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Revisiting the Government Revenue-Expenditure Nexus: Evidence from 15 OECD Countries Based on the Panel Data Approach*

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Abstract
This paper utilizes panel unit root, panel cointegration, and panel Granger causality test techniques to examine the inter-temporal relationship between government revenues and government expenditures in a panel of 15 OECD countries over the period 1992–2006. We find evidence of bidirectional causality between government revenues and government expenditures, supporting the fiscal synchronization hypothesis. The findings of this paper have important implications for fiscal policy decision-making in these 15 OECD countries after the signing of the EU Treaty in Maastricht on February 7, 1992.

1. Introduction

Understanding the relationship between government spending and taxation is important in evaluating the government's role in the distribution of resources. The purpose of this paper is to examine the inter-temporal relationship between government revenues and expenditures for a panel of 15 OECD countries over 1992––2006.

In the literature, the discussion of the causal link between government revenues and expenditures has resulted in several hypotheses. 1. The tax-and-spend hypothesis suggests that changes in revenues induce changes in expenditures. 2. The spend--and-tax hypothesis suggests the opposite in that changes in expenditures induce changes in revenues. 3. The fiscal synchronization hypothesis argues that revenues and expenditures decisions are made jointly. 4. Another view relates to the institutional separation of the expenditure and taxation decisions of government. This perspective suggests that government revenues and expenditures are independent of each other.

This paper intends to examine the relationship between government revenues and expenditures in a panel of 15 OECD countries. Tests on panel data are distinct in that they convey more information on the government revenue-expenditure relation through an increased number of observations from adding individual time series. Panel unit root and panel cointegration techniques are first applied to establish the long-run relation between government revenues and expenditures, and then panel error-correction models are employed to test the four hypotheses proposed in the literature. The results from our panel error-correction model indicate that a feedback

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(bidirectional causality) exists between government revenues and expenditures, supporting the fiscal synchronization hypothesis.

The rest of the paper is organized as follows. Section 2 describes the hypotheses and previous research. Section 3 discusses the methodology and data used in our study. Section 4 provides empirical results, while Section 5 offers some conclusions.

2. Hypotheses and Previous Research

Several hypotheses have been proposed to describe the inter-temporal relationship between government revenues and expenditures. First, the tax-and-spend hypothesis advanced by Friedman (1978) contends that changes in government revenues lead to changes in government expenditures. Friedman infers that tax increases will only lead to expenditure increases, resulting in an inability to reduce budget deficits. Curiously, Buchanan and Wagner (1978) argue for the opposite relationship: that decreased revenues lead to increased spending as consumers demand more programs. Empirically, this hypothesis is characterized by unidirectional causality running from government revenues to government expenditures.

Second, the spend-and-tax hypothesis proposes that changes in government expenditures lead to changes in government revenues. Peacock and Wiseman (1961) advocate that temporary increases in government expenditures due to economic and political crises can lead to permanent increases in government revenues from taxation, often called the "displacement effect." Empirically, the spend-and-tax hypothesis is characterized by unidirectional causality running from government spending to government taxes.

Third, Musgrave (1966) as well as Meltzer and Richard (1981) suggest that voters compare the marginal benefits and marginal costs of government services when formulating a decision in terms of the appropriate levels of government revenues and government expenditures. Thus, revenue and expenditure decisions are jointly determined under this fiscal synchronization hypothesis. Empirically, this hypothesis is characterized by contemporaneous feedback or bidirectional causality between government revenues and government expenditures.

A fourth hypothesis stated by Baghestani and McNown (1994) relates to the institutional separation of the expenditure and taxation decisions of government. This perspective suggests that revenues and expenditures are independent of each other. Empirically, this hypothesis is characterized by non-causality between government revenues and government expenditures.

Although the tax-and-spend, spend-and-tax, fiscal synchronization, and institutional separation hypotheses are easy to distinguish from one another, different studies on the same country result in different conclusions. The results from these empirical studies are sensitive to the sample period under examination, the degree of temporal aggregation, the inclusion of macroeconomic controls, and the choice of econometric methodology. In the case of the United States, Blackley (1986), Ram (1988), and Hoover and Sheffrin (1992) provide evidence to support the tax-and--spend hypothesis, while Anderson et al. (1986), Furstenberg et al. (1986), Jones and Joulfaian (1991), and Ross and Payne (1998) find support for the spend-and-

-tax hypothesis. Manage and Marlow (1986), Miller and Russek (1990), and Owoye (1995) suggest the fiscal synchronization hypothesis is valid for the United States, while Baghestani and McNown (1994) support the institutional separation hypothesis.

In a study of OECD countries, Joulfaian and Mookerjee (1991) find support for the tax-and-spend hypothesis in Italy and Canada; support for the spend-and-tax hypothesis in the United States, Japan, Germany, France, the United Kingdom, Austria, Finland, and Greece; and support for the fiscal synchronization hypothesis in Ireland.

In our paper, we apply the panel data approach to investigate possible changes in the behavior of fiscal authorities related to the signing of the EU Treaty in Maastricht on February 7, 1992, with the setting up of the fiscal convergence criteria that urged the EU countries to consolidate public finances in the run-up to the EMU on January 1, 1999, when most EU legacy currencies were replaced by the euro, and in the context of the SGP since then. The following section will elaborate on the methodology to be used in this study along with a description of the data.

3. Methodology and Data

The countries used in this study are as follows: Australia, Austria, Belgium, Canada, Demark, Finland, France, Germany, Ireland, Italy, Korea, the Netherlands, Switzerland, the United Kingdom, and the United States. The annual data are obtained from the OECD.Stat online database. General government revenues (Rev), general government expenditures (Exp), and GDP at constant prices (deflated at 2000 market prices) are collected over the period of 1992–2006.

Our econometric methodology proceeds in three stages. First, we implement the Fisher PP panel unit root test proposed by Maddala and Wu (1999) to ascertain the order of integration of the three variables. Second, conditional on finding that these variables are integrated of order one we test for panel cointegration using the approach suggested by Kao (1999). Third, we test for Granger causality between government revenues and government expenditures.

3.1. Fisher Phillips-Perron Panel Unit Root Tests

The Fisher Phillips-Perron (PP) test was proposed by Maddala and Wu (1999) and Choi (2001). In contrast to the IPS test, which is a parametric and asymptotic test, the PP test is a nonparametric and exact test. If we define π_i as the *p*-value from any individual unit root test for a cross-section, then under the null of a unit root for all cross-sections, we have the asymptotic result that

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(\pi_i) \rightarrow N(0,1) \tag{1}$$

Here, we define Φ^{-1} as the inverse of the standard normal cumulative distribution function. The Monte-Carlo studies of Maddala and Wu (1999) show that the Fisher PP test has a higher power than the IPS test.

3.2. Kao (Engle-Granger Based) Cointegration Tests

Once the existence of a panel unit root has been established, the issue arises whether there is a long-run equilibrium relationship between the variables under study. Given that each variable is integrated of order one, we test for panel cointegration using Kao's (1999) tests. Consider the following system of cointegrated regressions:

$$y_{it} = \alpha_i + x_{it}\beta + u_{it} \tag{2}$$

where $i = 1, \cdots\cdots, N, t = 1, \cdots\cdots, T$

$$x_{it} = x_{it-1} + \varepsilon_{it} \tag{3}$$

where α_i are individual constant terms, β is the slope parameter, u_{it} are stationary disturbance terms, and finally, by construction, y_{it} and x_{it} are integrated processes of order one for all i.[1]

The zero mean innovation vector $w_{it} = (u_{it},\ \varepsilon_{it})$ satisfies

$$\frac{1}{\sqrt{T}} \sum_{t=1}^{[Tr]} w_{it} \Rightarrow B_i(\Omega) \qquad \text{for all } i \text{ as } T \to \infty \tag{4}$$

where $[Tr]$ denotes the largest integer <= Tr and $B_i(\Omega)$ is a vector Brownian motion with asymptotic covariance Ω.

Under the assumptions that the process w_{it} is independent across i, i.e., $E(w_{it} w'_{js}) = 0$ for all $i \neq j$ and for all *t, s*, that x_{it} are not cointegrated, i.e., Ω_{22} is non--singular, and using Phillips and Moon's (1999) sequential limit theory, in which $T \to \infty$ first followed by $N \to \infty$, Kao (1999) derives two types of panel cointegration tests. The first is a Dickey-Fuller (DF) type test and the second is an Augmented Dickey-Fuller (ADF) type test. Both tests can be calculated from:

$$\hat{u}_{it} = \rho \hat{u}_{it-1} + \sum_{j=1}^{p} \varphi_j \Delta \hat{u}_{it-j} + v_{it} \tag{5}$$

where the residuals $\hat{u}_{it}$ are obtained from Equation (2). The following specification of null and alternative hypotheses is used:

$$H_0 : \rho = 1, \quad H_A : \rho < 1 \tag{6}$$

Kao (1999) proposes four DF-type statistics. The first two DF statistics are based on assuming strict exogeneity of the regressors with respect to the errors in the equation, while the remaining two allow for endogeneity of the regressors. In addition, Kao (1999) proposes an ADF test statistic. Finally the DF statistics, which allow for endogeneity, and the ADF statistic involve deriving some nuisance parameters from the long-run conditional variances Ω. The asymptotic distributions of all tests converge to a standard normal distribution $N(0,1)$ as $T \to \infty$ and $N \to \infty$.

Based on Gutierrez's paper (2003), Kao's panel tests have higher (lower) power than Pedroni's tests when a small-T (high-T) number of observations are included in a homogeneous panel.

[1] Indeed, more regressors can be included in Eq. (2) as well as trend variables.

3.3. Panel Granger Causality Tests

Given that the series under investigation are cointegrated, Equations (7) and (8) were estimated using a panel-based vector error-correction model (VECM) with a dynamic error correction term based on Holtz-Eakin et al. (1989). The main purpose of the exercise is to establish the causal linkages between government revenues (Rev) and government expenditures (Exp) with GDP as a control variable.[2] This means that the traditional panel VAR model is augmented with a one period lagged error correction term, which is obtained from the cointegrated model. The panel Granger causality test will be based on the following equations:

$$\Delta \mathrm{Re}v_{it} = \pi_{1g} + \sum_{p} \pi_{11ip} \Delta \mathrm{Re}v_{it-p} + \sum_{p} \pi_{12ip} \Delta Exp_{it-p} + \sum_{p} \pi_{13ip} \Delta GDP_{it-p} + \psi_{1i} ECT_{it-1} \qquad (7)$$

$$\Delta Exp_{it} = \pi_{2g} + \sum_{p} \pi_{21ip} \Delta Exp_{it-p} + \sum_{p} \pi_{22ip} \Delta \mathrm{Re}v_{it-p} + \sum_{p} \pi_{23ip} \Delta GDP_{it-p} + \psi_{2i} ECT_{it-1} \qquad (8)$$

Here, ECT_{it}[3] are the estimated residuals ε_{it} (the error correction term) from the long-run model in Equation (2), $\psi_{i,i} ECT_{it}$ reflect the long-run equilibrium relationship among the variables, Δ denotes the first difference operator, and p denotes the lag length selected. From the system, the panel Granger-causality tests are examined by testing whether all the coefficients of ΔExp_{it-p} or $\Delta \mathrm{Re}v_{it-p}$ are statistically different from zero as a group based on a standard F-test and/or the $\psi_{i,i}$ coefficient of the error correction is also significant (denoting long-run causation). Since the Granger-causality tests are very sensitive to the lag length selection, in this paper the lag lengths are determined using Hsiao's (1979) sequential procedure, which is based on the Granger definition of causality and Akaike's (1974) minimum final prediction error (FPE) criterion. This procedure is known as the stepwise Granger-causality technique, which provides a statistical criterion for choosing the optimum lag length using past information. Thornton and Batten (1985) have found Hsiao's method to be superior to both arbitrary lag length selection and several systematic procedures for determining lag length.

4. Empirical Results

4.1 Result of Fisher PP Panel Unit Root Tests

Summary statistics for government revenues, expenditures, and GDP for the 15 OECD countries in our sample over the period 1992–2006 are not reported here (due to space constraints) but are available upon request.

[2] We include GDP as a control variable in the model like Anderson et al. (1986), von Furstenberg et al. (1986), Baghestani and McNown (1994), and Ross and Payne (1998). This approach allows us to distinguish between the direct causality relation between revenues and expenditures and the indirect causality effects via GDP. The majority of the other papers that employ a bivariate framework will suffer from the ever-present econometric problem of the third missing variable (Granger and Newbold, 1986), resulting in potentially inaccurate results and conclusions.

[3] ECT_{it} in Eq. (7) and Eq. (8) are the estimated residuals from Eq. (2), where

$\mathrm{Re}v_{it} = \alpha_{1i} + \beta_{11i} Exp_{it} + \beta_{12i} GDP_{it} + \varepsilon_{it}$ and $Exp_{it} = \alpha_{2i} + \beta_{21i} \mathrm{Re}v_{it} + \beta_{22i} GDP_{it} + \varepsilon_{it}$.

Table 1 Results of Fisher PP Panel Unit Root Tests

General Government Revenue			General Government Expenditure			GDP		
	No trend	Trend		No trend	Trend		No trend	Trend
Rev_{it}	4.9855	2.2850	Exp_{it}	6.3657	-0.7805	GDP_{it}	8.4222	-1.5949
	(1.0000)	(0.9888)		(1.0000)	(0.2176)		(1.0000)	(0.0554)
ΔRev_{it}	-5.8096***	-4.5131***	ΔExp_{it}	-8.6528***	-9.5590***	ΔGDP_{it}	-7.8503***	-5.4694***
	(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.0000)	(0.0000)

Note : *** and ** reject H_0 *:* Unit Root at 1% and 5% level of significance.

Table 2 Result of Kao's Residual Cointegration Test

	t-Statistic	Prob.
ADF	-15.9829***	(0.0000)

Note: *** and ** reject H_0 : No Cointegration at 1% and 5% level of significance.

A three-stage procedure was followed to test the direction of the causality. In the first stage the order of integration was tested using the Fisher PP panel unit root test. *Table 1* shows the results of the panel unit root tests. The Fisher PP statistics for the levels of government revenues, government expenditures, and GDP do not reject the null hypothesis of a unit root. However, when we take the first difference of each of the variables, the Fisher PP statistics are higher than their respective critical values at the 1% level. Therefore, we conclude that $[\mathrm{Re}v_{it}, Exp_{it}, GDP_{it}]$ are each integrated of order one or I(1). In the next stage, we will test whether there is a long-run equilibrium relationship among these three variables.

4.2 Result of Kao's Cointegration Tests

The second stage involves testing for the existence of a long-run equilibrium relationship among government revenues, government expenditures, and GDP within a trivariate framework. Based on Kao's (1999) ADF test statistics reported in *Table 2*, we find that government revenues, government expenditures, and GDP are cointegrated within the panel of these 15 OECD countries at a lag length of 2.

4.3 Result of Panel Granger Causality Tests

The existence of a cointegrating relationship suggests that there must be Granger causality in at least one direction. *Table 3* examines short-run, long-run, and joint Granger causality within the panel-based vector error-correction model. The F-statistics on the independent variables in each of the two equations (7 and 8) indicate statistical significance of the short-run, long-run, and joint causal effects at the 1% level. This finding supports the fiscal synchronization hypothesis, which argues that revenue and expenditure decisions are made jointly. The results show that there is bidirectional Granger causality between government revenues and government expenditures during the period of 1992–2006 under study. The findings of this paper have important implications for fiscal policy decision-making in these OECD countries after the signing of the EU Treaty in Maastricht on February 7, 1992. This outcome suggests that fiscal policymakers in these 15 OECD countries do not make spending (tax)

Table 3 Results for Panel Causality Tests (Wald Tests

Dependent Variable	Source of Causation (Independent Variables)				
	Short Run		Long Run	Joint (Short Run and Long Run)	
	$\Delta Rev_{it\text{-}1\&it\text{-}2}$	$\Delta Exp_{it\text{-}1\&it\text{-}2}$	$ECT_{it\text{-}1}$	$\Delta Rev_{it\text{-}1\&it\text{-}2}$ & $ECT_{it\text{-}1}$	$\Delta Exp_{it\text{-}1\&it\text{-}2}$ & $ECT_{it\text{-}1}$
ΔRev_{it}	127.5222***	62.0437***	77.5251***	133.0616***	85.1133***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ΔExp_{it}	17.9898***	32.1436***	38.0876***	62.7206***	87.3005***
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note : X^2-statistics (*p*-value) are given in the table and *** stands for 1% level significance.

decisions in isolation from tax (spending) decisions. The joint determination of revenues and expenditures is appealing as long as it effectively restrains the budget deficit. This means that efforts to enhance sources of revenue should be accompanied by reductions in spending for those OECD countries with budget deficits.

5. Conclusions

Using a three-stage procedure, comprising the Fisher PP panel unit root test, the Kao cointegration test, and the panel Granger causality test, we find a bidirectional causal relation between government revenues and government expenditures, which lends support to the fiscal synchronization hypothesis in these OECD countries over 1992–2006. This outcome suggests that fiscal policymakers in these 15 OECD countries should set revenues and expenditures simultaneously. Countries with budget deficits should raise revenues and cut spending simultaneously in order to control their budget deficits.

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