)	-0.0705 (2.31)
ln (K/L)	-0.163 (8.19)	0.144 (9.61)	0.109 (2.25)	-	-0.1419 (2.31)
(K/L)	0.187E-04 (12.13)	0.398E-04 (4.94)	-0.309E-04 (4.06)	0.260E-04 (10.33)	0.6786E-04 (7.17)
T	-	-	0.636E-02 (4.35)	0.110 (62.23)	-
T^2	-0.334E-02 (11.79	-0.183E-02 (15.24)	-	-0.679E-02 (46.81)	-0.5315E-2 (6.65)
T^3	0.105E-03 (10.89)	0.455E-04 (10.43)	-	0.123E-03 (32.09)	0.166E-03 (5.09)
D	0.053 (3.25)	-	-		-
Mean lnAP SE	9.5657 0.0149	7.9889 0.722E-02	8.6697 0.0113	8.1661 0.3627E-02	8.9762 0.0356
$\bar{R}^2$	0.971	0.993	0.530	0.999	0.933
d	1.954	2.432	1.02	1.523	0.646

a: Sample: 1971-1991, N=21.

The estimates for five countries of the Southern Cone presented in Table 4 (and

Appendix B Table 1) look very similar when judged by economic and statistical criteria. Virtually all regression coefficients are statistically significant with a príorí expected signs. The rate of growth of average labor productivity in each country drifts over time, although the patterns of drifts are not always uniform. The overall estimates for Chile and Peru judged by some diagnostic statistics, specifically the d-ratio, are comparatively less robust and suggest some further scope for refining their production functions.

The focus of attention is the estimate of parameter α. It is interesting to note from Table 4 that the estimated value of α-1, the production elasticity of military expenditure share, for each country is negative, and the estimates are mostly significant at the five percent level. It means that if military expenditures are substituted by nonmilitary expenditures the overall productivity of each country would be estimated to improve.

Table 5. Implied Production Elasticities (ηs) and Marginal Productivity Coefficients of Military Expenditures

Coefficient	Argentina	Bolivia	Chile	Paraguay	Peru
η_{MILS}	-0.048	-0.013	-0.043	-0.173	-0.071
η_{MILEX}	-0.050	-0.013	-0.045	-0.209	-0.076
MGDP/MMILEX	-1.824	-0.436	-0.721	-7.259	-2.296

Note: Marginal productivity coefficients are evaluated at mean points of MILS, that is, the share of MILEX in GDP. The mean points of 1970-91 are, Argentina: 0.0276, Bolivia: 0.030, Chile: 0.0623, Paraguay: 0.0288, Peru: 0.033.

Partial elasticities of production (η_{MILEX}) and the marginal productivity coefficients of military expenditure (MGDP/MMILEX) implied by estimated production functions (Table 4) are shown in Table 5. The marginal productivity coefficients vary inversely with the level of MILS, but we have evaluated them at MILS' mean point for each country.[7] The computed values of these elasticities presented in Table 5 are quite revealing. For example, the value of MILS' elasticity suggests that 0.048 of every growth point is lost in Argentina when its military's share of GDP grows by one point. The other four countries seem to undergo a similar loss. Paraguay, with the highest (absolute) value of elasticity of 0.173, bears the heaviest cost in terms of productivity. This finding is not surprising in view of the fact that military expenditure in Paraguay grew relentlessly during the two decades of 1970's and 1980's. Consequently, in 1980's the annual military expenditure on an average was double the size its of 1970's level.

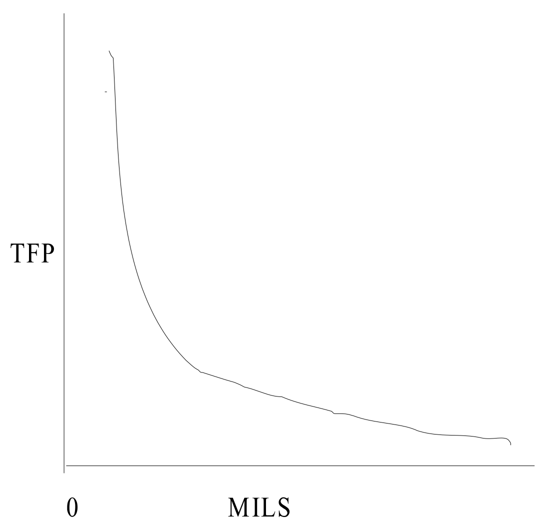

Figure 7. Total Factor Productivity

Our results indicate clearly that the military sector of each country has a negative impact on its productivity and growth. The nature of the relationship is nonlinear. The marginal effect of military expenditure on productivity declines in absolute value with the size of the military sector. The relationship between the total factor productivity (TFP) and the military share (MILS) suggested by our estimates is traced above in Figure 7.

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[7] $\eta_{MILS} = \partial \ln GDP / \partial \ln MILS$; $\eta_{MILEX} = \partial \ln GDP / \partial \ln MILEX$; $\partial GDP / \partial MILEX = \eta_{MILEX} / MILS$..

The implications of such a relationship are straightforward and cannot be ignored. If any of these countries were to *shift* any *existing* resources from the military sector towards civilian use, it would achieve substantial gains in economic productivity with no *additional* spending.

4. What if Military Shares had been One Percent of GDP?

A new scenario estimates recreated history over the sample period, 1970-1991, for the five countries by controlling military expenditure for each country and maintaining it at a low level (minimal point) of one percent of its GDP.[8] From the estimated production functions the levels of total factor product for each country are computed and the differences from the baseline estimates are measured.[9] The difference between TFP estimates under new scenario and the status quo estimates for each country gives an estimate of the value of its total product lost due to its excessive military expenditure. The estimates of lost product in millions of 1990 US dollars are given in Table 6, and in terms of percentage of GDP in Table 7. The aggregate figures of the five countries making the Southern Cone are presented in Table 8. The average losses of annual growth rates over the two decades separately and for the entire sample period are summarized in Table 9. The relationships between MILS and the lost growth, by country, are traced in Figures 8-12. Lost growth rates of all the countries are shown together in Figure 13. The corresponding patterns for the entire Southern Cone are traced in Figures 14-15.

Table 6. Product Loss Due to Defense Burden in Excess of 1 % of GDP
(millions of 1990 US dollars)

[8] One percent minimal defense/police expenditures is chosen following an example set by Costa Rica in Central America.

[9] Baseline, or status quo, values are the values estimated by using actual levels of MILS for each country.

	ARGENTINA	BOLIVIA	CHILE	PARAGUAY	PERU
1971	1618.484	5.471	184.330	50.199	1537.601
1972	1547.297	13.438	192.848	62.260	1501.090
1973	1471.493	16.194	186.936	56.639	1606.727
1974	1228.812	12.752	251.062	45.010	1499.512
1975	1649.656	12.742	234.778	57.463	1737.267
1976	2940.769	14.212	205.320	56.589	1811.478
1977	2958.516	13.884	232.979	55.706	2135.161
1978	3183.437	12.549	248.398	58.008	1758.466
1979	3047.891	13.123	238.422	36.389	1141.618
1980	2832.434	18.424	230.087	41.016	1373.933
1981	2762.320	14.918	244.944	50.025	1176.212
1982	2134.273	9.901	265.784	73.629	1326.759
1983	2055.555	7.215	245.102	70.498	1221.566
1984	1357.969	9.908	246.129	66.968	886.580
1985	1318.000	9.712	250.909	69.856	958.494
1986	1297.457	8.005	254.266	69.773	821.442
1987	1257.098	7.349	248.286	51.679	814.205
1988	1135.635	7.349	228.085	56.422	491.483
1989	952.014	7.424	225.860	43.058	479.983
1990	564.648	6.408	216.764	39.710	526.610
1991	631.092	6.325	212.079	64.507	260.517

Table 7. Growth Loss (%) Due to Defense Burden in Excess of 1 % of GDP

	ARGENTINA	BOLIVIA	CHILE	PARAGUAY	PERU
1971	1.16	0.14	1.04	2.83	4.58
1972	1.10	0.32	1.10	3.29	4.38
1973	1.02	0.36	1.13	2.79	4.32
1974	0.81	0.27	1.51	2.04	3.64
1975	1.08	0.26	1.57	2.43	4.09
1976	1.95	0.27	1.32	2.23	4.25
1977	1.81	0.25	1.38	1.98	5.04
1978	2.05	0.22	1.37	1.85	4.33
1979	1.84	0.23	1.22	1.04	2.69
1980	1.66	0.34	1.10	1.05	2.99
1981	1.79	0.27	1.12	1.18	2.41
1982	1.51	0.19	1.35	1.76	2.73
1983	1.44	0.14	1.27	1.74	2.92
1984	0.94	0.20	1.22	1.60	2.07
1985	0.97	0.19	1.20	1.61	2.21
1986	0.89	0.16	1.15	1.60	1.67
1987	0.84	0.14	1.07	1.14	1.50
1988	0.78	0.14	0.92	1.17	0.99
1989	0.67	0.14	0.83	0.84	1.15
1990	0.39	0.12	0.78	0.75	1.31
1991	0.41	0.11	0.72	1.19	0.63

Table 8. Lost Product and Growth Due to Excessive Defense Burden: Southern Cone

	Lost Product ($ mill)	Lost Growth (%)	Realized Growth (%)	Potential Growth (%)
1971	3396.086	1.73	5.83	7.56
1972	3316.934	1.67	1.01	2.68
1973	3337.988	1.64	2.81	4.45
1974	3037.148	1.40	6.49	7.89
1975	3691.907	1.70	0.23	1.93
1976	5028.369	2.32	-0.41	1.91
1977	5396.247	2.34	6.40	8.74
1978	5260.859	2.36	-3.57	-1.21
1979	4477.443	1.89	6.20	8.09
1980	4495.895	1.82	4.49	6.31
1981	4248.419	1.81	-4.74	-2.93
1982	3810.347	1.74	-6.96	-5.22
1983	3599.936	1.69	-2.68	-0.99
1984	2567.555	1.18	1.80	2.98
1985	2606.971	1.24	-3.52	-2.28
1986	2450.943	1.09	7.75	8.84
1987	2378.618	1.01	4.83	5.84
1988	1918.974	0.83	-2.74	-1.91
1989	1708.340	0.77	-3.58	-2.81
1990	1354.141	0.61	0.04	0.65
1991	1174.520	0.50	6.50	7.00

Table 9. Lost Growth Rates (%) of Southern Cone Countries
(Mean Values)

	!971-80	1981-91	1971-91
Argentina	1.45	0.97	1.20
Bolivia	0.27	0.16	0.21
Chile	1.27	1.06	1.16
Paraguay	2.15	1.33	1.72
Peru	4.03	1.78	2.85
Southern Cone	1.89	1.13	1.49

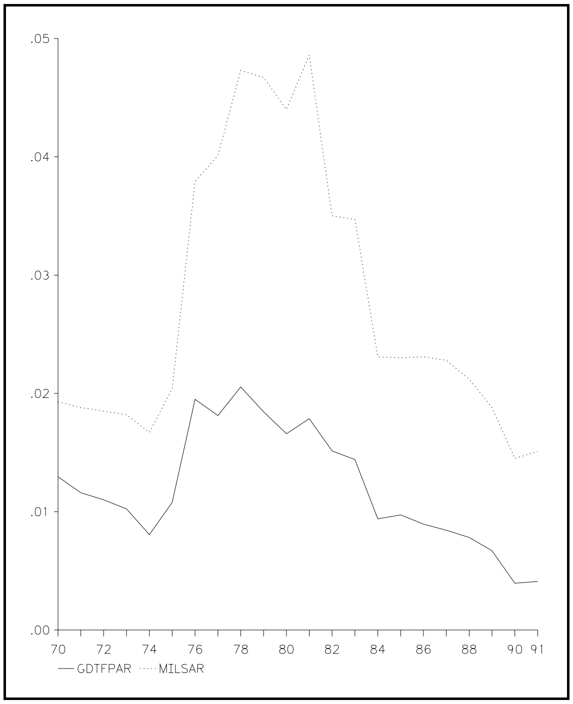

Figure 8. MILS & Lost Growth of Argentina, 1970-91

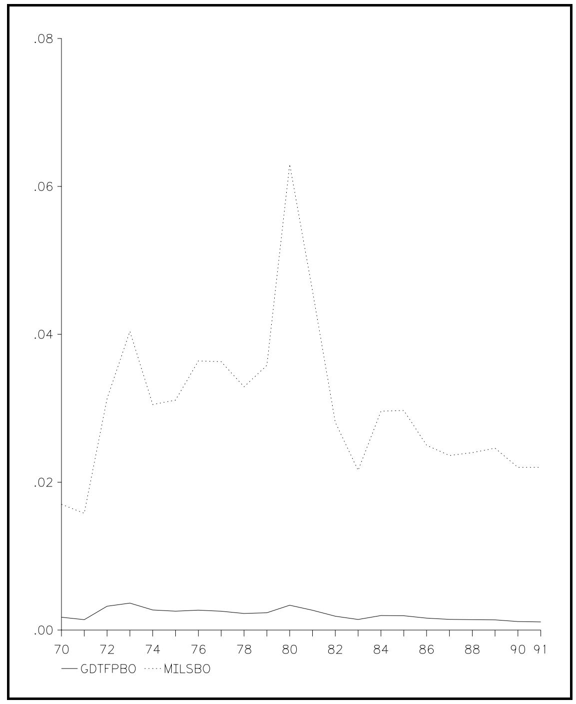

Figure 9. MILS & Lost Growth of Bolivia, 1970-91

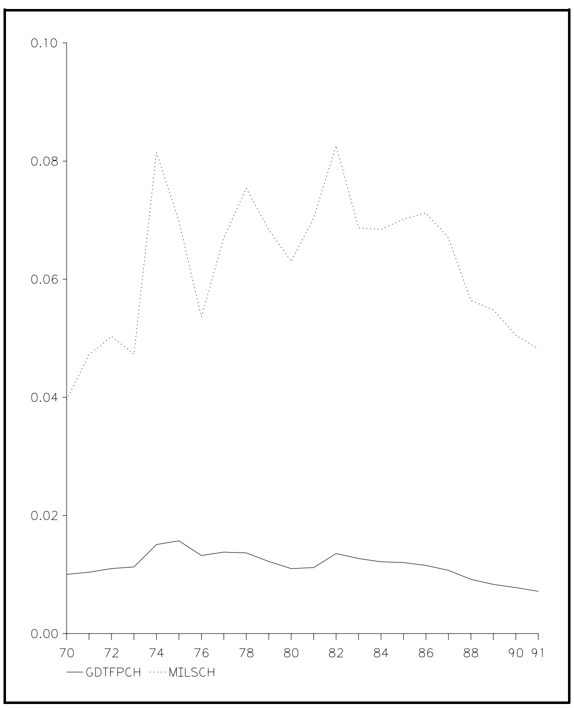

Figure 11. MILS & Lost Growth of Chile, 1970-91

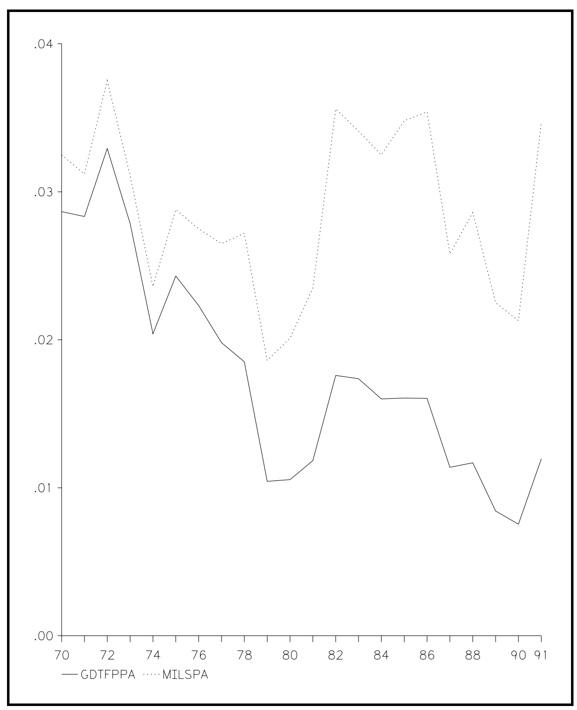

Figure 10. MILS & Lost Growth of Paraguay, 1970-91

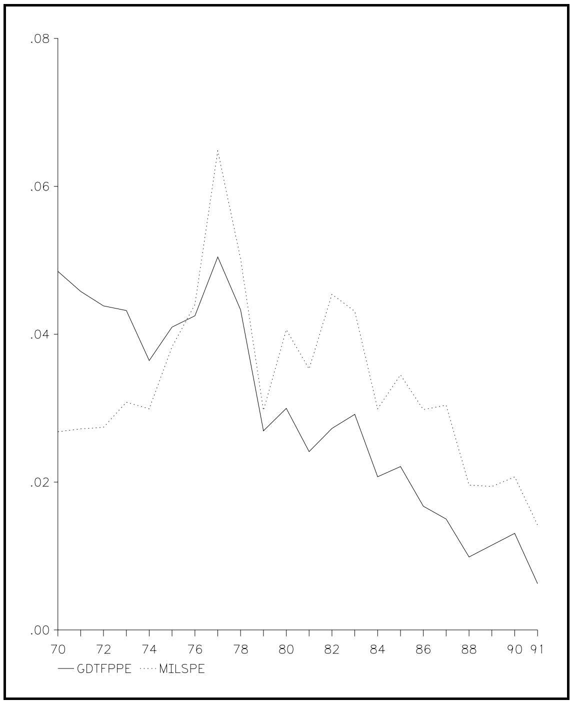

Figure 12. MILS & Lost Growth of Peru, 1970-91

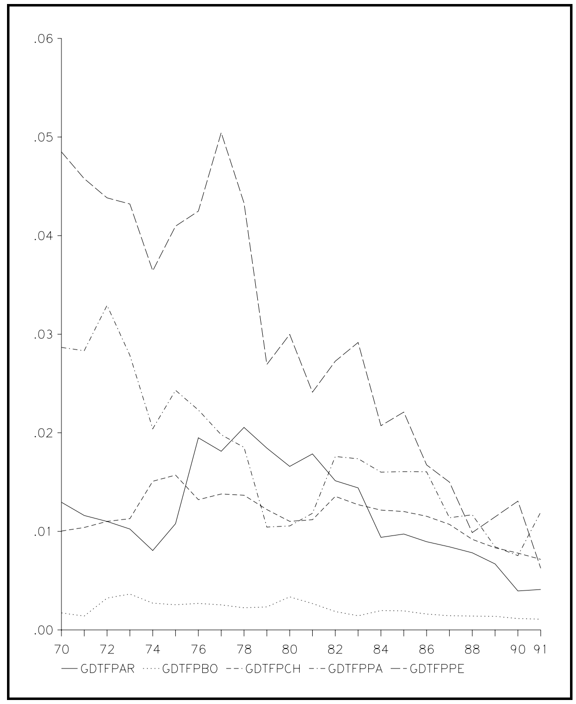

Figure 13. Lost Growth Rates of Five Countries, 1970-91

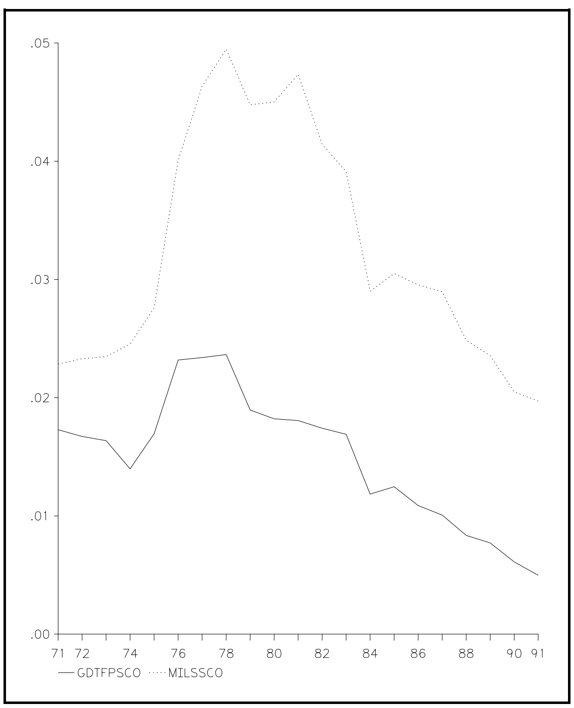

Figure 14. MILS & Lost Growth of SC

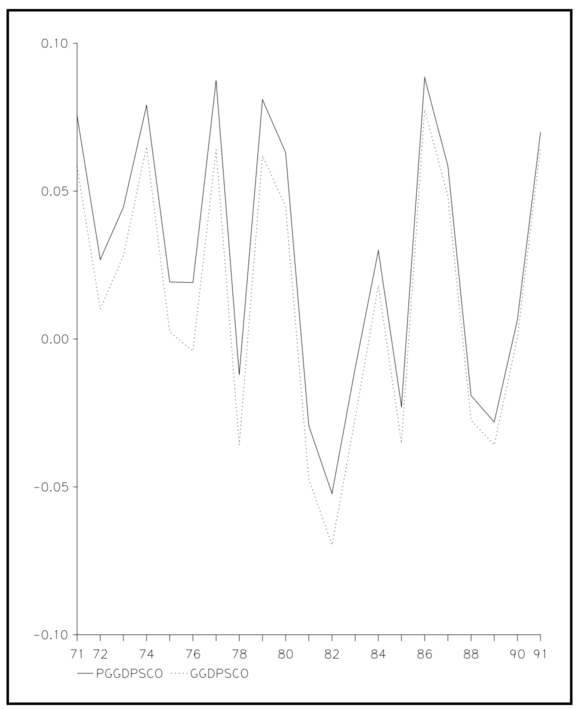

Figure 15. Potential Growth Rates & Realized Growth Rates of SC

The estimates of lost product of scone countries are illuminating. It appears (Table 7), for example, that Argentina lost on an average nearly 2 points of its potential percentage growth every year during 1976-81. These were the years that have been described as the years of the 'Dirty War'. In 1976, Isabel Peron's civilian government fell in a military coup, and the new military government instituted a reign of terror. Thereafter, in April-June, 1982, was the Falklands War with the United Kingdom which Argentina lost ignominiously. In the aftermath of the Falklands War the country returned to civilian rule once again, and any loss of productivity due to 'excessive military expenditure' fell substantially to less than half a point. Similarly, in Chile , in !973, Augusto Pinochet, in a military coup, ousted S. Allende who was duly elected as President in 1970. Pinochet and his military junta ran Chile until 1988. It was by the election of 1989 that the country returned to civilian rule. It is estimated that from 1974 to 1988, Chile lost annually one to one-and-a-half point of its potential growth. This loss declined in the subsequent years after civilian rule was restored.

Estimates of loss of productivity in Bolivia, Paraguay and Peru uncover similar scenarios. Peru, until 1978, lost over four growth points annually under the military rule, and Paraguay lost close to two points. All these losses are large and very significant compared to what these countries were actually able to achieve. The losses for the entire region are presented in Table 8. The region lost its potential growth, year after year, up to 2.36 percent.

5. Some Conclusions

There is a long history of correlation studies that try to establish causal analysis and conclusions about the effects of defense spending on economic growth. More than 25 years ago, Benoit (1973) examined the development effects, by estimating relationships between growth performance and military spending in developing countries. A follow-on study has recently been published by Dakurah, Davies and Sampath (2001), in which the authors try to study the relationship from the viewpoint of lead-lag pattern using Granger time series analysis. There is precious little attention being paid to underlying structural analysis, using widely accepted analytical construct of economics. Partial or semi reduced forms are less than satisfactory for this purpose.

In the present paper, there is an explicit attempt to get at the issue by using production function analysis and estimation. In particular, estimation by instrumental variables attempts to deal with the “semi” and “partial” aspects of reduced form analysis. There are two important properties of the analysis of the present paper, namely, attempts to look at the supply side of the problems and the longer run aspects that work through the technology of the economies studied. Military capital does not generate a lasting supply of useful goods over their lifetime, as does nonmilitary capital (either in human or fixed tangible asset form). There are short-run demand-side positive effects, and these have been studied in the context of modeling other Latin American countries, but remains to be done in the present case.

The findings of the present paper do show a significant trade-off between military and nonmilitary spending, and it is to be hoped that additional work on expanded data resources will enable one to estimate both demand and supply side effects simultaneously. And, of course, recent deterioration and instability of the Argentinian economy and political system is so dominant that any analysis of more and less military expenditure in Argentina needs to be further couched in broader terms. In the meanwhile, an unescapable conclusion from the current analysis is that a potential reservoir of ‘peace dividend’ does exist in the Southern Cone region, and it could be tapped by shifting productive resources from the military to the civilian sector. Is there an economic argument to shift resources from the military to the nonmilitary sector? From the above analysis, the answer is emphatic yes.

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Appendix A

Let the two inputs production function be written as,

$$(1A)\qquad \frac{GDP}{L} = A\left(\frac{K}{L}\right)^{\beta} e^{\gamma(\frac{K}{L}) + \sum_{i=1}^{3}\delta_i T^i}\mu.$$

We may express GDP as a sum of two components, military expenditure (MILEX) and GDP net of military expenditure (GDPN). Furthermore, denoting the respective ratios of military and nonmilitary expenditures to GDP as MILS (MILEX/GDP) and NMILS (GDPN/GDP), equation (1A) can be expressed as,

$$\frac{MILEX + GDPN}{L} = A\left(\frac{K}{L}\right)^{\beta} e^{\gamma(\frac{K}{L}) + \sum_{i=1}^{3}\delta_i T^i},$$

$$(2A)\qquad \Rightarrow \quad \frac{MILEX}{L} = -\frac{NMILS \times GDP}{L} + A\left(\frac{K}{L}\right)^{\beta} e^{\gamma(\frac{K}{L}) + \sum_{i=1}^{3}\delta_i T^i},$$

$$that\ is\ (2A')\qquad \frac{MILEX}{L} = (1 - NMILS)^{\alpha}\, A\left(\frac{K}{L}\right)^{\beta} e^{\gamma(\frac{K}{L}) + \sum_{i=1}^{3}\delta_i T^i}, \qquad \alpha = 1.$$

Equation (2A') explains the military-sector component of output per worker. In practice, α may not be equal to unity, and if both sides of equation (2A') are multiplied by GDP and divided by MILEX, adding a random term, we can express equation (2A') back in terms of GDP per worker given by equation (2) of the text. That is,

$$(2)\qquad \frac{GDP}{L} = A\left(\frac{MILEX}{GDP}\right)^{\alpha-1}\left(\frac{K}{L}\right)^{\beta} e^{\gamma(\frac{K}{L}) + \sum_{i=1}^{3}\delta_i T^i}\mu.$$

Appendix B

Definitions of the variables:

GDP	: gross domestic product in millions of 1990 US dollars, GDP=GDPN+MILEX.
GDPN	: gross domestic product of nonmilitary sector in millions of 1990 US dollars.
GFI	: gross fixed investment in millions of 1990 US dollars.
K	: utilized capital stock = KS*CU, where KS is capital stock and CU is capacity utilization rate, in millions of 1990 US dollars.
KS	: 1969 KS = GFI; otherwise, KS=(1.05)*KS(-1)+GFI, in millions of 1990 US dollars.
L	: economically active population, thousands of persons.
MILEX	: military expenditure in millions of 1990 US dollars, MILEX=MILS*GDP.
MILS	: ratio of military expenditure to GDP, MILEX/GDP.
PMIL	: per capita military expenditure, 1990 US dollars.
T	: chronological time, 1969=1.
AP	: average productivity, GDP/L.
D	: dummy variable, D=1 for 1969-1980, otherwise D=0.

Suffix:

AR	: Argentina
BO	: Bolivia
CH	: Chile
PA	: Paraguay
PE	: Peru

Appendix B Table 1. Statistical Equation: ‘Ordinary Least Squares’ Estimation

$$lnAP \; ' \; lnA \; \% \; (\alpha \& 1) lnMILS \; \% \; \beta \ln(\frac{K}{L}) \; \% \; \gamma(\frac{K}{L}) \; \% \; \delta_1 T \; \% \; \delta_2 T^2 \; \% \; \delta_3 T^3 \; \% \; \varepsilon D \; \% \; \ln\mu .$$

Sample: 1970-1991, N=22

Regressors	Argentina	Bolivia	Chile	Paraguay[a]	Peru
Constant	10.609 (27.69)	6.837 (44.24)	7.714 (19.09)	7.099 (520.3)	9.692 (17.09)
ln MILS	-0.046 (2.31)	-0.011 (1.32)	-0.044 (2.17)	-0.173 (3.85)	-0.072 (1.59)
ln (K/L)	-0.157 (3.37)	0.140 (6.59)	0.110 (2.28)	-	-0.136 (2.12)
(K/L)	0.184E-04 (6.97)	0.415E-04 (4.15	-0.309E-04 (2.72)	0.261E-04 (6.75)	0.670E-04 (6.37)
T	-	-	0.627E-02 (2.79)	0.110 (43.46)	-
T^2	-0.332E-02 (7.27	-0.184E-02 (4.15)	-	-0.679E-02 (30.32)	-0.529E-2 (6.40)
T^3	0.104E-03 (6.45)	0.462E-04 (6.87)	-	0.123E-03 (19.86)	0.165E-03 (4.94)
D	0.054 (2.81)	-	-		-
Mean lnAP SE	9.5657 0.0149	7.9889 0.751E-02	8.6697 0.0113	8.1661 0.3627E-02	8.9762 0.0356
$\bar{R}^2$	0.971	0.993	0.530	0.999	0.933
d	0.972	2.377	1.039	1.527	0.648
		ρ-values:			
BG-LM(1)	0.981	0.486	0.000	0.329	0.000
BP-het	1.00	1.00	1.00	1.00	1.00
J-B	0.536	0.735	0.267	0.966	0.713
R-RSET	0.981	0.014	0.006	0.168	0.071

a: Sample: 1971-1991, N=21.