METU International Conference in Economics / VII
September 6-9 , 2003, Ankara, Turkey

AN ECONOMETRIC ANALYSIS OF THE EFFECTS OF AGGREGATE DEFENSE SPENDING ON AGGREGATE OUTPUT: THE CASE OF TURKEY, 1950-2002

Abstract

This study utilizes the new macroeconomic theory and multivariate cointegration analysis in search of the effects of aggregate defense spending on aggregate output in Turkey.
This study provides the empirical evidence that there is a strong positive long-run relationship between aggregate defense spending and aggregate output in Turkey over the estimation period.
The findings of this study contradict the previous empirical results on the same topic obtained from the neoclassical production function and traditional regression analysis.

Keywords: Aggregate defense spending; Aggregate output; Cointegration analysis

JEL Classification: E69; E60; H50.

Correspondence to :

Dr Ferda Halıcıoğlu
Department of Economics
The Business School
The University of Greenwich
Greenwich, London, SE10 9LS
UK
Tel: +44 (0) 20 8331 8039
Fax: +44 (0) 20 8331 9005
e-mail 1: R.F.Halicioglu@greenwich.ac.uk (during term times)
e-mail 2: fhalicioglu@yahoo.co.uk (outside term times)

1. INTRODUCTION

The relationship between the military expenditure and economic growth has been frequently explored empirically in the defense economics literature since the early 1970's. The initial research into the topic by Benoit (1973 and 1978) presented an empirical positive relationship between the defense expenditures and growth by employing the Sperman rank order correlation and OLS technique in a sample of 44 LDCs (less developed countries). However, these findings were challenged initially by Deger and Smith (1983), Chan (1985), and Deger (1986) on the basis of theoretical and econometric methodology that were employed in Benoit's studies. Since the early 1980's, several empirical applications and versions of the so-called Deger type supply and demand models have provided a negative relationship between defense expenditures and growth apart from for a few exceptions. The Deger-type models are based on the initial study of Feder (1983), which is also adopted by Biswas and Ram (1986) that found no consistent and statistical relationship between economic growth and military spending. Sandler and Hartley (1995: 215-219) discusses the findings of those studies in detail until 1992. Similarly, Galvin (2003: 52) points out the other studies in the literature over the last decade that provides negative empirical relationship between the defense expenditures and growth.

The main characteristics of Deger type supply and demand studies that find a net negative relationship between defense expenditures and growth are as follows:

i. the supply side equations are derived from the Feder-Biswas and Ram modelling and are based on the disaggregated neo classical production function. The demand side equations are derived from Keynesian cross function. Disaggregation of the neoclassical production function allows researchers to analyse the impact of military expenditures on growth, savings, balance of payments, etc, in addition the defense expenditure equation is analysed separately. As Sandler and Hartley (1995: 211) points out "supply-side models are, by their nature, associated with a positive impact of defense on growth, unless the defense sector has a strong negative productivity effect compared with the other sectors. In contrast, the demand-side models are apt to be associated with a negative impact on growth as military expenditures crowd out private and public investment".
ii. they use mainly traditional econometric techniques such as ordinary least squares (OLS), two stage least squares (2SLS), and three stage least squares (3SLS) equations, and employ the growth rates of the variables, which exclude the long-run analyses from the estimations.
iii. cross-sectional analyses are more popular than the country specific studies. Therefore they provide little or no economic analysis for an individual country.

An alternative to Deger type supply and demand studies has been suggested by Atesoglu (2002), which presents a significant and substantial positive impact of the defense sector on growth by using the new macroeconomic model, as proposed by Romer (2000) and Taylor (2000). The new macroeconomic model replaces the standard IS-LM and AD-AS models and is empirically tested by the multivariate cointegration technique of Johansen (1991). This study also adopts the approach of

Atesoglu (2002) and analyses the effect of military expenditures on Turkey's growth levels. This study differs from the previous studies concerning the impact of defense expenditures on Turkey's growth levels as follows: it utilizes the new macroeconomic theory along with the multivariate cointegration technique of Johansen (1991) that is found to be superior to other cointegration techniques as proposed by Gonzalo (1994). Even though the study by Sezgin (2001) for Turkey is an exception of findings of previous Deger type demand and supply models, it is, like all Deger type models, static in nature and does not allow dynamic economic policy analyses. The previous study of Sezgin (2000) attempts to utilize the Engle-Granger (1987) cointegration technique on the Deger type model using the disaggregated data of Turkish military expenditures. Yet the findings of that study are limited to, fiscal policies ignoring the impact of monetary policy.

This paper is designed as follows: section 2 introduces the new macroeconomic model that provides the new rationale of estimating the relationship between the defense sector and growth. Section 3 briefly outlines the selected cointegration technique. Section 4 presents the empirical results with their economic implications. And finally, section 5 is devoted to the concluding remarks.

2. A BRIEF OUTLINE OF THE NEW MACROECONOMIC MODEL WITH DEFENSE EXPENDITURES

Atesoglu (2002: 56-57) outlines a simpler version of the new macroeconomic model of Romer (2000) and Taylor (2000) with an extension for defense expenditures. The empirical equation is derived from the augmented Keynesian cross model that also includes defense expenditures as a separate variable:

$$Y_t = C_t + I_t + X_t + GE_t + ME_t \quad (1)$$

where Y_t is real aggregate output, C_t is real consumption, I_t is real investment, X_t is real net exports, GE_t is real non defense government expenditures, and ME_t is real defense expenditures. Then the right hand side variables in the Keynesian cross are written out with their own equations and sign expectations of parameters except the exogenous variable, GE_t as follows:

$$C_t = a + b(Y_t - T_t) \quad (2)$$

$$T_t = c + dY_t \quad (3)$$

$$I_t = e - fR_t \quad (4)$$

$$X_t = g - hY_t - iR_t \quad (5)$$

where T_t is real taxes, R_t is real interest rate.

For simplicity, Atesoglu (2002) ignores the fact that R_t is in the complete version of the new macroeconomic model and is explained by additional equations. This paper also adopts the same approach and treats R_t as an exogenous variable. It should also be noted that the investment equation in the traditional Keynesian model is assumed to be related to the nominal interest rate as discussed in Gordon (2000). If one solves equations 1-5 for a reduced form of Y_t, the resulting equation added with a stochastic disturbance term (u_t) would be as follows:

$$Y_t = a_1 + a_2 GE_t + a_3 ME_t + a_4 R_t + u_t \tag{6}$$

where $a_1 = [(a - bc + e + g)/(1 - b(1-d) + h)]$, $a_2 = a_3 = 1/[(1 - b(1-d) + h)]$ $a_4 = -(f + i)/[(1 - b(1-d) + h)]$ and $a_2, a_3 > 0,\ a_4 < 0$.

Equation 6 is an estimable form of the new macroeconomic model in which the impact of military and government expenditures on output is measured along with interest rates. Taylor (2001) also proposes a similar Keynesian cross model as discussed above.

3. COINTEGRATION METHODOLOGY

Traditional econometric techniques using time series data implicitly assume that the data used in estimation are stationary. However, if the data properties are not explored before estimation, it leads to spurious results. Having an estimation in the form of variables' growth rates or in their first differences may eliminate the trend from the variables but causes further problems as the estimations do not provide the parameters for a dynamic analysis as discussed by Thomas (1997). In analysing the time series data properties, the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979 and 1981) unit root test is most commonly applied. If the ADF unit root regression equation suffers from a serial correlation, it becomes invalid: applying the Phillips-Peron (PP) (Phillips and Peron, 1988) unit root test is used as one alternative.

Cointegration analysis, on the other hand, provides important long-run information. The pioneering cointegrating study of Engel-Granger (1987), which is based on only a single long-run relationship between the variables, was further developed and extended into the multivariate cointegration technique by Johansen (1988, 1991) and Johansen and Juseliues (1992). The above-mentioned cointegration analysis requires that the time series variables in an estimation procedure should be integrated order of one, which implies that they are stationary in their levels or in their first differenced forms.
The Johansen-Juselius multivariate cointegration technique is based on the error correction representation of the Vector Autoregression (VAR) model with Gaussian errors.
A general unrestricted VAR model with the lag length, *p,* can be expressed in vector format as follows:

$$\Delta X_t = \Pi_0 + \Pi_1 \Delta X_{t-1} + \Pi_2 \Delta X_{t-2} + ... + \Pi_{p-1} \Delta X_{t-p+1} + \pi X_{t-p} + B Z_t + v_t \tag{7}$$

where X_t represents $m \times 1$ vector of $I(1)$ variables, Z_t stands for $s \times 1$ vector of $I(0)$ variables (which can include seasonal dummies or innovations in variables that are exogenous to the VAR), Π's are unknown parameters and v_t is the error term. The hypothesis that π has a reduced rank $r < m$ is tested using the two likelihood tests, known as the maximum eigenvalue (λ-max) and the trace test statistics, to determine the number of cointegrating vectors (r). The lag length of the VAR structure is decided on the basis of several criteria but the Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SBC) are the most commonly used. Granger (1997) point outs that the selection of lag intervals in the Johansen cointegration technique is not very straightforward and therefore the Johansen test results are sensitive to changes in the lag intervals selected.

4. EMPIRICAL RESULTS

All the series in equation (6) apart from the real interest rate is evaluated in logarithmic form. Full definitions and sources of the time series of this study are included in the appendix A. The ADF and PP unit root tests for the variables are implemented and Table 1 displays results. All the series in equation (6) appear to contain a unit root in their levels, indicating that they are integrated at order one and thus they are difference stationary.

Table 1: Tests for Integration

ADF test statistic Variable					Phillips-Peron test statistic Variable				
Levels		k lag	Differences	k lag	Levels		t lag	Differences	t lag
LRY	-2.43	1	-4.25*	2	LRY	-2.89	5	-15.24*	5
LRGE	-1.70	1	-3.89*	1	LRGE	-2.25	5	-6.60*	5
LRME	-1.88	1	-3.75*	1	LRME	-2.35	5	-6.93*	5
RR	-3.11	2	-3.21*	5	RR	-3.13	5	-10.94*	5

Notes: Sample levels 1956-2002 and differences 1957-2002. Rejection of unit root hypothesis, according to McKinnon's critical value at 5 % is indicated with an asterisk. ADF tests include an intercept and a 1 to 5 lagged difference variable and k stands for the lag level that maximizes the AIC (Akaike Information Criteria). Phillips-Peron tests have also an intercept and t stands for the selected truncation lag level.

The empirical findings of Johansen-Juselius cointegration technique for equation (6) are summarized in panel A and B of Table 2. The trace test suggests three possible long-run relationships at the 90% level of significance in the VAR under consideration. Out of three possible long-run relationships, vector 3 seems to be conforming fully to the sign expectations of equation (6).

Table 2: Johansen and Juselius Co-integration Tests and Results

Panel A: the results of λ -max and trace tests

Variables: LRY, $LRGE$, $LRME$, RR

Null	Alternative	λ -max statistic	90% critical value	Trace statistic	90% critical value
$r = 0$	$r = 1$	37.82	25.80	77.24	49.95
$r \leq 1$	$r = 2$	21.21	19.86	39.42	31.93
$r \leq 2$	$r = 3$	12.43	13.81	18.20	17.88

Panel B: estimate of cointegrating vectors

LRY	constant	$LRGE$	$LRME$	RR
Vector 1: normalized coefficients				
-1.000	2.688	0.044	0.761	0.009
Vector 2: normalized coefficients				
-1.000	2.299	0.354	0.474	0.003
Vector 3: normalized coefficients				
-1.000	2.400	0.513	0.302	-0.010

Notes: r =number of cointegrating vectors. The VAR structure is based on the AIC and SBC values which sets the value of p=1 but they are not reported due to space considerations.

According to the results revealed in panel B of Table 2, there is a strong positive long-run relationship between the real output and real defense spending. It seems that a 1 percent rise in real defense expenditure would lead to a 0.30 percent increase in real output. The impact of real non-defense government spending on the real output is about twice the size of real defense spending. However, the impact of monetary policy, represented by the real interest rate is rather small in comparison to the fiscal policies. These findings are in contrast with most of the previous empirical studies on the impact of the military spending on the real output apart from a few country specific cases; see in details Sandler and Hartley (1995) and Galvin (2003).

5. CONCLUDING REMARKS

This study has adopted the approach of Atesoglu (2002) and has attempted to provide a long-run positive empirical relationship betwen the real Turkish defense spending and the real Turkish output by employing the new macroeconomic theory and multivariate cointegration technique. The findings of this study are in line with that of Atesoglu (2002) but differs from the previous empirical studies on the same topic for Turkey which presented results indicating a negative or ambiguous role for defense expenditure. It is clear that a rise or fall in the Turkish military spending will cause changes in the macroeconomic equilibrium in the long-run. The impact of the military expenditures on the real output level is strong and positive and about half the size of the real non-military defense expenditures. Nevertheless the effect of the monetary policy on the real output is at negligible level, but the sign is as expected.

APPENDIX A

A.1. Data discussions

The econometric estimation period is selected as 1950-2002 due to data reliability and compatibility between the Turkish data sources and the internationally available longest data sets that could be obtained from OECD, IMF and SIPRI. Although the Turkish data set span for the Turkish military expenditures is stretched to far before 1950 and is analyzed by Ozmucur (1996), however, they are not consistent with other international data sets. The reliability and compatibility of the Turkish military defense spending is also discussed in Sezgin (2001) and Gunluk-Senesen (2002).

A.2. Data definitions and sources

LRY is the natural logarithm of the real Turkish GNP in billions of Turkish Liras (TL) at 1990 market prices. The nominal GNP is deflated by the Turkish consumer price index of 1990=100, which is derived from own construction of the chain consumer price index of 1938=100. Source: Main economic and social indicators of Turkey, 1923-1998 and subsequent annual statistics published by the State Institute of Statistics (SIS) of Turkey.

LRGE is the natural logarithm of the real non defense government expenditures in billions of TL at 1990 market prices . The real non-defense government spending is calculated by subtracting the real military spending from the real government expenditures and adding them to the real total fixed investments. The data transformation is above. Sources: SIS, ministry of finance of Turkey and SIPRI.

LRME is the natural logarithm of the real defense spending in billions of TL at 1990 market prices, which also includes the real total fixed investments. The data transformation is above. Sources: SIS, SIPRI and the Turkish ministry of finance of general directorate of budget and fiscal control publication on defense and national security (1924-1993) and subsequent years.

RR is the real average interest rate for bank deposit. Before 1970, discount rate of the central bank of Turkey is used a proxy for the average interest rate since there is no data available for those years. RR is calculated as follows: (((1+R/100))/(1+P/100))-1)*100) where R is the annual nominal interest rates and P is annual consumer price inflation rates. Source: Main economic and social indicators of Turkey, 1923-1998 and subsequent annual statistics published by the SIS of Turkey..

The econometric estimations are implemented by using Microfit 4.0 interactive econometric software developed by Pesaran and Pesaran (1997).

REFERENCES

Atesoglu, H.S. (2002) "Defense Spending Promotes Aggregate Output in the United States- Evidence from Cointegration Analysis", *Defence and Peace Economics* **13**(1), 55-60.

Benoit, E. (1973) *Defense and Economic Growth in Developing Countries,* (Lexington Books, Boston).

Benoit, E. (1978) "Growth and Defense in Developing Countries", *Economic Development and Cultural Change* **26**(2), 271-287.

Biswas, B. and Ram, R. (1986) "Military Expenditures and Economic Growth in Less Developed Countries: An Augmented Model and Further Evidence", *Economic Development and Cultural Change* **34**(2), 361-372.

Chan, S., (1985) "The Impact of Defense Spending on Economic Performance: A Survey of Evidence and Problems", *Orbis* **29**(2), 403-434.

Deger, S. (1986) "Economic Development and Defense Expenitures", *Economic Development and Cultural Change* **35**(1), 179-196.

Deger, S. and Smith, R.P. (1983) "Military Expenditures and Growth in Less Developed Countries", *Journal of Conflict Resolution* **27**(2), pp.335-353.

Dickey, D.A. and Fuller, W.A. (1981) "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root" *Econometrica* **49**(4), 1057-1072

Dickey, D.A., and Fuller, W.A. (1979) "Distributions of the Estimators for Autoregressive Time-Series with a Unit Root", *Journal of the American Statistical Association* **74**(3), 427-31.

Engle, R.F., and Granger, C.W.J. (1987) "Co-integration and Error Correction: Representation, Estimation and Testing", *Econometrica* **55**(2), 251-276.

Feder, G. (1983) "On Exports and Economic Growth", *Journal of Development Economics* **12**(1/2), 59-73.

Galvin, H. (2003) "The Impact of Defence Spending on the Economic Growth of Developing Countries: A Cross-Section Study", *Defence and Peace Economics* **14**(1) 51-59.

Gonzalo, J. (1994) "Five Alternative Methods of Estimating Long-Run Equilibrium Relationships", *Journal of Econometrics* **60**(1/2), 203-233.

Gordon, R. J. (2000) *Macroeconomics* (Addison-Wesley-Longman, New York).

Granger, C. W. J. (1997) "On Modeling the Long-run in Applied Economics", *Economic Journal* **107**(440), 169-177.

Gunluk-Senesen, G. (2002) "Budgetary Trade-offs of Security Expenditures in Turkey", *Defence and Peace Economics* **13**(4), 385-403.

Johansen, S. and Juselius, K. (1992) "Testing Structural Hypotheses in a Multivariate Cointegration Analysis at the Purchasing Power Parity and the Uncovered Interest Parity for the UK", *Journal of Econometrics* **53**(2), 211-244.

Johansen, S. (1991) "Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models", *Econometrica* **59**(6), 1551-1580.

Johansen, S. (1988) "Statistical and Hypothesis Testing of Co-integration Vectors", *Journal of Economic Dynamics and Control* **12**(2), 231-254.

Ministry of Finance of Turkey of General Directorate of Budget and Fiscal Control, (1992), *Defense and National Security (1924-1993)*, (Ankara University Press, Ankara, "in Turkish").

Ozmucur, S. (1996) *The Economics of Defense and the Peace Dividend in Turkey* (Bogazici University Printhouse, Istanbul).

Pesaran, M.H. and Pesaran, B. (1997) *Microfit 4.0 Interactive Econometric Analysis* (Oxford University Press, Oxford).

Phillips, P. C.B. and Perron, P. (1988) "Testing for a Unit Root in Time Series Regression", Biometrika **75**(2). 335-346.

Romer, D. (2000) "Keynesian Macroeconomics without the LM Curve", *Journal of Economic Perspectives* **14**(2), 149-169.

Sandler, T. and Hartley, K. (1992) *Defence Economics* (Oxford University Press, Oxford).

Sezgin, S. (2001) "An Empirical Analysis of Turkey's Defence-Growth Relationships with a Multi-equation Model (1956-1994)", *Defence and Peace Economics*, **12**(1), 69-81.

Sezgin, S. (2000) "Defence Expenditure and Economic Growth in Turkey: A Disaggregated Analysis", *Yapi Kredi Economic Review* **2**(1), 67-77.

SIS (State Institute of Statistics of Turkey), *Main Economic and Social Indicators of Turkey, 1923-1998,* and various *Annual Statistics,* (SIS Press, Ankara).

SIPRI Yearbooks, *World Armaments and Disarmaments*, Oxford University Press, Oxford, (various issues).

Taylor, J.B. (2001), *Principles of Macroeconomics*, Third edition (Houghton Mifflin Company, Cambridge).

Taylor, J.B. (2000), "Teaching Modern Macroeconomics at the Principles Level", *American Economic Review* **90**(2), 90-94.

Thomas, R.L. (1997) *Modern Econometrics: An Introduction* (Addison-Wesley, Harlow).