13. MILITARY SPENDING AND ECONOMIC GROWTH NEXUS IN SIXTEEN LATIN AND SOUTH AMERICAN COUNTRIES: A BOOTSTRAP PANEL CAUSALITY TEST[1]

Hsien-Hung KUNG[1]
Jennifer C. H. MIN[2]

Abstract

This study revisits the causal linkages between military spending and economic growth in sixteen Latin and South American countries (i.e., Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela) by focusing country-specific analysis for the period 1988-2010. The panel causality analysis that accounts for dependency and heterogeneity across countries supports evidence on the direction of causality is consistent with the neutrality hypothesis for twelve countries and a military spending-growth hypothesis for Belize and Nicaragua. Regarding the direction of growth-military spending nexus, we find one-way Granger causality running from economic growth to military spending for Bolivia and Ecuador.

Keywords: military expenditure; economic growth; dependency and heterogeneity; panel causality test, Latin and South American countries.

JEL Classification: H5, O41, C33, O5 1. Introduction

Over the past several decades, a plethora of empirical studies have devoted increasing interest to investigating the relationship between military spending and economic growth in both developing and developed countries, as it has important energy policy implications. The importance of military spending in the economic development process has lead researchers to concentrate on empirically identifying the nature of causal linkages between military spending and economic growth.

Early studies examining the relationship between military spending and economic growth looked at the simple correlation between these two variables (for example,

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[1] *Department of Marketing and Distribution Management, Hsing Wu University, Taipei, Taiwan E-mail: 083010@mail.hwu.edu.tw ; limi.f.kung@gmail.com.*

[2] Corresponding author: Department of International Business, Ming Chuan University, No. 250, Sec. 5, Zhongshan N. Rd., Taipei 11103, Taiwan. E-mail: jennifer_min.tw@yahoo.com.tw.

Benoit, 1973, 1978). Another group of studies including Lim (1983), Faini *et al*. (1984), Deger (1986), Grobar and Porter (1989), Ram (1995), Cohen *et al.* (1996), Antonakis (1997), Galvin (2003), Klein (2004), and Keller *et al.* (2009) test the military-growth relationship by estimating growth functions that include military spending as an explanatory variable for cross-sections of developing countries. The association between military spending and economic growth was established by looking at the sign and statistical significance of the coefficient of military spending. Although this methodology may be useful in examining the military-growth relationship, it provides no means of determining the direction of causality.

Recent studies examining the military-growth relationship go beyond looking at the significance of the coefficient of military spending and address the issue of direction of causation using techniques in the Granger (1969) framework. For example, Joerding (1986) test for Granger causality between military spending and economic growth on 57 LDCs and he notes that economic growth may be causally prior to military spending. LaCivita and Frederiksen (1991) investigate the causal relationship between military spending and economic growth in 62 developing countries and Granger-causality results indicate a feedback relationship exists between military spending and economic growth for the majority of their sample countries. This feedback relationship implies that neither economic growth nor military spending can be considered exogenous.

The econometric approach to tackle the problem was soon to change – recent advances in time series analysis – cointegration tests, the vector error correction mechanism (VECM) and common stochastic trends analysis – provide more effective techniques to study the long-run equilibrium relationships among integrated variables. The techniques of cointegration analysis have been employed in the recent studies by Chen (1993), Assery (1995), and Chang *et al.* (2001) to study the causal link between military spending and economic growth for Mainland China, by Atesoglu (2009) for the USA, by Landau (1996) for the OECD, by Madden and Haslehurst (1995) for Australia, by Özsoy (2008) for Turkey, by AL-Jarrah (2005) for Saudi Arabia, by Narayan and Singh (2007) for Fiji Island, by Chang *et al.* (2001), Lee and Chang (2006) and Lin *et al.* (2012) for Taiwan. In the case of multi-country studies, we find the studies of Gadea *et al.* (2004), Lee and Chen (2007), Hirnissa and Baharom (2009), Paradhan (2010), Chang *et al.* (2011) and Wijewerra *et al.* (2011).

Conventional time-series tests do not only fail to consider information across countries, but also have lower test power. In order to increase the power in testing the relationship, many researchers develop and implement the use of panel data. For example, Kollias *et al.* (2007) using panel data analysis, address the causal ordering issue between growth and military spending in the case of the European Union (EU15). Results reported herein suggest the presence of a positive feedback between growth and military expenditure in the long run and a positive impact of the latter on growth in the short run. Lee and Chen (2007) apply recently developed panel unit root tests and heterogeneous panel cointegration tests, and conclude that there is fairly strong evidence in favor of the hypothesis of a long-run equilibrium relationship between military spending and output. Wijeweera and Webb (2011) also use a panel co-integration approach to examine the relationship between military spending and economic growth in the five South Asian countries over the period of 1988–2007. They find that a 1% increase in military spending increases real GDP by only 0.04%, suggesting that the substantial amount of public expenditure that is currently directed towards military purposes in these countries has a negligible impact upon economic growth.

This paper revisits the military spending and economic growth nexus in 16 Latin and South American (LSA) countries (i.e., Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela) over the period of 1988-2010 by focusing on country-specific analysis. In detecting causal linkages, we apply panel causality approach, which is able to account for both cross-country interrelations and country-specific heterogeneity.

The modeling approach followed in our study can be thought as a systematic way to detect causal linkages in the panel data framework. The empirical analysis begins with testing dependency and homogeneity across 16 countries, due to the fact that ignoring cross-country dependency and country-specific heterogeneity may lead to drive misleading inferences regarding the direction of causality and, thereby, policy implications. Then, we carry out the panel causality testing approach, which is able to capture cross-section and slope homogeneity features of the panel. The results show that the direction of causality seems to be in favor of the neutrality hypothesis in 12 out of 16 countries and a military spending-growth hypothesis for Belize and Nicaragua. Regarding the direction of growth-military spending nexus, we find one-way Granger causality running from economic growth to military spending for Bolivia and Ecuador.

The plan of this paper is organized as follows. Section 2 presents the theoretical structure of military expenditure and economic growth. Section 3 presents the data used in our study and Section 4 briefly describes the bootstrap panel Granger causality test proposed by Kónya (2006). Section 5 first presents our empirical results and then discusses some economic and policy implication of our empirical findings. Section 6 concludes the paper.

2. Theoretical Structure

Following the aggregate production function setting of both Barro (1990) and Guaresma and Reitschuler (2003), we view the military spending as a governmental spending which is non-rival and non-excludable (Samuelson, 1954). The aggregate production function may be expressed as follows (Lai *et al.*, 2005; and Lee and Chen, 2007):

$$GDP_t = f(MS_t, L_t, K_t) \tag{1}$$

where: *GDP*, *MS*, *L* and *K* represent real output, real military spending, labor force, and real capital stock, respectively.

Military spending is included in the aggregate production function because of the Keynesian-type aggregate demand stimulation and spin-off effects (Deger, 1986), the increased spending will require an expanded budget, if increase in defense outlays for procurement and research to be overall stimulus economic activity and create additional jobs. Formula (1) implies that military spending can stimulate GDP.

By assuming that the aggregate production function is of the Cobb–Douglas type and has constant returns to scale and by dividing by labor and taking logarithms, our empirical model, which is set up in terms of labor force, can be expressed as:

$$PGDP_t = \alpha_1 + \alpha_2 PMS_t + \alpha_3 PK_t + \varepsilon_t \quad (2)$$

$$PMS_t = \alpha_1 + \alpha_2 PGDP_t + \alpha_3 PK_t + \varepsilon_t \quad (3)$$

where: ε_t is the random error term.

We measure the variables of per capita real GDP (*PGDP*), per capita real military spending (*PMS*), and per capita real capital stock (*PK*) at constant 2005 prices, and we transform them into natural logarithms. The per capita setting can also be viewed and proved in Brumm (1997), Lai *et al*. (2005), Lee and Chen (2007).

3. Data

The annual data used in this study cover the period from 1988 to 2010 for 16 Latin and South American countries (i.e., Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela)[3]. The variables in this study include per capita real GDP (*PGDP*), per capita real military spending (*PMS*), and per capita real capital stock (*PK)*. Both per capita real GDP and per capita real capital stock are taken from the World Development Indicators (WDI, 2011), and per capita real military expenditure is taken from the *Stockholm International Peace Research Institute* (SIPRI). The empirical period is dependent on the availability of data, so that the time period we use is 1988–2010. Table 1 reports the military spending as a share of GDP for each country. We find that Chile and Mexico have the highest and lowest average military spending as a share of GDP, of 3.7% and 0.5%, respectively, over the period 1988-2010. One interesting finding is that military spending as a share of GDP decreased over time for most of these Latin and South America countries under study.

Table 1

Military Spending as a Share of GDP for LSA Countries (1988-2010)

	1988	1990	1995	2000	2005	2010	1988-2010 (Average)
Argentina	1.4	1.1	1.5	1.1	0.9	1.1	1.1
Belize	1.0	1.2	1.3	0.9	1.0	0.9	1.1
Bolivia	5.1	2.7	2.1	2.0	1.9	2.4	2.2
Brazil	2.1	1.9	1.9	1.8	1.5	2.4	1.7
Chile	5.0	4.3	3.1	3.7	3.6	3.9	3.7
Colombia	3.0	2.7	2.6	3.1	3.4	4.3	3.3
Dominican Republic	1.1	0.9	0.7	1.2	0.8	0.6	0.9
Ecuador	2.0	1.9	2.4	1.7	2.6	4.3	2.2
El Salvador	3.2	2.3	1.0	0.9	0.6	0.6	1.2
Guatemala	1.6	1.5	1.0	0.8	0.4	0.4	0.8
Mexico	0.5	0.5	0.6	0.6	0.4	0.5	0.5
Nicaragua	3.1	3.8	1.1	0.8	0.7	0.7	1.4

[3] *The limitation of database and lack of data source induce that only 16 Latin and South America countries can be employed in this study.*

	1988	1990	1995	2000	2005	2010	1988-2010 (Average)
Paraguay	2.9	1.2	1.3	1.1	0.8	1.3	1.2
Peru	1.3	0.1	1.9	2.0	1.5	1.6	1.4
Uruguay	2.6	2.9	2.0	1.5	1.3	1.8	1.9
Venezuela	2.5	2.0	1.5	1.5	1.4	1.5	1.5

Source: Own calculations based on SIPRI data.

4. Methodology

Our empirical methodology is carried out in two steps. First, we devote our attention to preliminary analysis to investigate cross-section dependence and slope homogeneity. In the second step, based on the results from preliminary analysis we apply an appropriate panel causality method, which is able to represent cross-section and slope homogeneity features of our panel data set. In what follows, we briefly outline the econometric methods.

4.1. Preliminary Analysis

4.1.1. Testing Cross-Section Dependence

One important issue in a panel causality analysis is to take into account possible cross-section dependence across countries. This is because the high degree of globalization, international trade and financial integration make a country to be sensitive to the economic shocks in other countries. If we paraphrase this argument to the 16 Latin and South American countries, cross-sectional dependency may play important role in detecting causal linkages for these 16 Latin and South American countries because these countries are highly integrated. It is worthwhile noting here that ignoring cross-section dependency leads to substantial bias and size distortions (Pesaran, 2006), implying that testing for the cross-section dependence is a crucial step in a panel data analysis.

To test for cross-sectional dependency, the Lagrange multiplier (LM hereafter) test of Breusch and Pagan (1980) has been extensively used in empirical studies. The procedure to compute the LM test requires the estimation of the following panel data model:

$$PGDP_{it} = \alpha_i + \beta_i' x_{it} + u_{it} \text{ for } i = 1, 2, ..., N;\ t = 1, 2, ..., T \quad (4)$$

where: *i* is the cross section dimension, *t* is the time dimension, x_{it} is $k \times 1$ vector of explanatory variables (such as *PMS* and *PK*), α_i and β_i are the individual intercepts and slope coefficients, respectively, which are allowed to vary across states. In the LM test, the null hypothesis of no-cross section dependence– $H_0 : Cov(u_{it}, u_{jt}) = 0$ for all *t and* $i \neq j$ – is tested against the alternative hypothesis of cross-section dependence $H_1 : Cov(u_{it}, u_{jt}) \neq 0$, for at least one pair of $i \neq j$. Pesaran (2004) proposed a cross-section dependency test (the so-called *CD* test) for panel data models, where $T \to \infty$ and $N \to \infty$ in any order. However, the *CD* test is subject to decreasing power in certain situations that the population average pair-wise correlations are zero, although the underlying individual population pair-wise correlations are non-zero (Pesaran *et al.*, 2008). Furthermore, in stationary dynamic panel data models the *CD* test fails to reject the null hypothesis when the factor loadings have zero mean in the cross-sectional dimension (Sarafidis *et al.*, 2009). In order to deal with these problems, Pesaran *et al.* (2008) proposes a bias-adjusted test, which is a modified version of the LM test by using the exact mean and variance of the LM statistics.

4.1.2. Testing Slope Homogeneity

Second issue in a panel data analysis is to decide whether or not the slope coefficients are homogenous. As indicated by Granger (2003), the causality from one variable to another variable by imposing the joint restriction for the whole panel is the strong null hypothesis. Moreover, the homogeneity assumption for the parameters is not able to capture heterogeneity, due to country specific characteristics (Breitung, 2005).

The most familiar way to test the null hypothesis of slope homogeneity $H_0 : \beta_i = \beta$ for all *i* against the hypothesis of heterogeneity $H_1 : \beta_i \neq \beta_j$ for a non-zero fraction of pair-wise slopes for $i \neq j$ is to apply the standard *F* test. The *F* test is valid for cases where the cross section dimension (N) is relatively small and the time dimension (T) of panel is large; the explanatory variables are strictly exogenous; and the error variances are homoskedastic. By relaxing homoskedasticity assumption in the *F* test, Swamy (1970) developed the slope homogeneity test on the dispersion of individual slope estimates from a suitable pooled estimator. Pesaran and Yamagata (2008) proposed a standardized version of Swamy's test (the $\mathring{\Delta}$ test) for testing slope homogeneity in large panels. The $\mathring{\Delta}$ test is valid as $(N,T) \to \infty$ without any restrictions on the relative expansion rates of N and T when the error terms are normally distributed. Under the null hypothesis with the condition of $(N,T) \to \infty$ so long as $\sqrt{N} / T \to \infty$ and the error terms are normally distributed, the $\mathring{\Delta}$ test has asymptotic standard normal distribution.

4.2. The Panel Causality Test

The existence of cross-section dependency and heterogeneity across these 16 Latin and South American countries requires a panel causality method that should account for those dynamics. The Granger causality means that the knowledge of past values of one variable, (X), helps to improve the forecasts of another variable, (Y). To test for the Granger causality among the variables in a panel data requires a careful treatment at least in terms of two issues, one is control for a possible cross-sectional dependence across the members of the panel, the other one is to consider the heterogeneity in estimated parameters for each individual of panel in order to impose a restriction for the causal relationship. To examine the direction of causality in a panel data, to date three approaches have been employed. The first approach is based on estimating a panel vector error correction model by means of a generalized method of moments (GMM) estimator. However, this approach is not able to take into account either the cross-sectional dependence or the heterogeneity; the GMM estimators can produce inconsistent and misleading parameters unless the slope coefficients are in fact homogeneous (Pesaran *et al*. 1999). The second approach is based on Hurlin's (2008) approach that controls for the heterogeneity, but it is not able to account for the cross-sectional dependence. The last approach is the Kónya (2006) model.

The bootstrap panel causality approach proposed by Kónya (2006) is able to account for both cross-section dependence and country-specific heterogeneity. This approach is based on the Seemingly Unrelated Regression (SUR) estimation of the set of equations and the Wald tests with individual specific country bootstrap critical values.[4] Since country-specific bootstrap critical values are used, the variables in the system do not need to be stationary, implying that the variables are used in level form, irrespective of their unit root and cointegration properties. Thereby, the bootstrap panel causality approach does not require any pre-testing for panel unit root and cointegration analyses. Besides, by imposing country specific restrictions, we can also identify which and in how many countries exist Granger causal relation between military spending and economic growth.

The system to be estimated in the bootstrap panel causality approach can be written as follows:

$$PGDP_{1,t} = \alpha_{1,1} + \sum_{i=1}^{ly_1} \beta_{1,1,i} PGDP_{1,t-i} + \sum_{i=1}^{lx_1} \delta_{1,1,i} PMS_{1,t-i} + \sum_{i=1}^{lz_1} \gamma_{1,1,i} PK_{1,t-i} + \varepsilon_{1,1,t}$$

$$PGDP_{2,t} = \alpha_{1,2} + \sum_{i=1}^{ly_1} \beta_{1,2,i} PGDP_{2,t-i} + \sum_{i=1}^{lx_1} \delta_{1,2,i} PMS_{2,t-i} + \sum_{i=1}^{lz_1} \gamma_{1,2,i} PK_{2,t-i} + \varepsilon_{1,2,t} \qquad (5)$$

M

$$PGDP_{N,t} = \alpha_{1,N} + \sum_{i=1}^{ly_1} \beta_{1,N,i} PGDP_{N,t-i} + \sum_{i=1}^{lx_1} \delta_{1,N,i} PMS_{1,N,t-i} + \sum_{i=1}^{lz_1} \gamma_{1,N,i} PK_{N,t-i} + \varepsilon_{1,N,t}$$

and

$$PMS_{1,t} = \alpha_{2,1} + \sum_{i=1}^{ly_2} \beta_{2,1,i} PGDP_{1,t-i} + \sum_{i=1}^{lx_2} \delta_{2,1,i} PMS_{1,t-i} + \sum_{i=1}^{lz_2} \gamma_{2,1,i} PK_{1,t-i} + \varepsilon_{2,1,t}$$

$$PMS_{2,t} = \alpha_{2,2} + \sum_{i=1}^{ly_2} \beta_{2,2,i} PGDP_{2,t-i} + \sum_{i=1}^{lx_2} \delta_{2,2,i} PMS_{2,t-i} + \sum_{i=1}^{lz_2} \gamma_{2,2,i} PK_{2,t-i} + \varepsilon_{2,2,t} \qquad (6)$$

M

$$PMS_{N,t} = \alpha_{2,N} + \sum_{i=1}^{ly_2} \beta_{2,N,i} PGDP_{N,t-i} + \sum_{i=1}^{lx_2} \delta_{2,N,i} PMS_{N,t-i} + \sum_{i=1}^{lz_2} \gamma_{2,N,i} PK_{N,t-i} + \varepsilon_{2,N,t}$$

where: *PGDP* denotes per capital real GDP, *PMS* refers to per capita military spending, *PK* refers to per capita capital (as a control variable), *l* is the lag length.

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[4] *In analysis of panel data, when the equilibrium errors are correlated across equations, the seemingly unrelated regression estimation strategy can be applied to cointegrating regressions to obtain asymptotically efficient estimators(see* Zellner 1962; *Mark* et al., *2005).*

Because each equation in this system has different predetermined variables while the error terms might be contemporaneously correlated (i.e., cross-sectional dependency), these sets of equations are the SUR system. In the bootstrap panel causality approach, there are alternative causal linkages for a country in the system that: (i) there is one-way Granger causality from *PMS* to *PGDP* if not all $\delta_{1,i}$ are zero, but all $\beta_{2,i}$ are zero, (ii) there is one-way Granger causality running from *PGDP* to *PMS* if all $\delta_{1,i}$ are zero, but not all $\beta_{2,i}$ are zero, (iii) there is two-way Granger causality between *PMS* and *PGDP* if neither $\delta_{1,i}$ nor $\beta_{2,i}$ are zero, and finally (iv) there is no Granger causality between *PMS* and *PGDP* if all $\delta_{1,i}$ and $\beta_{2,i}$ are zero.

It is important to note here that because the results of the causality test may be sensitive to the lag structure, determining the optimal lag length(s) is crucial for robustness of findings. As indicated by Kónya (2006), the selection of optimal lag structure is of importance because the causality test results may depend critically on the lag structure. In general, both too few and too many lags may cause problems. Too few lags mean that some important variables are omitted from the model and this specification error will usually cause bias in the retained regression coefficients, leading to incorrect conclusions. On the other hand, too many lags waste observations and this specification error will usually increase the standard errors of the estimated coefficients, making the results less precise. For a relatively large panel, equation and variable with varying lag structure would lead to an increase in the computational burden substantially. In determining the lag structure, we follow Kónya's approach that maximal lags are allowed to differ across variables, but to be the same across equations. We estimate the system for each possible pair of ly_1, lx_1, ly_2, lx_2, lz_1, and lz_2, respectively, by assuming from 1 to 4 lags, and then choose the combinations which minimize the Schwarz Bayesian Criterion.

5. Empirical Results

As outlined earlier, testing for cross-sectional dependency and slope homogeneity in a panel causality study is crucial for selecting the appropriate estimator. Taking into account both cross-sectional dependency and country-specific heterogeneity in empirical analysis is crucial, since states are highly integrated and have a high degree of integration in economic relations. Thereby, our empirical study starts with examining the existence of cross-sectional dependency and heterogeneity across the countries in concern. The results of the cross-section dependence and slope homogeneity tests are reported in Table 2. The cross-section dependence tests strongly indicate that the null hypothesis of no cross-section dependence is rejected at 1 percent level of significance. The cross-section dependence tests thereby support evidence of high integration among these 16 Latin and South American countries, which implies that a shock occurred in a country is quickly transmitted to other countries as is expected.

Table 2

Cross-sectional Dependence and Homogeneity Tests

	Military Expenditure (Per capita real Gross Capita as a control variable)
CD_{BP}	84.209***
CD_{LM}	5.681***
CD	6.353***
LM_{adj}	14.168***
Swamy(1970)	153.709***
$\tilde{\Delta}$	29.104***
$\tilde{\Delta}_{adj}$	1.4419*

*Notes: *** and * indicate significance at the 0.01 and 0.1 levels, respectively.*

Table 2 also reports the results of the slope homogeneity tests of Swamy (1970) and Pesaran and Yamagata (2008). Both tests reject the null hypothesis of the slope homogeneity hypothesis, supporting the country-specific heterogeneity. The rejection of slope homogeneity implies that the panel causality analysis by imposing homogeneity restriction on the variable of interest results in misleading inferences. Thereby, direction of causal linkages between military expenditure and economic growth in these 16 Latin and South American countries seems to be heterogonous, implying that the direction causal linkages among the variables of interest may differ across countries.

Table 3

PME Does Not Granger Cause PGDP

Countries	Wald Statistics	Bootstrap Critical Value		
		1%	5%	10%
Argentina	25.307	175.531	81.533	55.730
Belize	178.497***	118.032	53.931	35.005
Bolivia	18.069	148.515	68.213	45.184
Brazil	36.552	165.338	75.721	50.591
Chile	1.934	105.470	51.796	35.023
Colombia	6.112	140.827	59.978	39.332
Dominican Rep	17.117	125.155	59.003	39.247
Ecuador	0.049	102.203	50.801	33.082
El Salvador	1.497	183.869	86.555	57.763
Guatemala	13.556	127.371	61.797	41.365
Mexico	35.282	114.276	56.212	36.257
Nicaragua	56.777**	75.582	33.625	22.627
Paraguay	1.516	187.066	86.748	57.894
Peru	11.108	107.883	54.435	35.411
Uruguay	15.183	188.514	83.018	54.362
Venezuela	0.355	112.594	51.928	34.338

*Notes: *** and * indicate significance at the 0.01 and 0.1 levels, respectively. Bootstrap critical values are obtained from 10,000 replications.*

The existence of cross-sectional dependency and heterogeneity across countries supports evidence on the suitability of bootstrap panel causality approach. The results of the bootstrap panel Granger causality analysis[5] are reported in Tables 3 and 4. Results show one-way Granger causality from military spending to economic growth in two countries, Belize and Nicaragua. For the rest of countries, the null hypothesis of no causality running from military spending to economic growth cannot be rejected. As regards to the direction of Granger causality running from economic growth to military spending, the null hypothesis is rejected only in the cases of Bolivia and Ecuador. Again, for the rest of countries the null hypothesis of no causality running from economic growth to military spending cannot be rejected.

Table 4

PGDP Does Not Granger Cause PME

Countries	Wald Statistics	Bootstrap Critical Value		
		1%	5%	10%
Argentina	4.825	80.855	41.962	27.491
Belize	0.4483	79.124	39.364	25.815
Bolivia	20.101*	48.809	23.950	16.188
Brazil	7.106	55.935	26.207	16.938
Chile	11.852	157.055	81.115	55.963
Colombia	20.073	87.846	42.105	26.500
Dominican Rep	0.139	51.885	26.964	17.336
Ecuador	131.266***	100.041	47.528	28.992
El Salvador	17.410	141.628	70.435	48.466
Guatemala	18.770	81.930	41.135	27.614
Mexico	13.955	91.723	42.742	28.594
Nicaragua	0.039	131.096	66.572	44.007
Paraguay	10.492	104.735	49.943	32.677
Peru	0.828	60.299	28.599	18.686
Uruguay	2.828	77.676	39.904	26.964
Venezuela	2.362	97.919	49.690	32.688

*Notes: *** and * indicate significance at the 0.01 and 0.1 levels, respectively. Bootstrap critical values are obtained from 10,000 replications.*

Several interesting things need to be noted. First, we found one-way Granger causality running from military spending to economic growth in only two countries, Belize and Nicaragua. Regarding the direction of military spending to economic growth we do not find any significant relationship in the other 14 countries (i.e., Argentina, Bolivia, Brazil, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Paraguay, Peru, Uruguay, and Venezuela). These results indicate that military spending play an important role for economic growth in both Belize and Nicaragua. On the other hand, regarding the direction of economic growth to military spending we found one-way Granger causality running from economic growth to military spending for two countries (i.e., Bolivia and Ecuador). These results indicate that when the economy is in boom, the military spending will grow in these

[5] *We refer to Kónya (2006) for the bootstrap procedure on how the country-specific critical values are generated.*

two countries, but not in the other 14 countries (i.e., Argentina, Belize, Brazil, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela). Overall, our results indicate that military expenditure is not a strongly exogenous variable relative to economic growth for most of these 16 Latin and South American countries under study, with the exception of Belize and Nicaragua.

The above-mentioned discussion states that the time series approaches overlook cross-sectional dependency across countries in the causality test and, hence, they may result in misleading inferences regarding the nature of causality between military spending and economic growth. We find out strong evidence on the existence of cross-section dependence among these 16 Latin and South American countries and, thereby, it might be concluded that the policy implications driven from the causality approach that accounts for cross-sectional dependency seem to be more appropriate. Furthermore, we also detected cross-country heterogeneity in the panel of 16 Latin and South American countries, implying that each country may develop its own military policies.

The bootstrap panel causality approach that takes into account both cross-sectional dependency and cross-country heterogeneity indicates that the nature of causality between the military spending and economic growth is in favor of the neutrality hypothesis in 12 of these 16 Latin and South American countries. More specifically, the neutrality hypothesis holds for military expenditure-economic growth nexus in Argentina, Brazil, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Mexico, Paraguay, Peru, Uruguay, and Venezuela, and the only two countries that support the growth hypothesis are Belize and Nicaragua.

6. Conclusions

In this study, the causal linkages between military spending and economic growth are analyzed by applying the bootstrap panel Granger causality approach using data from 16 Latin and South American countries over the period 1988-2010. We find that (i) by formula (2), there is one-way Granger causality running from military spending to economic growth in Belize and Nicaragua, (ii) by formula (3), there is one-way Granger causality from economic growth to military spending in Bolivia and Ecuador, (iii) there is no causal linkage between military spending and economic growth in Argentina, Brazil, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Mexico, Paraguay, Peru, Uruguay, and Venezuela, (iv) there is no feedback between military spending and economic growth in any of these 16 Latin and South American countries. Thereby, the bootstrap panel Granger causality analysis supports the growth hypothesis for Belize and Nicaragua; and the neutrality hypothesis for 12 countries. The results obtained in this paper provide policy implications for the 16 Latin and South American countries to develop sound military strategies within the context of economic growth.

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