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THE CAUSE OF HIGHER ECONOMIC GROWTH: ASSESSING THE LONG-TERM AND SHORT-TERM RELATIONSHIPS BETWEEN ECONOMIC GROWTH AND GOVERNMENT EXPENDITURE

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This study examines the cause of higher (5% or more) economic growth rates in countries around the world over the past 35 years. It explores the long- and short-term relationships between GDP and government expenditures in these countries. A panel data set of 60 countries over the period from 1976 to 2010 is deployed to implement pooled mean group estimation. Countries are divided into three economic growth rate groups: high, middle, and low. Panel-based/error correction models are used to estimate long-term equilibrium relationships and short-term dynamics between government expenditures and GDP growth rates. Results indicate that the hypothesis of a common long-term elasticity and a short-term dynamic relationship between GDP growth rates and government expenditures cannot be rejected for high group countries, whereas for middle group countries this is true only for the long term, not for the short term. No long-term or short-term relationship between these two variables exists for low-growth-rate countries.

Keywords: Government Expenditure, Growth Rates, Panel Co-integration, Error Correction Models

1. INTRODUCTION

The aim of this study is to investigate the cause of higher economic growth rates (higher than 5%) in countries around the world over a period of 35 years (1976–2010). The achievement of 5% growth or more is thought to be linked to government expenditures. That is, growth rates of 5% or higher cannot be achieved without higher government expenditures. To determine the cause of higher economic growth, the links between economic growth and government expenditures are examined.

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The main focus of this study lies in the dynamic properties of the relationship between these two variables. Specifically, the aim of this study is to answer the following questions: Is government expenditure linked to 5% or more growth in output through a stable long-term relationship? How important is the speed at which expenditure adjusts to the level of potential output predicted in the long run?

Macroeconomics, especially the Keynesian school of thought, suggests that government spending accelerates economic growth. Thus, government expenditure is regarded as an exogenous force that changes aggregate output. Government expenditure is assumed to be the main determinant of GDP growth. In other words, an increase or a decrease in government expenditure is assumed to have positive or negative effects on GDP growth, respectively.

This implies that there is a long-run tendency for national income to grow as government expenditures increase.

We use pooled mean group (PMG) estimators that allow country-specific adjustment coefficients in long-term panel estimation [Pesaran et al. (1999)]. Nowadays, PMG estimates are frequently used in applied econometric works. For example, we can point to the analysis of institutional effects on innovation and growth [Guellec and van Pottelsberghe de la Potterie (2001)]; modeling the Euro area demand of money [Golinelli and Pastorello (2002)]; the analysis of wealth effects on the consumption function [Barrel and Davis (2004)]; exploring the impact of policies on fertility rates [D'Addio and Mira D'Ercole (2005)]; explaining how to identify the determinants of sovereign risks in gold standard [Cameron, Gai, and Tan (2006)]; analyzing the link between fiscal policies and trade balance [Funke and Nickel (2006)]; and analyzing the effects of financial intermediation on economic activity [Loayza and Ranciere (2006)].

Panel unit-root tests are performed to assess whether the variables we use in this analysis are stationary. Then the existence of a long-term relationship between variables is verified, using residual-based Pedroni (1999) panel co-integration tests. Granger (1986) and Engle and Granger (1987) proposed models known as error correction models (ECMs) that we found useful as a more comprehensive method of causality testing when variables are co-integrated [Chang (2002)]. ECMs provide more information because through their application it is possible to estimate both short- and long-run effects. According to Granger (1986), ECMs produce better short-run forecasts and provide the short-run dynamics necessary to obtain long-run equilibrium [Ekanayake (1999)].

If Y_{it} and G_{it} are co-integrated, an ECM representation for the PMG estimator (PMG) could have the following form:

$$\Delta Y_{it} = \alpha_0 + \alpha_1 E_{it-1} + \sum_{j=1}^{n} \alpha_{2it} \Delta Y_{it-j} + \sum_{it-1}^{n} \alpha_{3it} \Delta G_{it-j} + U_{it}, \tag{1}$$

where Δ is the lag and difference operators and E_{it-} are the error correction terms. The error correction term E_{it-1} in (1) is the lagged value of the residuals from the

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OLS regression of Y_{it} on G_{it}. In (1), ΔY_{it}, and U_{it} are stationary, implying that the right-hand side must also be stationary. It is obvious that (1) in first differences is augmented by the error correction terms E_{it-1}, indicating that ECMs and co-integration are equivalent representations.

In two major respects, advanced knowledge of the dynamic relationship between government expenditure and GDP needs to be considered. First, this knowledge improves our understanding of long-term, structural, and public finance issues. It could, particularly, help in assessing the impacts on expenditures and, subsequently, on deficits arising from a structural deceleration in growth (e.g., associated with aging populations or a decline in TFP growth), or equally, from an improvement in growth potential (e.g., related to structural reforms). Second, a more thorough understanding of the dynamic relationship between government expenditure and GDP aids in our conception of policy-relevant issues over a short- to medium-term horizon.

It has been argued by many studies that the key to attaining a benchmark against which to evaluate the stance of expenditure policy and, in turn, the stance of overall fiscal policy is to dispose of a reliable amount of the structural relationship between government expenditure and potential output. Understanding what neutral expenditure policy would consist of is necessary to judge whether expenditure policy is expansionary or contractionary. However, no clear a priori explanation exists for what expenditure policy concerns, despite a broad consensus that a neutral revenues policy is such that government revenues move together with output, to an extent depending on structural factors such as the degree of progression of the tax system and the responsiveness of various tax bases with respect to output (the output elasticity of revenues).

A benchmark for neutral expenditure policy, based on empirical evidence, can be formulated by estimating the long-term relationship between government expenditure and GDP. Estimates of the speed at which government expenditures adjust to GDP in the long run, following a shock in economic activity, would also prove useful for policy making.

Three panel data sets of three groups of countries, including 60 countries in total, are deployed over a period of 35 years from 1976 to 2010. In this study, an attempt is made to use pure data. In particular, noncyclical adjusted government expenditure and GDP data are used to determine what causes a 5% or higher growth rate. A panel dimension of this data set is utilized in a way that (i) improves the command of statistical tests for analyzing the dynamic properties of macroeconomic series through panel unit root and co-integration tests and way that (ii) attains country-specific information on adjustment dynamics by means of PMG estimation.

The empirical analysis in the remainder of the paper proceeds as follows. After the literature review in the second section, the methodology and data are discussed in the third section. This is followed by the fourth section, in which the empirical results of our analysis are presented. First, a description of the data set on government expenditure and potential output is inspected by means of graphical analysis. Second, panel unit root tests are performed to assess whether the variables we used in the analysis were stationary. Third, the existence of a long-term relationship between primary expenditure and potential output is verified by means of the residual-based Pedroni (2000) panel co-integration tests. Fourth, the dynamic relationship between government expenditure and GDP is analyzed empirically by testing an error correction mechanism with the PMG estimator. The last section is devoted to concluding remarks.

2. THE LITERATURE REVIEW

The question of whether government expenditure affects economic growth has attracted considerable interest among economists and policy makers all over the world. Empirical studies in this area seem to be moving in two directions: toward the effects of government expenditure on economic growth, and toward how such growth can affect government spending in the economy.

Two theoretical approaches have debated the relationship between GDP and government expenditure. One perceives government expenditure to be an essential part of aggregate demand in the economy, through which the fluctuation of GDP is determined. This perception, which dominated during the 1950s and the 1960s, is now mainly referred to John Maynard Keynes and his followers. The second theoretical approach is Wagner's Law (a principle named after the German economist Adolph Wagner, 1835–1917). According to Wagner's Law, the development of an industrial economy will be accompanied by an increased share of public expenditure in gross national product.

In the first theoretical approach, causality runs from government spending to economic growth, whereas the latter law postulates that causality runs in the opposite direction [Abu-Bader and Abu-Qarn (2003)]. Following Keynes's approach, public expenditure is seen as an exogenous factor to be used as a policy instrument to influence growth. On the other hand, Wagner argues that expenditure is an endogenous factor or an outcome, not a cause, of growth in national income [Ansari et al. (1997)].

The relationship between government expenditure and economic growth has been tackled from various angles in the empirical literature. One angle investigates the determinants of government size across countries, concentrating on alternative explanations such as per capita income [e.g., Peltzman (1980), Borcherding (1985)], the relative price of government-provided goods and services [Baumol (1967)], demographic structures [Heller and Diamond (1990)], and the size of [Alesina and Wacziarg (1998)] or the degree of openness in the economy [Rodrik (1998)]. Moreover, a growing strand of research aims at clarifying cross-country structural differences in the size of government on the basis of political fundamentals that shape the extent of deficit bias related to free riding in government expenditure provisions and governments' myopia [Persson and Tabellini (1999); Persson et al. (2000); Milesi-Ferretti et al. (2002)]. It has also been shown that the way budgetary processes are structured affects the fiscal performance of countries [e.g.. Von Hagen and Harden (1995), Hallerberg et al. (2001)].

This empirical literature also demonstrates a connection between expenditure and economic growth over time. Some of it aims to describe long-term tendencies in history [Tanzi and Schuknecht (2000)]. Other parts of it concentrate more heavily on empirical estimation of the elasticity of government expenditure with respect to output, often overtly aiming to empirically test "Wagner's Law"—for example, hypothesizing that government expenditure increases disproportionately to economic activity. The fundamental notion here is that, generally, goods and services provided by the government sector—including redistribution via transfers and the activities of public enterprises—have income elasticity greater than one, i.e., are superior goods.

Initial analyses interpreted government expenditure as regressive to GDP without taking dynamic properties into account [e.g., Ram (1987)]. Later, test specifications were implemented by taking nonstationarity and co-integration into account. As a result, more structured modeling of expenditure dynamics was enabled, introducing the distinction between a long-term relationship and short-term adjustment [Kolluri et al. (2000); Akitoby and Cinyabuguma (2004); Wahab (2004)]. For example, implementing cross-country analyses allowed dynamic specifications.

In some studies, increasing government expenditure has had a positive effect on economic growth [Singh and Sahni (1984); Ram (1986); Holmes and Hutton (1990)]. In other studies, increasing government expenditure has had a negative effect on economic growth in many developed and less-developed countries [Landau (1983, 1986); Barth et al. (1990)].

Ram (1986) found no consistent causal relationship between government expenditures and economic growth, based on his study of 63 developed and developing countries. His findings were similar to those of Ahsan et al. (1989), which assessed U.S. data, and those of Conte and Darrat (1988), which analyzed OECD countries' data from 1960 to 1984. Similarly, Conte and Darrat (1988) also found no consistent causality between the two variables.

Other studies have looked at the effect of government expenditures on economic growth, using different approaches. For example, Cheng and Lai (1997) examined the causality between government expenditure and economic growth, along with money supply, using South Korean data from 1954 to 1994. In their study they found that there is bidirectional causality between government expenditures and economic growth in South Korea.

Ghali (1999) studied the causal relationships between government expenditures and economic growth in ten OECD countries using a quarterly data set that covered the period from 1970:1 to 1994:3. His results supported the Keynesian view.

Al-Faris (2002) examined the nature of the relationship between economic growth and public expenditure in the Gulf Cooperation Council using annual data from 1970 to 1997 in the context of Wagner's Law and Keynesian theory. This empirical investigation did not support the hypothesis of public expenditure causing national income, as proposed by Keynesian theory.

Wahab (2004) assessed annual government expenditure and GDP time series data from 1950 to 2000 in OECD countries. He found that when the economy grows at or above trend growth, government expenditure tends to increase, and when economic growth moves to below trend growth, growth in government expenditure declines more than proportionately with a slowing economy.

Arpaia and Turrini (2008) estimated the long- and short-run relations between government expenditure and potential output across EU countries. They used a sample comprising 15 EU countries over a period of 34 years (1970–2003). Their hypothesis of a common long-term elasticity close to unity between cyclically adjusted primary expenditure and potential output could not be rejected, despite long-run elasticity decreasing considerably over the decades and being significantly higher than unity in catching-up countries, in fast-aging countries, in low-debt countries, and in countries with weak numerical rules for the control of government spending.

Wu et al. (2010) reexamined the causal relationship between government expenditure and economic growth in 182 countries from 1950 to 2004. Their empirical results strongly supported both Wagner's Law and the hypothesis that government spending is helpful for enhancing economic growth regardless of how variables are measured. When countries were disaggregated by income levels and degree of corruption, their results confirmed a bidirectional causality between government activities and economic growth.

Dandan (2011) investigated the impact of public expenditures on economic growth using time series data in Jordan from 1990 to 2006. His study found that government expenditure at the aggregate level can have positive impacts on the growth of GDP, which is compatible with Keynesian theory.

Ray and Ray (2012) empirically assessed the connection between government developmental expenditure and economic growth in India using annual data from 1961–1962 to 2009–2010. In their assessment, the Granger causality test confirmed the absence of any kind of short-run causality between economic growth and developmental expenditures. Their error correction estimates proved that developmental expenditures and GDP growth are mutually causal.

Together, these empirical studies emphasize three distinctive results. First, there is a bidirectional causal relationship between government expenditure and economic growth. Second, economic growth acts as a causal engine in the fluctuation of government expenditure. Third, although causal movement from government expenditures to economic growth is emphasized, the results of such long- and short-run relationships are mixed.

3. METHODOLOGY AND DATA

3.1. Empirical Approaches

Our target is to exploit both time series and cross-sectional (i.e., across countries) data, thus improving the statistical properties of estimates when the number of observations over time is based on annual data and the size of a taken sample becomes limited. When a smaller sample size is used, this becomes a matter of consideration in the estimation and testing process of stochastic properties in time series data. It may lead to low power stationarity and co-integration tests. To avoid such outcomes, the inference on the time series properties of data can be improved upon when integration and co-integration tests are applied to a whole panel rather than to each unit separately.

Moreover, in order to avoid spurious regressions when time series data are deployed, the following three steps are considered: (i) we check whether the series are stationary; (ii) we check whether a co-integration relationship exists between the series when they are not stationary; and (iii) when a co-integration relationship exists between series, we use ECMs to analyze the long-term relationship between variables jointly with short-term adjustment toward long-term equilibrium.

Panel unit root and panel co-integration tests need to be used extra cautiously because they are based on the presumption that univariate (i.e., country-specific) tests for variables using augmented Dickey–Fuller (ADF) regressions have low power. Although unit-by-unit ADF tests normally tend to accept the null of a unit root, panel unit root tests often reject this null. Such rejections must be treated with a great deal of caution. Consequently, these rejections, instead of being attributed to the higher power of panel unit root tests, may be attributed simply to the oversizing that is present when co-integrating relationships link the units of the panel together. The study by Banerjee et al. (2005) demonstrates clearly the importance of taking proper account of the presence of cross-unit co-integrating relationships in interpreting the results of unit root tests in panels. These three authors in [Banerjee et al. (2004)] displayed that disregarding the co-integrating relationships across the countries in the panel will result in serious difficulties in making inferences about co-integration within each country in a panel. They indicated that when the restriction that there are no co-integrating relationships among the variables across the countries in the panel is valid, the tests have the correct size and high power to detect co-integration. If the restriction is invalid, however, the tests for co-integration tend to be clearly oversized especially as T increases, so that the null of no co-integration is rejected too often in relation to the nominal confidence level (or size) of the test.

3.2. Panel Unit Root Tests

Whether all units are stationary with the same autoregressive coefficient across units (the homogeneous alternative hypothesis) remains to be determined. This suggests that in all countries, the relevant variable must converge toward its average at the same speed. It is therefore necessary to test the null unit root hypothesis against its homogeneous alternative, stationarity.

An ADF regression of the following type should be performed for tests that allow heterogeneous serial-correlated errors, country-specific fixed effects, and

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country-specific deterministic trends:

$$\Delta y_{it} = \delta_i \tau + \emptyset_i y_{it-1} + \sum_{j}^{p_i} \beta_{ij} \Delta y_{it-j} + \in_{it}, \tag{2}$$

where y_{it} is GDP in our case, i denotes panel units (countries in our case), t is time, τ is a common trend across countries, p_i is the country-specific lag order, and ϵ_{it} are stochastic errors.

Panel unit root tests require two conditions, one condition being cross-sectional data independence. These tests are applied to demeaned data in order to meet this first condition. This means that if countries are equally affected by common factors (i.e., aggregate disturbances common to all), then demeaning the data permits one to eliminate cross-sectional dependence. The second required condition is that data should be free of deterministic trends. This means that if a country encounters specific deterministic trends, a unit root hypothesis test on OLS detrended data should be performed. Tests are therefore performed on demeaned and OLS detrended data.

The null (H_0) and alternative (H_1) hypotheses are set up as follows:

$$H_0 : \phi_i = 0; \, H_1 : \phi_i = \phi < 0.$$

This hypothesis testing will be carried out based on the 5% level of significance. If the probability of the ADF test is smaller than the 5% level of significance, the null hypothesis will be rejected in favor of the alternative hypothesis.

3.3. Panel Co-integration Tests

The next step involves showing that idiosyncratic error terms are independent across units in each panel, i.e., that conflicts in one unit do not spread to other units. However, co-integration may still exist between some units in the panel and there is the issue of possibly having multiple co-integration vectors.

Residual-based tests of the no co-integration null hypothesis developed by Pedroni (1995, 1997, 1999) are employed. These tests permit country-specific short-term dynamics and long-term relationships and are carried out on the residuals of a static regression.

These tests are based on the following regression:

$$e_{it} = \alpha_i + \theta_i y_{it} + u_{it}, \tag{3}$$

where e_{it} is the log of government expenditure in country i and year t, y_{it} is the log of potential GDP, u_{it} is a stochastic residual, and α_i is the country-specific intercept. The elasticity of expenditure to output, θ_i, is allowed to vary across individual countries. The two variables are co-integrated if the linear combination of I (1) variables is stationary. This implies that deviations of one variable from the path prescribed by the co-integration relationship are transitory (i.e., without memory). A long-term relationship exists between the variable in this case, and temporary deviations can be modeled using an ECM.

Two types of tests need to be considered in order to find which one is more powerful. The first type is called the within-dimension approach test. This test is based on panels including panel ν-statistic,[1] panel ρ-statistic,[2] panel PP-statistic,[3] and panel ADF-statistic. These statistics pool the autoregressive coefficients across different members for unit root tests on the estimated residuals. The second test is based on the between-dimensions approach, which includes group ρ-statistics, group PP-statistics, and group ADF-statistics. Between-dimensions-based statistics are just the group mean approach extensions of the within-dimension-based ones. These statistics are based on estimators that simply average the estimated coefficients for each member individually.

We restrict our analysis to panel ADF and group ADF Pedroni co-integration tests, which are sufficient for studies of the small sample properties of these tests. In terms of power, it can be shown that panel ADF tests (obtained by pooling along the within dimension) perform better than other tests.

The null hypothesis of no co-integration between the series will be tested against the alternative of their co-integration. The null hypothesis will be rejected in favor of the alternative hypothesis if the probability of the ADF test is less than the level of significance of 5%.

3.4. Error Correction Models

The ECMs are found plausible for this analysis. They are a comprehensive method of causality testing when variables are co-integrated. Panel unit-root tests and panel co-integration tests need to be performed before running the ECMs. We need to make sure whether or not the variables are stationary, and the existence of a long-term relationship between variables is verified using the residual-based Pedroni (1999) method.

The advantage of using an error correction specification is that, on one hand, it allows testing short-run relationships through lagged differenced explanatory variables and, on the other hand, testing long-run relationships through lagged error correction terms.

A general dynamic specification can be represented by an autoregressive distributed lag model of order p_i and q_i, ARDL (p_i, q_i):

$$e_{it} = \sum_{j=1}^{p_i} \lambda_{ij} e_{it.j} + \sum_{j=0}^{q_i} \delta_{ij} y_{it.j} + \mu_i + u_{it}, \qquad (4)$$

where μ_i is an unobserved country-specific effect and u_{it} is the error term.

The ARDL (p_i, q_i) can be rewritten in the following ECM form:

$$\Delta e_{it} = \phi_i \left(e_{it-1} + \frac{\beta_i}{\phi_i} y_{it} \right) + \sum_{j-1}^{p_i-1} \lambda^*_{ij} \Delta e_{it.j} + \sum_{j=0}^{q_i} \delta^*_{ij} \Delta y_{it.j} + \mu_i + u_{it}, \qquad (5)$$

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where

$$\emptyset_i = -\left(1 - \sum_{j=1}^{\rho_i} \lambda_{ij}\right); \beta_i = \sum_{j=0}^{q_i} \delta_{ij}\ ; \lambda_{ij}^* = -\sum_{k=j+1}^{\rho_i} \lambda_{ik}; \delta_{ij}^* = -\sum_{k=j+1}^{\rho} \delta_{ik}.$$

When the ARDL (p_i, q_i) is stable, means error correcting, the adjustment coefficient ϕ_i should be negative and less than 1 in absolute value. In this case, the long-run relationship is defined by

$$e_{it} = \frac{\beta_i'}{\phi_i} y_{it} + \eta_{it},$$

where η_{it} is a stationary process.

At equilibrium, trend expenditure and potential output are connected to each other, with a long-term elasticity of

$$\theta_i = -\frac{\beta_i}{\phi_i}$$

The following ECM can be estimated in two different ways:

$$\Delta LGDP_{it} = \alpha_0 + \alpha_1 E_{it-1} + \sum_{it=1}^{n} \alpha_{2it} \Delta LGDP_{it-j} + \sum_{it-1}^{n} \alpha_{3it} \Delta LGEX_{it-j} + U_{it}. \quad \textbf{(6)}$$

1. Traditional time series models do not take cross-country correlations in the data into account. Dynamic fixed effect models, which control for country fixed effects, impose the same coefficients for all countries. Unless the slope coefficients are identical, pooling produces inconsistent estimates of the parameters value. In order to tackle this issue, a mean group (MG) estimator, consisting of estimating the coefficient of each cross section and then taking an average, needs to be applied. The MG estimator, however, does not account for the fact that some of the parameters may be the same across countries, implying that its estimates are likely to be inefficient and strongly affected by the presence of outliers, particularly in small samples.
2. The PMG Estimator works as an intermediate choice between imposing slope homogeneity and no restrictions. This estimator combines the characteristics of other pooled estimators (the fixed effect estimator in particular) with those of the mean group estimator.

Both short- and long-run dynamics are treated differently by the PMG estimator. The short-run dynamics is able to vary across countries, whereas long-run effects must remain the same. In the event of data having complex, country-specific, short-term dynamics that cannot be captured, imposing the same lag structure on all countries using the PMG estimator is appropriate. Furthermore, because it does not impose any restrictions on short-term coefficients, the PMG provides important information on country-specific speed convergence values that move

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toward the long-term relationship linking government expenditure and potential output.

3.5. Data

We take primary government expenditure into account, rather than exploring the link between economic activity and different government expenditure subcategory definitions. We employ this broad expenditure aggregate for two reasons. First, government deficit and debt, and ultimately the overall sustainability of public finances, are effectively determined by overall government expenditure. Second, using various government expenditure categories separately via the estimation of dynamic equations does not produce a significantly different relation to economic activity across different types of expenditure.

In this study, business cycle adjustments have not been considered in the data of the two variables, because the benefit of using a structural nature analysis is greater than that of analyzing business cycle rotations. Not considering business cycle adjustments is justifiable so long as samples are big enough.

The bottom line is that government expenditure and potential output are interconnected in such a way that the former reacts to changes in the latter. This makes the public sector subject to change when the size of the economy is modified. Changes in government expenditure are presumed to affect aggregate demand, in turn changing the level of GDP. It is still difficult to distinguish whether government expenditure affects GDP or vice versa. However, because this relationship is not a direct relationship and it changes through aggregate demand, which is mostly influenced by government expenditures, at least in emerging and developing countries, GDP acts as a function of government expenditures.

To investigate the relationship between GDP and government expenditures, we use annual data from 1976 to 2010 for 60 countries. Yearly observations of GDP growth rates, GDP as a total figure, and specific country government expenditures were obtained from the online resource of the United Nations. Estimation periods were determined by the availability of adequate data on all variables. The data explanations and sources of each variable are as follows:

> GDP growth (annual %): Annual percentage growth rates of GDP at market prices based on constant local currency came from the EconStats web page, the World DataBank, and OECD StatExtracts.

GDP (current US$): GDP at purchasers' prices is the gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. Data are represented in current US$. Dollar figures for GDP are converted from domestic currencies using single-year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor

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is used. Data are from the EconStats web page, the World DataBank, and OECD StatExtracts.

GEX (constant price, 2000 US$): General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation. Data are from the EconStats web page, the World DataBank, and OECD StatExtracts.

4. EMPIRICAL RESULTS

Countries have been split into three groups based on their annual growth rates over the defined period. The first group consists of countries having GDP annual growth rates higher than 5% 15 or more times from 1976 to 2010. The second group consists of countries having GDP annual growth rates higher than 3% 15 or more times for the same period. The last group is composed of countries having GDP annual growth rates smaller than 3% from 1976 to 2010. These groups are referred to as high-, middle-, and low-growth-rate countries. As Table 1 shows, group 1 consists of 19 countries, group 2 consists of 29, and group 3 of 12. Table 1 gives a list of countries in each group, as well as their average growth rates for the period from 1976 to 2010.

Table 1 shows that China (AGR = 9.597) was the country with the highest average growth rate for 35 years, whereas Nicaragua (AGR = 1.001) was the country with the lowest average growth rate. Although Nicaragua had the lowest average growth rate, it was still included in the second group because it had a GDP annual growth rate that was higher than 3% at least 15 times for the period from 1976 to 2010.

4.1. Graphical Analysis

Prefixes L and Δ are used to indicate whether the data are in natural logarithms or in the first difference form, respectively.

Figure 1 contains six graphs of each group's variable based on a particular form of the natural logarithm (L) data on GDP and GEX. All the graphs are trended, and they are not stationary.

Figure 2 shows graphs of two variables, ΔLGDP and ΔLGEX, in high-, middle-, and low-growth-rate countries. Graphs illustrate that first differences of GDP and GEX in all groups are stationary because they cross the zero lines frequently.

4.2. Panel Unit Root Tests

Before implementing the short- and long-run relationships between our two panel data sets of GDP and GEX, we performed panel unit-root tests to assess whether

TABLE 1. List of countries and their average growth rates for the period 1976–2010

Group 1 High growth rates ($n = 19$, obs.: 665)		Group 2 Middle growth rates ($n = 29$, obs.: 1,015)				Group 3 Low growth rates ($n = 12$, obs.: 420)	
Bangladesh	4.695	Bolivia	2.526	Luxemburg	4.088	Austria	2.264
Botswana	7.703	Brazil	3.188	Mexico	3.098	Belgium	2.068
China	9.597	Canada	2.723	Morocco	4.050	Cote d'Ivoire	1.864
Costa Rica	4.194	Colombia	3.740	Nicaragua	1.001	Denmark	1.938
Dominican Rep.	4.724	Ecuador	3.205	Norway	2.886	France	2.057
Egypt	5.666	El Salvador	1.842	Paraguay	4.092	Germany	2.009
Hong Kong	5.919	Finland	2.478	Peru	2.984	Hungary	1.663
India	5.839	Gabon	1.804	Philippines	3.573	Italy	1.860
Indonesia	5.719	Greece	2.167	Portugal	2.712	Netherlands	2.347
Ireland	4.501	Guatemala	3.204	Senegal	2.973	Sweden	2.026
Jordan	6.155	Honduras	3.852	Spain	2.526	Switzerland	1.653
Korea	6.458	Iceland	3.095	United States	2.923	United Kingdom	2.171
Malaysia	6.334	Japan	2.541	Uruguay	2.631		
Mauritius	4.443	Kenya	3.785	Venezuela, RB	2.194		
Pakistan	5.146	Lesotho	4.482				
Singapore	7.152						
Syrian Arab Rep.	4.494						
Thailand	5.970						
Tunisia	4.600						

the variables used in this study are stationary. The result of the ADF tests is shown in Table 2.

Probabilities of the ADF tests are presented in brackets. Probabilities less than 0.05 mean that the null hypothesis of the panel data not being stationary can be rejected in favor of the alternative hypothesis of the panel data being stationary. The first differences of the two variables' panel data (ΔLGDP and ΔLGEX) of all groups are stationary, as the probabilities are less than the 5% significance level.

4.3. Panel Co-integration Test

The unit root tests showed that the panel data sets are not stationary and they are $I(1)$. They will be stationary if we take the first differences of the panel data. The question that needs to be addressed now is whether a long-term equilibrium relationship exists among the variables. The existence of such a long-term relationship between GDP and GEX can be verified using residual-based Pedroni (1999) panel co-integration tests. These test results are reported in Table 3.

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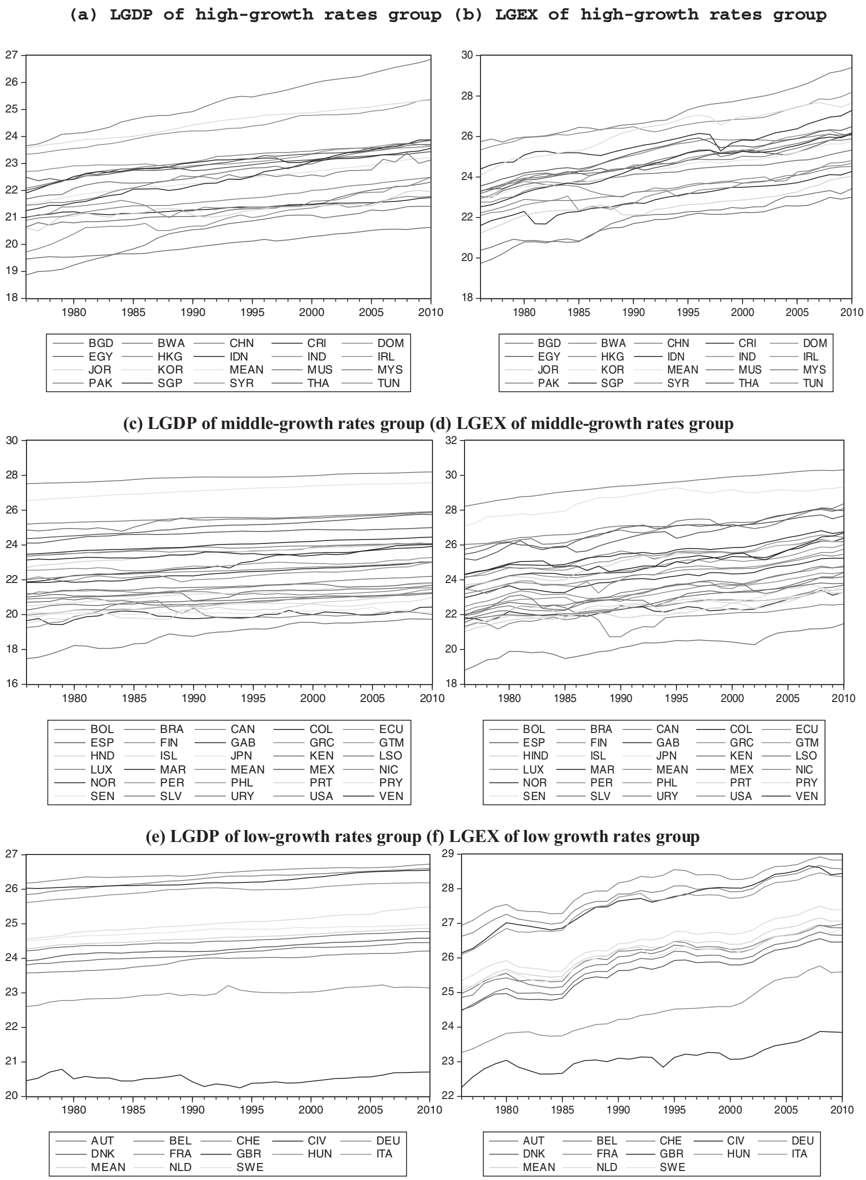

FIGURE 1. Graphs of LGDP and LGEX with their cross-sectional means.

We conclude that primary expenditure and potential output are co-integrated on the basis of the overall evidence, and provided that group ADF, which allows a more general structure of the residual correlation under the null hypothesis, is also the most effective test. These results are based on the fact that the probabilities of the ADF tests are all at less than the 5% level of significance.

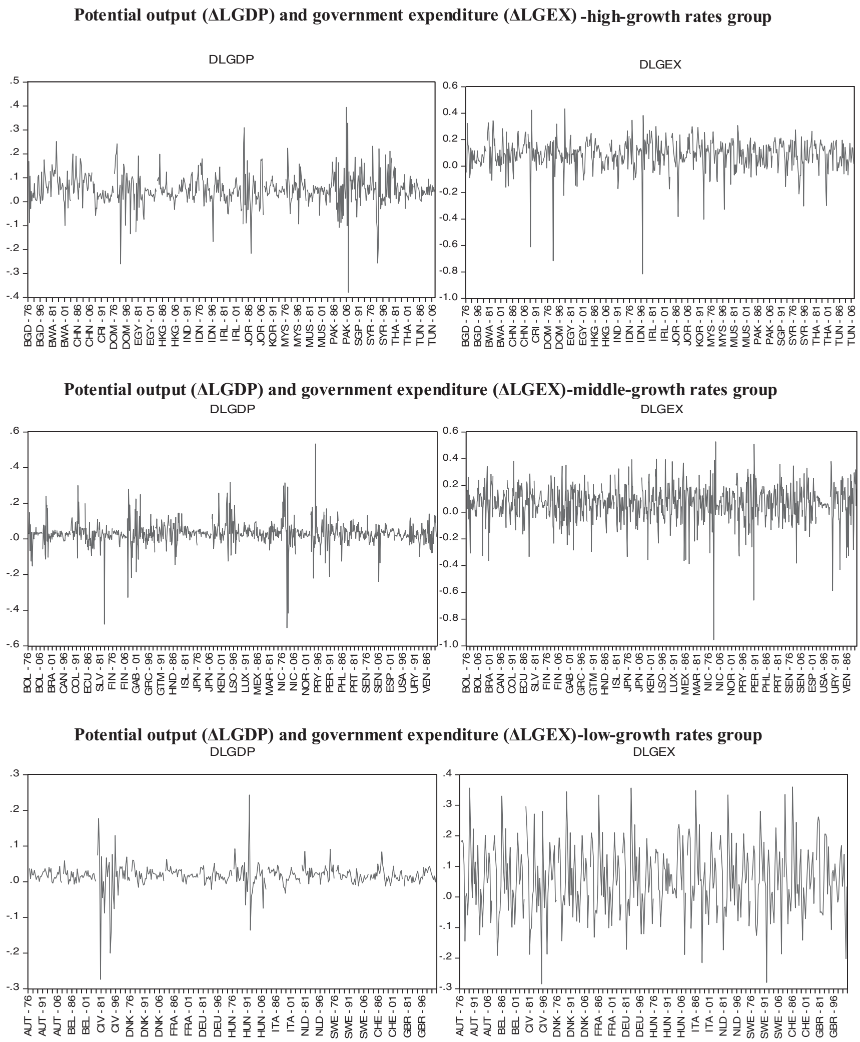

FIGURE 2. Graphs of ΔLGDP and ΔLGEX. Graphs of the first differences of GDP and GEX in all groups illustrate that ΔLGDP and ΔLGEX are stationary.

We proceed with modeling an error correction mechanism, which allows country-specific and short-term coefficients, having established that government expenditure is co-integrated with potential output.

4.4. Pooled Mean Group Error Correction Model Estimation

PMG estimates require disturbances to be independently distributed across units and over time with zero mean and constant variance. We model cross-sectional

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TABLE 2. Panel unit root tests (ADF—Fisher chi-squared) of GDP and GEX

	Data		Log of data		First difference of log	
	GDP	GEX	LGDP	LGEX	ΔLGDP	ΔLGEX
Group 1 (high growth rates)	3.099 (1.00)	0.805(1.00)	24.532(0.95)	10.571(1.00)	136.808(0.00)	189.969(0.00)
Group 2 (middle growth rates)	19.022 (1.00)	2.784(1.00)	55.511(0.57)	22.533(1.00)	240.254(0.00)	267.040(0.00)
Group 3 (low growth rates)	9.727(0.99)	2.096(1.00)	24.425(0.44)	11.125(0.99)	104.209(0.00)	134.592(0.00)

Notes: H_0: series has a unit root and is not stationary; H_1: series has no unit root and is stationary. Test is based on 5% level of significance. Parentheses show probabilities. "L" denotes the natural logarithm of each variable and "Δ" denotes the first difference of each variable.

TABLE 3. Pedroni residual co-integration test results, LGDP and LGEX, 1976–2010

	Statistic	Prob.	Weighted statistic	Prob.
Results for high-growth-rate group				
Panel v-statistic	3.989360	0.0000	4.061389	0.0000
Panel ρ-statistic	−2.448630	0.0072	−2.620288	0.0044
Panel PP-statistic	−2.962453	0.0015	−3.123134	0.0009
Panel ADF-statistic	−3.509044	0.0002	−4.042464	0.0000
Alternative hypothesis: individual AR coefs. (between-dimension)				
Group ρ-statistic	−1.403248	0.0803		
Group PP-statistic	−2.949927	0.0016		
Group ADF-statistic	−3.821838	0.0001		
Results for middle-growth-rate group				
Panel v-statistic	3.140173	0.0008	3.753035	0.0001
Panel ρ-statistic	−2.296343	0.0108	−2.278427	0.0114
Panel PP-statistic	−2.324206	0.0101	−2.308320	0.0105
Panel ADF-statistic	−2.687524	0.0036	−3.022811	0.0013
Alternative hypothesis: individual AR coefs. (between-dimension)				
Group ρ-statistic	−0.167378	0.4335		
Group PP-statistic	−1.486214	0.0686		
Group ADF-statistic	−3.002463	0.0013		
Results for low-growth-rate group				
Panel v-statistic	2.147297	0.0159	2.476133	0.0066
Panel ρ-statistic	−2.142520	0.0161	−2.210992	0.0135
Panel PP-statistic	−2.000168	0.0227	−2.098325	0.0179
Panel ADF-statistic	−2.680274	0.0037	−3.049621	0.0011
Alternative hypothesis: individual AR coefs. (between-dimension)				
Group ρ-statistic	−0.635184	0.2627		
Group PP-statistic	−1.421347	0.0776		
Group ADF-statistic	−3.183536	0.0007		

Notes: H_0: no co-integration between the series; H_1: the series are co-integrated. Test is based on 5% level of significance.

dependence, assuming the existence of observable common components in the residual. This is captured by group aggregate potential output, which is assumed to have an impact on government expenditures that will differ across countries.

PMG estimates of the ECM are reported in Table 4.

The empirical evidence for the high-growth-rate group, the result presented in part one of Table 4, shows that the coefficient of DLGEX (−1) is positive, 0.089529, and the obtained probability is 0.0001. The latter result proves that the coefficient of DLGEX (−1) is statistically different from zero, as the probability is less than the 5% level of significance. The ECM (−1) coefficient is negative and less than one, −0.013294, and the probability of this coefficient is 0.0229. Because the probability is less than the 5% level of significance, the ECM (−1) is statistically different from zero.

TABLE 4. Estimates of error correction models

Variable	Coefficient	Std. error	*t*-statistic	Prob.
		High-growth-rate group		
C	0.030219	0.003752	8.054479	0.0000
DLGDP(–1)	0.046662	0.039238	1.189215	0.2348
DLGEX	0.126615	0.022578	5.607943	0.0000
DLGEX(–1)	0.089529	0.022823	3.922756	0.0001
ECM(–1)	−0.013294	0.005829	−2.280720	0.0229
		Middle-growth-rate group		
C	0.015867	0.002559	6.200723	0.0000
DLGDP(–1)	0.138025	0.031828	4.336528	0.0000
DLGEX	0.118029	0.016478	7.162716	0.0000
DLGEX(–1)	0.019204	0.016861	1.138958	0.2550
ECM(–1)	−0.011485	0.004285	−2.680569	0.0075
		Low-growth-rate group		
C	0.014031	0.002131	6.583929	0.0000
DLGDP(–1)	−0.009468	0.050624	−0.187027	0.8517
DLGEX	0.028926	0.016240	1.781108	0.0757
DLGEX(–1)	0.025200	0.015887	1.586145	0.1135
ECM(–1)	0.004643	0.003097	1.499181	0.1346

A negative and less than one error correction coefficient, and being statistically different from zero, imply that any deviation in government expenditure from the value predicted by the long-run relationship with potential output triggers a change in the opposite direction in government expenditure for the high-growth-rate group. The average value of the error correction coefficient of government expenditure, −0.013, implies an adjustment speed of less than about one year.

From these results, it can be concluded that government expenditures have had significant effects on GDP growth rates in the short run as well as in the long run in countries experiencing high growth rates (more than 5%) for 15 or more than 15 years.

The results for the middle-growth-rate group, presented in the second part of Table 4, show that the coefficient of DLGEX (−1) is positive, 0.019204, and the calculated probability is 0.2550. The latter result proves that the coefficient of DLGEX (−1) is not statistically different from zero, as the probability is not smaller than the 5% level of significance. The ECM (−1) coefficient is negative and less than one, −0.011485, and the probability of this coefficient is 0.0075. Because the probability is less than the 5% level of significance, the ECM (−1) is statistically different from zero.

A negative and less than one error correction coefficient, and being statistically different from zero, imply that any deviation in government expenditure from the value predicted by the long-run relationship with potential output triggers a change in the opposite direction in government expenditure for the middle-growth-rate group. The average value of the error correction coefficient of government expenditure, −0.011, implies an adjustment speed of less than about one year.

From these results, it can be concluded that government expenditures have had significant effects on GDP growth rates in the long run only, not having any effects in the short run in countries experiencing middle growth rates (more than 3%) for 15 or more years.

The results for the low-growth-rate group, as shown in the third part of Table 4, display a positive coefficient of DLGEX (−1), 0.025200, and the calculated probability is 0.1135. The latter result proves that the coefficient of DLGEX (−1) is not statistically different from zero because the probability is not smaller than the 5% level of significance. The ECM (−1) coefficient is not negative but it is less than one, 0.004643. The probability of this coefficient is 0.1346. Because the probability is not less than the 5% level of significance, the ECM (−1) is not statistically different from zero.

From these results, it can be concluded that government expenditures have not had significant effects on GDP growth rates in the long run only as well as in the short run in countries experiencing low growth rates (less than 3%) for 15 or more years.

These results imply explicitly that without government expenditures, economic growth rates higher than 5% cannot be achieved in the short run as well as in the long run. Furthermore, the results verify that the low economic growth rate links with low government expenditures. High government expenditures are essential for high economic growth rates.

5. CONCLUDING REMARKS

Estimates of the long- and short-term relations between government expenditure and potential output for high-, middle-, and low-growth-rate countries around the world have been given in this paper. The aim of this study was to determine what causes 5% or more economic growth over time and across countries.

Estimating a dynamic relationship between the two variables turns out to be possible using the PMG estimator [Pesaran et al. (1999)]. This procedure allows one to combine the accuracy of estimates by pooling data from cross-country dimensions, while, at the same time, limiting the risk of estimate inconsistencies associated with the possible heterogeneity of regression coefficients across countries. The PMG enacts a common long-term elasticity for all countries, while allowing country-specific short-term elasticities.

Results show that the assumption of a common long-run elasticity is the case for the data of all country groups and is below unity. Group country-specific short-term elasticities imply on the average a speed of adjustment of government expenditure to potential output of about one year.

This study assumed that government expenditure is the main determinant of high economic growth. Panel co-integration tests revealed that government expenditure and potential output in high-growth-rate countries are linked by a stable long-term relationship.

For middle-growth-rate countries, the long-run relationship between government expenditure and potential output was found to be statistically significant, whereas the short-run relationship was found to be statistically insignificant.

For low-economic-growth-rate countries, neither the long-run nor the short-run relationship between government expenditure and potential output was found to be statistically significant.

What is found shows explicitly that high economic growth is severely linked to government expenditure. Governments of countries that reached economic growth rates of 5% or more at least 15 times have spent more than countries that have achieved 3–5% economic growth rates, called "middle-growth-rate countries," or less than 3% economic growth rates, called "low-growth-rate countries."

As economic growth theories and empirical studies have established, economic growth is linked to many economic factors, such as aggregate demand in the short run, factors of production in between, and factors such as education and government economic policy in the long run. However, as this study shows, the achievement of economic growth rates higher than 5% is tied to government expenditures.

NOTES

1. 1-Panel ν-statistic:

$$T^2 N^{3/2} Z_{\hat{V}NT} = T^2 N^{3/2} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^2 \right)^{-1}$$

where T is the number of observations over time and N denotes the number of individuals in the panel.

2. 2-Panel ρ-statistic:

$$T\sqrt{N} Z_{\widehat{P}NT-1} = T\sqrt{N} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{e}_{i,t-1}^2 \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{it} - \hat{\lambda}_i \right)$$

3. 3-Panel PP-statistic:

$$Z_{tNT}^{*} = \left(\tilde{S}_{NT}^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^2 \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1} \Delta \hat{e}_{it}$$

REFERENCES

Abu-Bader, S. and A.S. Abu-Qarn (2003) Government expenditures, military spending and economic growth: Causality evidence from Egypt, Israel, and Syria. *Journal of Policy Modelling* 25, 567–583.

Ahsan, S., A. Kwan, and B. Sahni (1989) Causality between government consumption expenditures and national income: OECD countries. *Public Finance* 44(2), 204–224.

Akitoby, B. and M. Cinyabuguma (2004) Sources of Growth in the Democratic Republic of the Congo: A Cointegration Approach. IMF working paper 04/114, International Monetary Fund, Washington, DC.

Alesina, A. and R. Wacziarg (1998) Openness, country size, and government. *Journal of Public Economics* 49, 305–321.

Al-Faris, A.F. (2002) Public expenditure and economic growth in the Gulf Cooperation Council countries. *Applied Economics* 34(9), 1187–1193.

Ansari, M.I., D.V. Gordon, and C. Akuamoah (1997) Keynes versus Wagner: Public expenditure and national income for three African countries. *Applied Economics* 29, 543–550.

Arpaia, A. and A. Turrini (2008) Government Expenditure and Economic Growth in the EU: Long-Run Tendencies and Short-Term Adjustment, European Economy. Economic paper 300, Directorate General Economic and Monetary Affairs, European Commission.

Banerjee, A., M. Marcellino, and C. Osbat (2004) Some cautions on the use of panel methods for integrated series of macroeconomic data. *Econometrics Journal* 7, 322–340.

Banerjee, A., M. Marcellino, and C. Osbat (2005) Testing for PPP: Should we use panel methods? *Empirical Economics* 30(1), 77–91.

Barrell, R. and E.P. Davis (2004) Consumption, Financial and Real Wealth in the G-5. Discussion paper 232, National Institute of Economic and Social Research, London.

Barth, J., R. Keleher, and F. Russes (1990) The scale of government and economic activity. *Southern Business and Economic Journal* 13, 142–183.

Baumol, W. (1967) Macroeconomics of unbalanced growth: The anatomy of urban crisis. *American Economic Review* 57, 415–426.

Borcherding, T.E. (1985) The causes of government expenditure growth: A survey of the US evidence. *Journal of Public Economics* 28, 359–382.

Cameron, G., P. Gai, and K.Y. Tan (2006). Sovereign Risk in the Classical Gold Standard Era. Working paper 11, Australian National University—Centre for Applied Macroeconomic Analysis.

Chang, T. (2002) An econometric test for Wagner's Law for six countries based on cointegration and error correction modelling techniques. *Applied Economics* 34, 1157–1169.

Cheng, B.S. and T.W. Lai (1997) Government expenditures and economic growth in South Korea: A VAR approach. *Journal of Economic Development* 22(1), 11–24.

Conte, M.A. and A.F. Darrat (1988) Economic growth and the expanding public sector: A re-examination. *Review of Economics and Statistics* 70(2), 322–330.

D'Addio, A. and M. Mira D'Ercole (2005) Policies, institutions and fertility rates: A panel data analysis in OECD countries. *OECD Economic Studies* 41, 7–43.

Dandan, M.M. (2011) Government Expenditures and Economic Growth in Jordan. In *International Conference on Economics and Finance Research (IPEDR)*, Vol. 4, pp. 467–470. Singapore: IACSIT Press.

Ekanayake, E.M. (1999) Exports and economic growth in Asian developing countries: Cointegration and error-correction models. *Journal of Economic Development* 24(2), 43–56.

Engle, R.F. and C.W.J. Granger (1987) Cointegration and error correction: Representation, estimation, and testing. *Econometrica* 55, 251–276.

Funke, K. and C. Nickel (2006) Does Fiscal Policy Matter for the Trade Account? A Panel Cointegration Study. ECB working paper 620.

Ghali, K.H. (1999) Government size and economic growth: Evidence from a multivariate cointegration analysis. *Applied Economics* 31(8), 975–987.

Golinelli, R. and S. Pastorello (2002) Modelling the demand for M3 in the euro area. *European Journal of Finance* 8, 371–401.

Granger, C.W.J. (1986) Developments in the study of cointegrated economic variables. *Oxford Bulletin of Economics and Statistics* 48, 213–228.

Guellec, D. and B. van Pottelsberghe de la Potterie (2001) R&D and productivity growth: Panel data analysis of 16 OECD countries. *OECD Economic Studies* 33, 2001/II.

Hallerberg, M., R. Strauch, and J. Von Hagen (2001) The Use and Effectiveness of Budgetary Rules and Norms in EU Member States. Report prepared for the Dutch Ministry of Finance by the Institute of European Integration Studies.

Heller, P.S. and J. Diamond (1990) International Comparison of Government Expenditure Revisited: The Developing Countries 1975–1986. IMF occasional paper 69.

Holmes, J.M. and P.A. Hutton (1990) On the causal relationship between government expenditures and national income. *Review of Economics and Statistics* 72(1), 87–95.

Kolluri, B.R., M. J. Panik, and M.S. Wahab (2000) Government expenditure and economic growth: Evidence from G7 countries. *Applied Economics* 32, 1059–1068.

Landau, D. (1983) Government expenditure and economic growth: A cross-country study. *Southern Economic Journal* 49(3), 783–792.

Landau, D. (1986) Government and economic growth in the less developed countries: An empirical study for 1960–1980. *Economic Development and Cultural Change* 35(1), 35–75.

Loayza, N. and R. Ranciere (2006) Financial development, financial fragility, and growth. *Journal of Money, Credit and Banking* 38, 1051–1076.

Milesi-Ferretti, G.M., R. Perotti, and M. Rostagno (2002) Electoral systems and public spending. *Quarterly Journal of Economics* 117, 609–656.

Pedroni, P. (1995) Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis. Indiana University working paper in economics 95–013.

Pedroni, P. (1997) On the Role of Cross Sectional Dependency in Panel Unit Root and Panel Cointegration Exchange Rate Studies. Working paper, Indiana University.

Pedroni, P. (1999) Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics* 61(S1), 653–670.

Pedroni, P. (2000) Fully modified OLS for heterogeneous cointegrated panels. *Advances in Econometrics* 15, 93–130.

Peltzman, S. (1980) The growth of government. *Journal of Law and Economics* 23, 209–289.

Persson, T., G. Roland, and G.Tabellini (2000) Comparative politics and public finance. *Journal of Political Economy* 108, 1121–1161.

Persson, T. and G. Tabellini (1999) The size and scope of government: Comparative policies with rational politicians. *European Economic Review* 63, 699–735.

Pesaran, M.H., Y. Shin, and R. Smith (1999) Pooled mean group estimator of dynamic heterogeneous panels. *Journal of the American Statistical Association* 94, 621–634.

Ram, R. (1986) Government size and economic growth: A new framework and some evidence from cross-section and time-series data. *American Economic Review* 76(1), 191–203.

Ram, R. (1987) Wagner's hypothesis in time-series and cross-section perspectives: Evidence from "real" data for 115 countries. *Review of Economics and Statistics* 69, 194–204.

Ray, S. and I.A. Ray (2012) On the relationship between government's developmental expenditure and economic growth in India: A cointegration analysis. *Advances in Applied Economics and Finance* 1(2), 86–94.

Rodrik, D. (1998) Why do more open economies have bigger governments? *Journal of Political Economy* 151, 997–1032.

Singh, B. and B.S. Sahni (1984) Causality between public expenditure and national income. *Review of Economics and Statistics* 66(4), 630–644.

Tanzi, V. and L. Schuknecht (2000) *Public Spending in the 20th Century: A Global Perspective*. Cambridge, UK: Cambridge University Press.

Von Hagen, J. and I.J. Harden (1995) Budget processes and commitment to fiscal discipline. *European Economic Review* 39(3), 771–779.

Wahab, M. (2004) Economic growth and government expenditure: Evidence from a new test specification. *Applied Economics* 36, 2125–2135.

Wu, S.Y., J.H. Tang, and E.S. Lin (2010) The impact of government expenditure on economic growth: How sensitive to the level of development? *Journal of Policy Modelling* 32, 804–817.