South Africa: An Econometric Analysis of Military Spending and Economic Growth

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Introduction

There is considerable debate in the literature over the effects of military spending on economic growth in developing economies. Following the early cross country studies, using average values over time and simple correlation techniques, the application of econometric models provided a wide variety of studies, but no clear consensus over the results. What started to become clear was that to understand the dynamics of the relation between military spending and growth it was necessary to focus on relatively homogeneous groups of countries as well as undertaking case studies of individual countries (Dunne, 1996). This chapter provides a contribution to the corpus of case studies by providing an analysis of South Africa, a particularly interesting focus of study because of the nature of its military industrial complex, the characteristics of the economy, and the fact that it has undergone considerable change. In addition, the country has relatively high quality data for a developing economy.

While there have been some studies of the relation between military expenditure and economic growth in South Africa, noticeably a recent special issue of the journal *Defence and Peace Economics* [Vol. 11, No. 6 (2000)], they are by no means exhaustive of the possibilities. This chapter provides a critical review of the approaches taken in econometric analyses of the defense-growth nexus in South Africa and then develops the analysis to overcome perceived deficiencies. New results are then provided using a cointegrating vector autoregressive (VAR) approach.

Historical background

Military spending has played an important role in South Africa. During the apartheid period high military burden supported the system internally and externally as part of a military-energy industrial complex (Fine and Rustomjee, 1996). In anticipation of the 1977 UN arms embargo a state arms producer, Armscor, was formed to develop domestic arms production capability and in 1982 entered the arms export market, having a policy of selling to all comers. This represented a huge change as prior to 1963 South Africa spent 70 percent of its defense budget overseas whereas by 1984 almost 100 percent was procured domestically. With the end of the apartheid system and of the cold war there have been significant cuts in military spending. The decline started in 1989-90 with the start of the abolition of apartheid, the establishment of civilian control of the military, and the termination of South Africa's nuclear weapons program. But the 1989-93 period also showed one of worst economic recessions in South African history. Still, even though manufacturing declined, the country's external position improved with the end of economic sanctions that had been imposed on South Africa during the apartheid years. Also, important strategic industries, such as Sasol, Armscor, and Mosgas, were commercialized and privatized.

With the new ANC government came not only the so-called Cameron Commission report into the country's arms exports practices, but also the voices of a number of "hawks," the smell of political compromise, and a defensive fight by vested interests in the military industrial complex. This has seen pressures for increases in military spending. The present situation sees an improving economic situation, considerable debate over the level of military spending, and an end to its decline. A recent large procurement order with offsets has highlighted the debates (Batchelor and Dunne, 1998; 2000).

One of the arguments in the policy debates concerned the possible negative impact of military spending cuts on economic growth. This has made research on the role and impact of such expenditures an important target for research. Before moving on to review existing applied studies of South Africa, the next section considers the more general theoretical and empirical work.

Economic effects of military spending

Any evaluation of the impact of military spending on growth is contingent on the theoretical perspective used. Neoclassical models are generally supply side models and focus on the tradeoff between "guns and butter." Keynesian models see military spending simply as one component of aggregate national spending and therefore focus on the economy's demand side (although, when formulated as an aggregate production

function, the econometric work does give the Keynesian models neoclassical flavor). A group of institutional economists focuses on the damaging impact of the military industrial complex on the economy, and Marxist views vary from those stressing positive economic effects, by preventing underconsumption or realization crises, to those highlighting the possible negative impact of military spending on the profit rate (Dunne, 1990).

When we move to empirical analyses it is necessary to determine the level of abstraction at which the analysis is to be presented and to operationalize the theory to form an applied model. This leads to a variety of empirical work from applied econometric to more focused institutional case study approaches. When statistical analysis is used it is generally within the neoclassical and Keynesian approaches, as these are most amenable to the creation of formal models. Some work adopts an *ad hoc* approach. Studies differ in terms of the country coverage, whether time series or cross section are used, the time period covered, and the empirical methods used (Dunne, 1996). In general, the empirical analyses have identified a number of channels by which military spending can influence the economy and they can be positive or negative. On the one hand, military spending can take skilled labor away from civilian production, but on the other hand can train workers, particularly in developing economies where the military may provide valuable skills. It can take the best capital equipment from civilian industry to produce a high technology enclave, but there may be positive externalities of the development of the military sector on the civilian sector. It can lead to damaging wars, but may maintain peace and lead to economic benefits from more prosperous allies. It can stimulate demand in a stagnant economy and lead to growth, but may create bottlenecks in a constrained economy. Finally, it may slow down development through the fostering of a militaristic ideology, but nationalist attitudes may increase effort and output and the military and ideology may be used to control the workforce. Clearly whether the overall effect is positive or negative is an empirical question and is likely to differ across countries.

Following the *ad hoc* approach of Benoit's original study (Benoit, 1978), which found a positive effect of military spending on growth in developing countries, an impressive literature has been built up. This has used econometric analysis of single equation reduced form equations and simultaneous equation models that model both direct and indirect effects (Dunne, 1996). In addition, macroeconometric models have been used to simulate the likely impact of changes in military spending at the country and international level (Gleditsch, *et al*., 1996).

Overall, the results tend to show an insignificant or negative impact of military spending on economic growth in developing countries and a clearer negative impact in

developed economies, as military spending siphons off investment rather than consumption spending. This does, however, hide the diversity of the literature. Much of the earlier cross-section analyses found sample selection to be important and this led to calls for more case studies. Time series analyses of individual economies and relatively homogenous groups of economies have improved the understanding of the economic processes at work but have also produced a variety of results. What is clear is that while cross-country studies can provide valuable general information it is important to build up more comprehensive case study analyses. The next section considers the analyses that have been undertaken for South Africa.

Analyzing military expenditure and growth in South Africa

Econometric analyses of the relation between military spending and growth in South Africa have followed the different approaches in the literature. There are the neoclassical growth models, with the Feder-Ram model being estimated by McMillan (1996) and by Batchelor, Dunne, and Saal (1998). A Keynesian simultaneous equation model with an aggregate production function has been estimated by Roux (1996) and by Dunne, Nikolaidou, and Roux (2000). Finally, Dunne and Vougas (1999) analyzed the relation between military spending and growth using Granger causality and cointegration techniques. There have also been attempts to use industrial level panel data, e.g., by Birdi, Dunne, and Saal (2000).

The simple Feder-Ram model has held something of a fascination for defense economists, mainly because of its ability to explicitly treat externality effects of the military on the non-military sector. For the basic model, assume two distinct sectors military (M) and non-military (C), that labor L and capital K are the divisible inputs, and that the military sector has an externality effect on the rest of the economy.

(9.1) $M = M (L_M , K_M)$
(9.2) $C = C (L_C , K_C , M)$

with

(9.3) $Q = M + C$
(9.4) $K = K_M + K_C$
(9.5) $L = L_M + L_C$

Allow input productivities to differ such that the ratios of the marginal productivities for

the sectors are:

(9.6) $M'_K / C'_K = M'_L / C'_L = 1 + ä$

Military spending can then have a productivity differential effect, ä, and an externality effect, äC / äM > 0. Reformulating in terms of aggregate inputs, taking the total derivative of Q, and then substituting and manipulating gives:

(9.7) $QD = â\, LD + á\, (I / Y) + ((ä / 1 + ä) - C_M)\, MD\, (M / Q)$

where YD = dY/Y; LD = dL/L ; MD = dM/M. The coefficient on the last term is the sum of the externality and factor productivity differential effects of military spending. Following Biswas and Ram (1986), and assuming that the externality parameter is not C_M but C_M (M/C) and is denoted è, allows us to write:

(9.8) $QD = â\, LD + á\, (I / Y) + ((ä / 1 + ä) - è)\, MD\, (M / Q) + è\, MD$

Separate estimates of è and ä can be obtained. To operationalize the model for empirical application the instantaneous rates of change of the variables are replaced by their discrete equivalents giving:

(9.9) $ÄY_t/Y_{t-1} = á_0 + á_1\, ÄL_t/L_{t-1} + á_2\, I_t/Y_{t-1} + á_3\, ÄM_t/M_{t-1}\, (M_t/Y_{t-1}) + á_4\, ÄM_t/M_{t-1}$

Initially, these models were used on cross sections, but increasingly have been applied to time series for individual countries. When this model was estimated using South African data for the period 1964-95 in Batchelor, Dunne, and Saal (2000) it gave the results displayed in table 9.1.

These results suggest that economic growth in South Africa can be only partly explained by the model, although the specification seems to be reasonable according to the different statistical tests. The R^2 suggests that the equation only explains 59 percent of the variation in the dependent variable, which in a time series regression is relatively poor. In addition, only the employment variable is statistically significant at the 5 percent significance level. This variable is the growth in non-agricultural labor which is used to approximate the labor force. Surprisingly, the investment term is insignificant. The military spending coefficient estimates suggest a positive externality effect, but a negative size effect, but these are only significant at 10 percent.

There are of course problems of multicollinearity with an equation of this form

particularly between the two military spending terms. This will mean that although the estimates are unbiased they are imprecise and unstable. One would

Table 9.1: Aggregate estimation results

			Using $\Delta K_t/K_{t-1}$ instead of I_t/Y_{t-1}	
Variable	Coefficient	t-ratio	Coefficient	t-ratio
Constant	0.03	1.4	0.01	1.9
I_t/Y_{t-1}	-0.08	0.8	0.02	0.1
$\Delta L_t/L_{t-1}$	0.78	4.4	0.72	3.4
$\Delta M_t/M_{t-1}$ (M_t/Y_{t-1})	-1.58	-0.4	-1.24	-0.3
$\Delta M_t/M_{t-1}$	0.07	1.1	0.05	0.4
	è = 0.07 and ä = -0.60		è = 0.05 and ä = -0.54	
	R^2 = 0.587; DW = 1.68		R^2 = 0.52; DW = 1.36	
	Serial correlation = 0.69		Serial correlation = 2.76	
	Functional Form = 3.86		Functional Form = 1.81	
	Normality = 0.11		Normality = 0.05	
	Heteroskedasticity = 0.44		Heteroskedasticity = 0.23	
	Joint LLR test for zero restrictions on military expenditure terms chi-squared 2:			
	0.48 (0.79)		3.65 (0.86)	

All chi-squared with 1 degree of freedom except normality test which is 2.

expect a high F statistic, but low individual significance, which is what we observe. However, the joint test of zero restrictions on the military variables' coefficients cannot be rejected, suggesting that there is no significant impact of military spending on growth.

The problems with these results led to considerations of how they might be improved. There are a number of options that have been taken by researchers. They have used a more detailed model that identifies more sectors. One study of particular interest is McMillan (1992) who estimates a variation of the model for South Africa for 1950-85. An extended model developed along these lines, in chapter 13 of this volume, finds improved result for Greece and Turkey. Another alternative is to consider the impact of military expenditure on the manufacturing sector alone, rather than the whole economy. When Batchelor, Dunne, and Saal (2000) also did this they found that the results for the manufacturing sector in South Africa were much better than for the aggregate data. Finally, the dynamics of the applied model can be considered. The move to a discrete model in the theory is somewhat *ad hoc* and it is possible that the

processes may have a longer memory than allowed for in the derived model. Batchelor, Dunne, and Saal, (2000) take the simple model for South Africa and use an ARDL estimation procedure to model the short-run dynamics. This does improve the performance of the model, but the strange nature of the composite variables gives some concern.

This leads us to suggest that it is necessary to further investigate the dynamics of the relation between military spending and growth and that it is also worthwhile considering an analysis at the level of manufacturing as well as the aggregate economy. Opting for an approach that uses a structural model, we have seen the problems with using the Feder-Ram model, while the nature of the commonly used Keynesian model limits the scope for developing the dynamic specification. This suggests the need to consider a different approach and to use a different model. An obvious alternative is to use an aggregate production function model and this is developed in the next section.

Developing the analysis

Taking the simple Cobb-Douglas model

(9.10) $Q = A K^{á} L^{â}$,

which in log form is

(9.11) $q = a + á\,k + â\,l$,

we can simply introduce military spending to this equation,

(9.12) $q = a + á\,k + â\,l + ã\,m$

where m is the log of military expenditure. In addition we add in a dummy variable to take account of the effect of sanctions which basic data analysis suggests was an important factor. To develop the dynamics of the model we use a cointegrating vector autoregressive (VAR) approach to estimate it. This allows us to focus explicitly on determining the short-run dynamics and long-run properties of our structural model.

Treating this within a VAR estimation framework within Microfit 4.0 (Pesaran and Pesaran, 1997) and starting from an order 4 VAR we get a VAR (2) as the optimal lag length. Using unrestricted intercepts and no trends gives one cointegrating vector,

(9.13) $z = 0.82\ q + 1.86\ k - 7.05\ l + 1.23\ m$

or

(9.14) $q = -2.27\ k + 8.63\ l - 1.51\ m$
(13.9) (41.3) (7.4)

where the asymptotic standard errors are in brackets. The coefficient on military spending is negative, but the results are strange, with all coefficients insignificant and a negative sign on capital. Its persistence profile converges quickly, within 9 years, but the underlying error correction model is a very poor specification for a growth equation, though again there is a negative but insignificant effect of m.

(9.15) $\Delta q_t = 2.3 + 0.22\ \Delta q_{t-1} + 0.11\ \Delta k_{t-1} - 0.10\ \Delta l_{t-1} - 0.03\ \Delta m_{t-1}$
(1.6) (0.9) (0.4) (0.3) (1.0)

$- 0.03\ ECM_{t-1} - 0.02\ DS$
(1.6) (2.2)

where ECM is the error correction term, DS the sanctions dummy, and the values of the t ratios are in brackets.

The rather large coefficient on the labor terms is worrying and may suggest that we have the wrong dependent variable and may be estimating a labor demand equation. Rather than simply move to another form of model we follow Batchelor, Dunne, and Saal (1999) and estimate the model on the manufacturing data. The order of the VAR is found to be 2 and unrestricted intercepts and no trends gives one cointegrating vector,

(9.16) $qm = 1.32\ k - 1.53\ l + 0.50\ m$
(0.7) (2.1) (0.5)

This gives a more sensible specification with the capital coefficient positive and significant at 10 percent. Military spending is now positive but insignificant. The underlying ECM model is

(9.17) $\Delta qm_t = 1.96 + 0.55\ \Delta qm_{t-1} + 1.23\ \Delta k_{t-1} - 0.84\ \Delta l_{t-1} - 0.08\ \Delta m_{t-1}$
(1.7) (3.6) (2.0) (1.6) (1.3)

$$+ 0.16\ ECM_{t-1} \quad -0.04\ DS$$
$$(1.6) \qquad (2.3)$$

In this case military spending has a negative short-run effect on growth.

Given the similarity of the normalized values of the coefficient on k and l a test on the cointegrating vector of á = - â in the original Cobb-Douglas equation seemed worthwhile. This restriction makes output a function of the capital-labor ratio and military expenditure and was accepted with $\div^2(2) = 0.03$ giving

$$(9.18) \quad qm = 1.23(k - l) + 0.44\ m$$
$$(0.19) \qquad (0.09)$$

with asymptotic standard errors in brackets. In fact the coefficient on the capital- labor ratio is not significantly different to one, $\div^2(2) = 0.98$, giving

$$(9.19) \quad qm = (k - l) + 0.51\ m$$
$$(0.08)$$

and an error correction equation for growth,

$$(9.20) \quad Äqm_t = 1.31 + 0.55\ Äqm_{t-1} + 1.02\ Äk_{t-1} - 0.89\ Äl_{t-1} - 0.07\ Äm_{t-1}$$
$$(1.7) \quad (2.6) \qquad (1.9) \qquad (1.7) \qquad (1.3)$$

$$+ 0.15\ ECM_{t-1} - 0.05\ DS$$
$$(1.7) \qquad (2.3)$$

These results show a positive long-run relation between military spending and manufacturing output, but a negative short-run effect (significant at 10 percent) of the growth of military spending on the growth of manufacturing output. The composite effect of the short-run coefficient on military spending and the error correction term suggests that the short-run impact of cuts in military expenditure will at worst not be significant. In this they tend to support the results of the previous studies.

Conclusions

South Africa clearly provides an interesting case study for the analysis of the impact of military spending on growth. This paper has provided some new results and has tried to

deal with some of the perceived deficiencies of previous work. Concerns about the Feder-Ram model, in terms of its specification and dynamics, led to the use of an aggregate production function, estimated using cointegrating VAR methods. Concerns with the problem of undertaking the analysis at an aggregate level in a country which, while a developing economy, has an advanced military industrial sector, led to a focus on manufacturing output.

When the model was estimated using GDP, the results were rather disappointing but suggested a negative though insignificant effect of military expenditure on growth. When estimated at the level of manufacturing the results show a positive long-run relation between military spending and growth, but a negative short-run effect (significant at 10 percent). The composite effect of the short-run coefficient on military spending and the error correction term suggests that the short-run impact of cuts in military expenditure will at worst not be significant. As we have seen, most of the empirical evidence tends to suggest a negative or insignificant effect of military spending on growth in South Africa. The results of this study, while providing some advance in the econometric analysis, do appear to be consistent with the previous findings.

Note

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