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► **To cite this version:**

George A. Vamvoukas. Panel Data Modeling and the Tax-Spend Controversy in the Euro Zone. *Applied Economics*, 2011, pp.1. <10.1080/00036846.2011.587777>. <hal-00716629>

**HAL Id: hal-00716629**

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Submitted on 11 Jul 2012

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## Panel Data Modeling and the Tax-Spend Controversy in the Euro Zone

Journal:	<i>Applied Economics</i>
Manuscript ID:	APE-2009-0272.R1
Journal Selection:	Applied Economics
Date Submitted by the Author:	20-Apr-2011
Complete List of Authors:	Vamvoukas, George; Athens University of Economics and Business, Business Administration
JEL Code:	E62 - Fiscal Policy Public Expenditures, Investment, and Finance Taxation < E6 - Macro Policy Formation, Macro Public Finance, Macro Policy, etc < E - Macroeconomics and Monetary Economics, H11 - Structure, Scope, and Performance of Government < H1 - Structure and Scope of Government < H - Public Economics
Keywords:	tax-spend controversy, Panel unit roots tests, panel GTSLS and GMM techniques, fiscal synchronization

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55 **Acknowledgements**

56 I wish to thank an anonymous referee for useful comments and suggestions.

57 The usual disclaimer applies.  
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## Abstract

This paper attempts to differentiate between the debatable tax and spend, spend and tax, fiscal synchronization and institutional separation hypotheses in order to explore empirically the interplay between public expenditures and public revenues in EMU member states. For this purpose, panel data models are derived to test the validity of the four hypotheses in EMU countries. A notable characteristic of the present paper is that the four hypotheses are tested by dividing EMU countries into various subgroups and using disaggregated data for government expenditures and revenues. Seeking for the robustness of the empirical evidence, the panel data methods of GTOLS and GMM are accordingly applied to identify the relationship between public outlays and taxation receipts. GTOLS and GMM results strongly support the fiscal synchronization hypothesis implying that budget decision-making is significantly influenced by both government expenditures and revenues components.

JEL Classification: E62

## I. Introduction

Government expenditure and government revenue are two of the major instruments of economic policy. In recent years, the relation between public outlays and public receipts has been one of the fundamental issues of applied economics. Four generations of theoretical models in relevant literature can be distinguished. First, the spend-tax hypothesis indicates that governments make expenditure decisions first and then adjust public revenues in order to accommodate these expenditures. Second, the tax-spend hypothesis argues that governments increase tax revenues ahead of engaging in additional outlays. Third, the fiscal synchronization hypothesis states that governments adjust expenditures and revenues simultaneously. Fourth, the institutional separation hypothesis suggests that government outlays and receipts vary independently of each other. The long-run increase of government deficit and public debt in various countries since 1970, has initiated a multitude of empirical analyses focusing on the links between expenditures and revenues and the consequences of debt financing.

This paper reexamines the tax-spend controversy by employing panel data from EMU (European Monetary Union) countries. In EMU most of the state governments have been confronted with severe budgetary imbalances in recent years. Policymakers are often faced with the question of either changing government outlays or government revenues to restore fiscal balance. Given the requirement of fiscal discipline, it is very interesting to examine the relationship between revenues and expenditures at the EMU level. Bearing in mind that a considerable number of EMU countries face serious macroeconomic imbalances due to large budget deficits, the links between government outlays and receipts constitute an important objective of empirical research seeking to establish the future path of budget deficits.

This paper's objective is to expand the existing literature on the tax-spend controversy in three aspects. First, unlike previous studies, we apply modern advances in panel data analysis to test the validity of the four hypotheses. EMU countries have been chosen with a view to encompass fiscal systems which have common economic and political policies. To the best of our knowledge, no preceding study has used panel data analysis to explore the linkage between government expenditures and tax revenues in the case of EMU. Until now, most empirical studies in the field have used time series techniques, based on cointegration procedures, ECM (error-correction

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4 modeling) and Granger causality tests to investigate the relationship between  
5 expenditures and revenues<sup>1</sup>. The second notable feature of the present paper is that  
6 the four hypotheses are investigated by subdividing government outlays and receipts  
7 into various components. The lack of recent empirical studies is that they do not  
8 examine the rationale of the four hypotheses by separating expenditures and revenues  
9 into different parts. The third goal of our study is to test the robustness of the results  
10 by dividing EMU countries into various subgroups. The four hypotheses are checked by  
11 applying GMM method and dividing EMU member states into various groups according  
12 to the level of GDP at Purchasing Power Parity(PPP) standards. It should be mentioned  
13 that EMU includes large countries such as Germany, France and Italy as well as small  
14 countries such as Luxemburg, Greece, Ireland and Portugal among others. Thus, the  
15 acceptability of a theory becomes more significant if this theory is empirically tested in  
16 countries of different economic magnitude and structures.

17  
18 The rest of the paper is organized in the following way. Section 2 briefly describes the  
19 four theoretical issues and the most recent empirical literature. Section 3 presents the  
20 methodology used in the empirical analysis. Section 4 describes the data set, reports  
21 the econometric results and provides a sensitivity analysis to test the robustness of the  
22 empirical findings. The last section discusses the policy implications of the results and  
23 concludes the study.

## 34 35 36 37 38 39 **II. Hypotheses and Evidence**

40 Different hypotheses can be formulated to examine the links between expenditures  
41 and revenues. The spend-tax hypothesis postulates that governments spend first and  
42 then raise revenues to finance those expenditures. Peacock and Wiseman (1961, 1979)  
43 are the leading figures of this hypothesis. They support that the path of public outlays  
44 is mainly influenced by the incidence of exogenous events such as wars, unstable  
45 political conditions, etc. These structural breaks may shift government expenditures to  
46 higher levels causing the expansion of tax receipts. Again, according to Peacock and  
47 Wiseman (1979) these large scale exogenous disturbances are determined by  
48 demographic, social, financial, technological, political-administrative and material  
49 factors<sup>2</sup>. The spend-tax hypothesis indicates that politicians increasing government  
50 expenditures more than tax revenues create budget deficits. Policymakers, trying to  
51 balance the budget, should keep expenditures within revenue limits. In this way,  
52 budgetary development dynamics are characterized by public spending, assigning to  
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4 government receipts a rather accommodating role. Von Furstenberg, et al. (1986),  
5 Vamvoukas (1997b), Dahlberg and Johansson (1998), Garcia and Henin (1999), Islam  
6 (2001), and Zapf and Payne (2009) found results to be consistent with the spend-tax  
7 hypothesis<sup>3</sup>.  
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11 The tax-spend hypothesis maintains the reverse relation, supporting that movements  
12 in public revenues generate changes in public expenditures. Friedman (1972, 1978),  
13 Buchanan and Wagner (1977, 1978) are the main proponents of this theory. The  
14 change of revenues rather than of expenditures is the one that determines the  
15 budgetary decision-making process. Policymakers regard revenues more autonomous  
16 than expenditures, so that the latter should be adjusted to the former in applying fiscal  
17 policy. As a consequence, implementing fiscal policy to reduce budget deficits,  
18 governments should try to increase first of all tax revenues. Considering that  
19 governments attempt to finance current deficits through future tax increases, they  
20 expect to remain within their intertemporal budget restraints by means of revenue  
21 adjustments.  
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25 Buchanan and Wagner (1978), suggesting one set of proposals for fiscal and monetary  
26 reform, support that a balanced budget should be one of the fundamental elements in  
27 almost any acceptable constitutional framework. However, a balanced budget must be  
28 based on the principle that tax revenues must determine the growth of government  
29 spending. According to Friedman (1978), there should be definite limits on government  
30 outlays. The benefits to small groups which cause the growth of public expenditure  
31 often hurt general interest. He also regards tax limitation amendments as a stopgap  
32 measure to reduce government expenditures, and thus, budget deficits. In Friedman's  
33 view, tax increases only produce the expansion of government spending and do not  
34 reduce budget deficit. Taking into account the validity of the tax-spend hypothesis, he  
35 suggests that tax cuts stop growth in government expenditures leading to the  
36 reduction of budget deficits. Bohm (1991), Darrat (1998), Chang et al. (2002), Narayan  
37 and Narayan (2006), Carneiro (2007), and Payne et al.(2008) have argued in favor of  
38 the tax-spend hypothesis.  
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42 In the outline of fiscal synchronization hypothesis, expenditures and revenues are  
43 adjusted simultaneously. Governments simultaneously determine an optimal package  
44 of expenditure programs along with the revenues necessary to finance expenditures.  
45 Albeit expenditures and revenues should move together, different goals of fiscal policy  
46 can bring the budget into transitory deficit or surplus. Authors such as Musgrave  
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(1966), Meltzer and Richard (1981) are the distinguished supporters of this hypothesis. In empirical perspective, the fiscal synchronization theory is considered by contemporaneous feedback between outlays and tax receipts. Governments, looking for short-run macroeconomic stability and high long-term growth rates, choose fiscal policy measures with respect to appropriate levels of outlays and revenues. Studies by Miller and Russek (1990), Baffes and Shah (1994), Hasan and Sukar (1995), Owoye (1995), Li (2001), Kollias and Paleologou (2006), report findings in favor of the fiscal synchronization hypothesis.

The fourth alternative argument, the institutional separation hypothesis, states that government decisions to tax are independent from decisions to spend. According to Wildavsky (1975) and Cameron (1978), government outlays and revenues follow in the long run an independent path. Increased public expenditures do not necessarily explain why people are willing to pay higher taxes. In this way, the public economy expands in conditions under which government outlays do not go along with tax revenues. Ram (1988), Hoover and Sheffrin (1992), Baghestani and McNown (1994), and Koren and Stiassny (1998) have presented results consistent with the institutional separation hypothesis.

### III. Methodology

Before engaging in the estimation of panel models, it is necessary to test the individual variables for stationarity. It is essential to note that various overidentifying restriction procedures developed by Sargan (1958), Hansen (1982), and others assume that regressors and instruments are nonstationary following a random walk process<sup>4</sup>. Consequently the first step of our empirical analysis is to test each variable under study for a unit root. After testing the individual variables for a unit root, the next stage of our methodology is to estimate various panel models. The category of models that can be estimated by employing different panel estimation techniques may be depicted by the following specification:

$$Y_{it} = \alpha + X'_{it} b_{it} + \delta_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where  $i = 1, 2, \dots, N$ , and  $t = 1, 2, \dots, T$ . The N cross sectional countries are observed over T time periods.  $\alpha$  reflects the overall constant in the panel model;  $\delta_i$  and  $\gamma_t$  show cross section or period specific effects which can be fixed or random;  $Y_{it}$  represents the dependent variable;  $X_{it}$  is a k-vector of explanatory variables; and

$\varepsilon_{it}$  are the disturbance terms. The vector  $b$  may be divided into sets of common, period specific, and cross section specific regressor coefficients, allowing for  $b$  coefficients to differ across periods or cross sections. Estimating panel model 1, the researcher may create interaction variables to generate variations for  $b$  coefficients across periods or cross section countries.

In equation 1 the terms  $\delta_i$  and  $\gamma_t$  may be handled employing fixed or random effects techniques. The fixed effects formulations use orthogonal projections which involve a proper approach to remove cross section means from the dependent variable and exogenous regressors. Given that in the estimation procedure instrumental variables are formulated with fixed effects, orthogonal projections are also applied to instruments. The random effects approaches suppose that the terms  $\delta$  and  $\gamma$  are realizations of independent random variables with zero mean and finite variance and the effects are not correlated with the idiosyncratic residuals  $\widehat{\varepsilon}_{it}$ . The covariance matrix of the composite error  $v_{it}$  ( $v_{it} = \delta_t + \gamma_t + \varepsilon_{it}$ ) can be calculated by the Wansbeek-Kapteyn procedure (1989). In large samples the Wansbeek-Kapteyn estimator of the component variances,  $Var(v_{it})$ , leads to similar results compared with Swamy-Arora and Wallace-Hussain estimators<sup>5</sup>. Having estimated the component variances, the next step is to use GTOLS (generalized two-stage least squares) to estimate the random effects model. The purpose of this technique is to GLS transform the dependent and regressor data included in the instruments prior to estimation. GTOLS methodology allows for various structures of correlation between the residuals. Period specific heteroskedasticity, contemporaneous covariances and between period covariances represent four basic specifications that permit a different pattern of residual variance.

Taking into account equation 1, GMM panel estimators may reflect moments of the following type:

$$f(b) = \sum_{i=1}^M Z_i' \varepsilon_i(b) \quad (2)$$

where  $Z_i$  represents a  $T_i \times p$  matrix of instruments for cross-section  $i$ , and

$$\varepsilon_i(b) = [Y_i - g(X_{it}, b)] \quad (3)$$

GMM panel estimators minimize the quadratic form,

$$g(b) = \Phi(b)' H \Phi(b) \quad (4)$$

where H is a  $p \times p$  weighting matrix. After estimating the coefficient vector  $\hat{b}$ , the coefficient covariance matrix is calculated as follows:

$$V(\hat{b}) = (\Phi' H \Phi)^{-1} (\Phi' H \Lambda H \Phi) (\Phi' H \Phi)^{-1} \quad (5)$$

where  $\Lambda$  is an estimator of  $E[\Phi_i(b)\Phi_i(b')] = E[Z_i' \varepsilon_i(b) \varepsilon_i(b') Z_i]$  and  $\Phi$  is a derivative matrix with dimensions  $T_i \times \kappa$ . In case where  $g(X_{it}, b) = X_{it}' b$ , the coefficient estimator  $\hat{b}$  and its variance estimator may be specified as

$$\hat{b} = (M'_{ZX} H M_{ZX})^{-1} (M'_{ZX} H M_{ZY}) \quad (6)$$

and

$$\text{Var}(\hat{b}) = (M'_{ZX} H M_{ZX})^{-1} (M'_{ZX} H \Lambda H M_{ZX}) (M'_{ZX} H M_{ZX})^{-1} \quad (7)$$

where  $M'_{ZX} = \left( \sum_{i=1}^M Z_i' X_i \right)'$  and  $M_{ZY} = \left( \sum_{i=1}^M Z_i' Y_i \right)'$ . GMM estimation procedure is based

upon three main steps: (i) determining the instruments Z, (ii) collecting the weighting matrix H, and (iii) specifying an estimator for  $\Lambda$ . In the GMM background, the researcher may formulate a wide range of specifications for H and  $\Lambda$ . Efficient GMM estimators can be computed by employing dynamic panel data techniques. To introduce dynamic panel data, consider the following specification:

$$Y_{it} = \sum_{j=1}^p \pi_j Y_{it-j} + X_{it}' b + \delta_i + \varepsilon_{it} \quad (8)$$

First differencing 8 produces:

$$\Delta Y_{it} = \sum_{j=1}^p \pi_j \Delta Y_{it-j} + \Delta X_{it}' b + \Delta \varepsilon_{it} \quad (9)$$

The individual effect  $\delta_i$  has been eliminated by first-differencing. Specification 9 depicts a dynamic panel model which may be estimated employing GMM methods. In GMM model 9 the period-specific instruments are related to lagged values of the dependent and predetermined variables. In the estimation procedure, along with the group of strictly exogenous variables, various instruments for each period will be used for pursuing to produce efficient GMM coefficients. Given that in model 9 the disturbances are not autocorrelated, the weighting matrix H is defined as

$$H = \left( M^{-1} \sum_{i=1}^M Z_i' \Xi Z_i \right)^{-1} \quad (10)$$

where  $Z_i$  includes a group of strictly exogenous and predetermined instruments and the matrix  $\Xi$  is employed in the two-step Arellano-Bond estimator.

#### IV. Data and Results

##### *Data*

The empirical analysis employs a balanced annual panel for dates from 1970 to 2006 for 12 EMU member countries, including Belgium, Germany, Ireland, Greece, Spain, France, Italy, Luxemburg, Netherlands, Austria, Portugal and Finland. Cyprus, Estonia, Malta, Slovakia and Slovenia were excluded from the analysis as the data set for these five countries was incomplete. It was indeed necessary to carry out the estimation procedure with the same data set of EMU countries in order to derive reliable results. The data set originates from the Eurostat database of the European Commission. The choice of the sample period was dictated by the fact that the data set for all the variables is available on a comparable basis for the 12 EMU member states. Panel data techniques use data on total expenditure of general government (G), public final consumption expenditure (GC), gross fixed capital formation (GF), other government expenditure (GO), total revenue of general government (R), indirect taxes (RI), direct taxes (RD), other government revenue (RO) and the rate of unemployment (U)<sup>6</sup>. The variables G, GC, GF, GO, R, RI, RD, and RO are in real terms the nominal data deflated by the GDP at current prices. U is introduced in the empirical analysis as a control variable in order to explore the pattern of relation between expenditures and revenues. Actually government outlays and receipts appear to be sensitive to unemployment rate changes.

##### *Panel unit root tests*

The estimation of various panel models, using such techniques as OLS, GLS, GTOLS and GMM, is based on the assumption that the variables G, GC, GF, GO, R, RI, RD, RO and U follow a random walk. IPS (Im, Pesaran and Shin) unit panel root tests is used to check the plausibility of this assumption<sup>7</sup>. Taking into account that our panel data analysis aims at evaluating the robustness of the results, EMU member countries are divided into various subgroups. In this way, IPS tests are performed for groups A, B and C which contain different EMU member states. In our testing procedure, IPS is the

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$W_{t-bar}$  statistic which explicitly takes into account the underlying ADF orders in calculating the mean and the variance adjustment factors<sup>8</sup>.

All unit root tests were carried out employing regressions with individual constants and trends at level forms. For the first order differences, only constant terms were included in the regressions, since differencing usually removed the deterministic terms. Lag length has been set to one year. It is clear that all the individual variables are found to be nonstationary<sup>9</sup>. The null hypothesis of a unit root is not rejected even at the 10% significance level. Moreover, when the IPS tests are performed to the first order differences, the null hypothesis of nonstationarity is easily rejected suggesting that each variable is I(1). It should be noted that conducting IPS tests across various intervals such as 1970-1991, 1992-2006 and 1998-2006, the results indicate that the individual variables are characterized as an integrated process of order one I(1) (details of the IPS tests can be obtained upon request).

#### *Panel GTOLS results*

Pooled panel models are estimated for every dependent variable. To evaluate the validity of the four hypotheses, we consider the GTOLS (generalized two stage least squares) panel estimation. The data set covers the period 1970-2006 and consists of three alternative groups of EMU countries. The dependent variable is either G or R and the regressors include GC, GF, GO, RI, RD, RO and U. Accounting for individual and period effects, we estimate fixed and random effects specifications. A constant term is added to the common part of the specification. In the fixed effects formulation, the fixed effects estimates are relative to the constant term to ensure that the effects add up to zero. In the panel estimation procedure we specify settings for White cross-section. White cross-section allows for estimating a GTOLS formulation correcting for both contemporaneous correlation and cross-sectional heteroskedasticity. Note that White cross-section estimation is a technique for computing coefficient covariances, and thus, calculating coefficient standard errors.

The results for the fixed effects specifications are reported in Table 1. All the specifications use White cross-section standard errors to permit for general contemporaneous correlation between the country residuals. The cross-sectional selection is adopted to show that covariances are allowed across cross-sectional units contemporaneously. White coefficient covariance for fixed effects estimates are computed by using the Arellano (1987) technique which is robust to arbitrary within

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4 cross-sectional residual correlation. The reported  $R^2$  and F-statistics describe the  
5 explanatory power of the entire model. WF is the Wald F-statistics which is used to test  
6 the original idiosyncratic errors for autocorrelation. The GTOLS fixed effects results  
7 suggest that there is an interplay between  $G_{it}$  and  $R_{it}$  in groups A, B and C, indicating  
8 the validity of the fiscal synchronization hypothesis. The signs on G and R are positive  
9 and highly significant. The independent variables  $G_{it}$  and  $R_{it}$  are statistically significant  
10 at even the 1% level. The high values of  $R^2$  and F-statistics suggest that the estimated  
11 models have excellent goodness of fit. The formal WF-statistics lead to the rejection of  
12 the null hypothesis that the original idiosyncratic errors are autocorrelated.

13  
14 The next stage of our empirical analysis is to reestimate the models by using the two  
15 way random effects specification. All the specifications are estimated by employing  
16 GTOLS. The Wansbeek-Kapteyn (1989) approach of calculating the estimates of  
17 random component variances is applied in the empirical procedure. In panel data  
18 modeling employing random effects estimation, it is assumed that the random effects  
19 are not correlated with the explanatory variables. In all the random effects  
20 specifications, the null hypothesis that the random effects are uncorrelated with the  
21 explanatory variables is tested by using a Hausman (1978) test. The Hausman statistic  
22 follows asymptotically the Chi-square with k degrees of freedom equal to the number  
23 of estimated coefficients.

24  
25 In all three groups of EMU countries the estimates of the random effects are in line  
26 with the fiscal synchronization theory. Both G and R have positive and highly significant  
27 signs, showing that government revenues and government expenditures affect one  
28 another. The HAU statistics provide evidence that the null hypothesis is not rejected,  
29 so that there is no misspecification in any estimated random effects model. Overall, in  
30 both fixed and random effects estimation, panel GTOLS results, for group A including  
31 twelve EMU countries as well as for groups B and C containing three and nine EMU  
32 member states respectively, lead to the validity of the fiscal synchronization  
33 hypothesis.

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35 To evaluate the results derived in Table 1 concerning the acceptability of the fiscal  
36 synchronization view, we continue our empirical analysis by adopting two approaches:  
37 (i) the aggregate variables G and R are decomposed into GC, GF and GO, and RI, RD  
38 and RO, respectively, in order to determine the components which exert more  
39 influence on the interplay between general government receipts and general  
40 government outlays and (ii) the unemployment rate (U) is introduced in the estimation  
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procedure, because  $U$  reflects total economic activity affecting the behavior of both expenditure and revenue. In Tables 2 and 3, pooled panel regressions are estimated for every dependent variable for the three groups of EMU member states. To test the validity of the four hypotheses we employ the GTSLS estimator.

Applying GTSLS we introduce in the instrument list the constant term and lags of the explanatory variables. The goodness of fit as measured by  $R^2$  and F-statistics is relatively satisfactory in all the specifications. The WF-statistics reveal no serious autocorrelation in the idiosyncratic errors. The main conclusion derived from the results of Tables 2 and 3 is that the categories GC, GF, GO, and RI, RD and RO have significant effects on R and G respectively, pointing out the robustness of GTSLS estimates. The estimated coefficients are statistically significant for the random and fixed effects approaches. As it may be seen, the empirical evidence in favor of the fiscal synchronization view does not change when separating between small and large EMU economies. This result shows that the interplay between expenditures and revenues is driven by both the small and large EMU member states. It is interesting to note that that estimating GTSLS models using various time frames such as 1970-1991, 1992-2006 and 1998-2006, the evidence indicates the acceptance of the fiscal synchronization hypothesis (details of the panel GTSLS results can be obtained upon request).

#### *Robustness checking*

In this part of our econometric analysis, we present alternative estimates to check the robustness of the results displayed in the previous subsection. In a methodological viewpoint, the robustness checking is based on two points. First, following an anonymous referee's suggestion for this journal to test the four hypotheses by dividing EMU countries into various subgroups according to the GDP, we distinguish groups B and C considering GDP at Purchasing Power Parities (PPPs) standards<sup>10</sup>. Assuming that the average GDP of EMU countries equals index 100, groups B and C contain respectively those EMU member states whose average current GDP at PPP standards over 1970-2006 was below or above 100. Consequently, group B includes Greece, Ireland, Italy, Portugal and Spain, namely, five EMU countries with average GDP at PPP standards below 100 during the entire period 1970-2006. Group C incorporates seven EMU member states which had average GDP at PPP standards higher than 100 over 1970-2006, namely, Austria, Belgium, Finland, France, Germany, Luxembourg and the Netherlands. Second, our empirical analysis will employ the first-difference

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GMM method developed by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998) among others. The GMM technique consists of an instrumental variables estimation of equation 9. In our case, the Arellano-Bond 2-step estimator is used to specify the GMM weighting and coefficient covariance computation choices. The Arellano-Bond 2-step estimator allows for computing white period robust standard errors. The right side of dynamic panel model 9 includes lags of explanatory variables expressed in first differences. The weighting matrix is selected in order to permit the GMM estimates to be robust to possible autocorrelation and heteroskedasticity of unknown type in the disturbances. The selected instruments need to be predetermined at the time of fiscal policy decisions. For exactly this purpose, the first two lags of explanatory variables are included in the instruments set. We perform an F-test to evaluate the null hypothesis that the lagged explanatory variables are redundant. Another important property of the instrument list is its exogeneity and uncorrelatedness with respect to the error terms. This property is evaluated by calculating a standard J-test for the validity of the over-identifying restrictions. The LM test statistics are used to examine the GMM model for first-and-second order serial correlation.

GMM results reported in Part I of Table 4 indicate a significant expenditure-and revenue-dominance. The high t-values on  $\Delta R_{it}$ ,  $\Delta G_{it}$ ,  $\Delta R_{it-1}$  and  $\Delta G_{it-1}$  give strong support to the fiscal synchronization hypothesis, reflecting the dominant role of government expenditures and revenues in the application of fiscal policy. Since the number of instruments is larger than that of explanatory variables, the J-test, known as the Sargan test of over-identifying restrictions, is used to test the null of  $E(\varepsilon_{it} / Z_{it}) = 0$ . The J-test follows asymptotically the Chi-squared distribution. The values of J-test statistics show that the null hypothesis is not rejected leading to the conclusion that the instrumental variables are exogenous, and thus, appropriately chosen. F-tests are performed to test the joint significance that  $\Delta R_{it-1}$ ,  $\Delta G_{it-1}$  and  $\Delta U_{it-1}$  are redundant in the equivalent GMM equations. The high values of F-statistics lead us to reject the null hypothesis suggesting that  $\Delta R_{it-1}$ ,  $\Delta G_{it-1}$  and  $\Delta U_{it-1}$  are not redundant in the unrestricted GMM specifications. The values of AR(1) and AR(2) are in general satisfactory, indicating that serial correlation is not a problem in the empirical analysis.

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4 To further evaluate the robustness of the results we re-estimate GMM models using  
5 the rate of unemployment (U) as a critical variable. Our empirical strategy is thus to  
6 estimate panel models in order to uncover to what extent the relative importance of  
7 the four hypotheses is affected by sub-groups of EMU countries and the presence of U  
8 that affects the behaviour of both receipts and outlays. GMM estimates presented in  
9 Part II of Table 4 are consistent with the fiscal synchronization hypothesis. The  
10 empirical evidence in favor of the fiscal synchronization view does not change using  
11 either U as a third variable or distinguishing between small and large EMU countries.  
12 In most cases, the standard Arellano-Bond 2-step estimators are very reliable,  
13 suggesting that the explanatory variables are highly significant. The Sargan test of  
14 over-identifying restrictions did not reject the null hypothesis of the validity of the  
15 instruments sets. AR(1) and AR(2) test statistics show that the errors do not face the  
16 problem of serial correlation. The high values of F statistics imply that the lagged  
17 variables  $\Delta R_{it-1}$ ,  $\Delta G_{it-1}$  and  $\Delta U_{it-1}$  are not redundant in the GMM equations.

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19 It seems crucial to understand that the homogenous results derived by GTOLS and  
20 GMM estimates in line with the rationale of fiscal synchronization hypothesis may  
21 depend on the structural similarities between EMU member states. Regarding that the  
22 government intertemporal budget constraint will eventually have to be satisfied, a  
23 simultaneous shift in tax receipts and government expenditures today puts a constraint  
24 on the path of both taxes and expenditures in the future. The SGP (Stability and  
25 Growth Pact) recommends to EMU member states that the general government deficit-  
26 to-GDP ratio should be below the line of 3.0%. This target implies that fiscal policy  
27 measures should adjust taxes and expenditures so as to keep the ratio of deficit-to-  
28 GDP within the three percent limit. The fulfilment of this goal will help achieve the  
29 60%-of-GDP debt target of EMU, and thus, making room for effective fiscal policy  
30 measures in growth-promoting EMU areas.

## 50 51 **V. Concluding Remarks**

52 This paper established the interplay between government revenues and government  
53 outlays for the case of EMU by using modern panel data techniques. As far as we  
54 know no previous study has investigated all the four hypotheses in the empirical  
55 framework of panel data modeling. It was interesting to explore the rationale of the  
56 four hypotheses when: (i) checking to what extent the relative importance of the four  
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4 hypotheses is affected by subgroups of EMU countries, (ii) adding in the empirical  
5 analysis as a third variable the rate of unemployment which reflects total economic  
6 activity and affects the behaviour of government revenues and outlays, and (iii)  
7 evaluating the robustness of the results with respect to disaggregated data of  $R_{it}$  and  
8  $G_{it}$ . Empirical validation was carried out by means of the estimation of GTOLS and  
9 GMM models. Our results lead to the important policy implication concerning a  
10 feedback effect between public receipts and public expenditures. This indicates  
11 acceptance of the fiscal synchronization hypothesis, implying that in EMU revenue  
12 decisions and expenditure decisions affect one another.  
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14 Note that GTOLS and GMM results appeared to be supportive of the fiscal  
15 synchronization hypothesis, either using the entire period 1970-2006, or employing  
16 various sample ranges such as 1970-1991, 1992-2006 and 1998-2006. The validity of  
17 the fiscal synchronization view establishes two guiding principles concerning the  
18 budgetary policies in the Euro zone. First, member states have realised that budgetary  
19 policies should be a matter of common concern and be able to achieve sustainable  
20 growth rates. Second, budgetary policies should be coordinated encouraging EMU  
21 member states to specify their own government spending and taxation decisions in  
22 order to avoid excessive budget deficits. Taking into account the economic  
23 interdependence between member states, the EMU recognises the consequences that  
24 fiscal policy measures applied in one country have on macroeconomic policies of other  
25 countries. Increasing economic interdependence between participating countries in  
26 EMU appears to rise the benefits of coordination in member states' fiscal policies.  
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28 From the point of view of effective budgetary policies, economic institutional  
29 configuration has as a result of the EMU'S budgetary targets having to be satisfied in  
30 the context of domestic policy making. EMU authorities try to reinforce the role of  
31 current framework in order to promote the effectiveness of member states public  
32 finances. Socio-economic policies in EMU should aim at stimulating better budgetary  
33 procedures at national level and improving the process that affects economic  
34 coordination. The right balance between government expenditures and government  
35 revenues in EMU can be found by focusing fiscal rules on avoiding budgetary instability  
36 and on ensuring long-term fiscal sustainability.  
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## Notes

1. Payne (2003) presents a detailed survey of the international empirical evidence on the revenue-expenditure nexus. Note that Payne (2003) mentions fifty three papers on the subject that investigate the four hypotheses using time series techniques.
2. The Peacock and Wiseman view is also known in the literature as the displacement hypothesis because the impact of exogenous disturbances displaces the growth pattern of government expenditure.
3. It should be noted that the spend-tax hypothesis is also in line with the Ricardian equivalence proposition. Along with a different procedure of theoretical analysis, the advocates of the Ricardian equivalence proposition argue that public spending leads to increases in tax revenues by means of the linkage between government borrowing and future tax liabilities. According to the Ricardian equivalence proposition, government borrowing today will lead to increased future tax liabilities. In this way government expenditures undertaken today will contribute to additional tax receipts in the future. For more details on the Ricardian equivalence paradigm, see Vamvoukas (1997a).
4. Kitamura (2006) provides a comprehensive description of the empirical framework for different overidentifying restrictions tests.
5. For more discussion on this point, see Baltagi (2005).
6. For more details on the specific definitions of the variables included in our econometric analysis, see Statistical Annex of European Economy, Autumn 2008.
7. See Im, et al.(2003), for an analytical discussion on IPS unit root test.
8. For a detailed analysis on the computation of  $W_{t-\bar{t}}$  statistics, see Im, et al. (2003).
9. To reserve space IPS test results are not reported here. However, IPS panel unit root tests can be obtained upon request.
10. PPPs for the 12 EMU countries are annual benchmark results computed by Eurostat. PPPs are the rates of currency conversion that eliminate the differences in price levels between the 12 EMU member states. GDP volume indices based on PPPs converted data indicate only differences in the volume of goods and services produced.

## References

- Arellano, M. (1987) Computing robust standard errors for within groups estimators, *Oxford Bulletin of Economics and Statistics*, 49, 431-34.
- Arellano, M. and Bond, S.R. (1991) Some tests on specification for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies*, 58, 277-97.
- Arellano, M. and Bover, O. (1995) Another look at the instrumental variables estimation of error-components models, *Journal of Econometrics*, 68, 29-51.
- Baffes, J. and Shah, A. (1994) Causality and comovement between taxes and expenditures: Historical evidence from Argentina, Brazil, and Mexico, *Journal of Development Economics*, 44:311-31
- Baghestani, H. and McNown, R. (1994) Do revenues or expenditures respond to budgetary disequilibria? *Southern Economic Journal*, 60, 311-22.
- Baltagi, B.H., (2005) *Econometric analysis of panel data*, 3rd edn, John Wiley & Sons, New York.
- Blundell, R. and Bond, S. (1998) Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics*, 87, 115-43.
- Bohn, H. (1991) Budget balance through revenue or spending adjustments? Some historical evidence for the United States, *Journal of Monetary Economics*, 27, 333-59.
- Buchanan, J.M. and Wagner, R.W (1977) *Democracy in deficit*, Academic Press, New York.
- Buchanan, J.M. and Wagner, R.W. (1978) Dialogues concerning fiscal religion, *Journal of Monetary Economics*, 4, 627-36
- Cameron, D.R. (1978) The expansion of the public economy: A comparative analysis, *The American Political Science Review*, 72, 1250-60.
- Carneiro, F.(2007) The oil cycle and the tax-spend hypothesis: The case of Angola, *Applied Economics Letters*, 14, 1039-45.
- Chang, T., Liu, W.R. and Caudill, S.B. (2002) Tax-and-spend, spend-and-tax, or fiscal synchronization: New evidence from 10 countries, *Applied Economics*, 34, 1551-61.
- Dahlberg, M. and Johansson, E. (1998) The revenue-expenditures nexus: Panel data evidence from Swedish municipalities, *Applied Economics*, 30, 1379-86.
- Darrat, A.F. (1998) Tax and Spend, or Spend and Tax? An inquiry into the Turkish budgetary process, *Southern Economic Journal*, 64, 940-56.
- Friedman, M. 1972. *An economist's protest*, Horton & Co, New Jersey.
- Friedman, M. (1978) The limitations of tax limitation, *Policy Review*, Summer, 7-14.
- Garcia, S. and Henin, P.Y. (1999) Balancing budget through tax increases or expenditure cuts: Is it neutral? *Economic Modelling*, 16, 591-612.
- Hansen, L.P. (1982) Large sample properties of generalized method of moments estimators, *Econometrica*, 50, 1029-54
- Hasan, S.Y. and Sukar, A.H. (1995) Short and long-run dynamics of expenditures and revenues and the government budget constraint: Further evidence, *Journal of Economics*, 22, 35-42.
- Hausman, J.A. (1978) Specification tests in econometrics, *Econometrica*, 46, 1251-72.
- Hoover, K. and Sheffrin, S. (1992) Causation, spending, and taxes: Sand in the sandbox or the tax collector for the welfare state? *American Economic Review*, 82, 225-48.
- Im, K.S., Pesaran, M.H. and Shin, Y. (2003) Testing for unit roots in heterogeneous panels, *Journal of Econometrics*, 115, 53-74.
- Islam, M.Q. (2001) Structural break, unit root, and the causality between government expenditures and revenues, *Applied Economics Letters*, 8, 565-67.

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4  
5 Kitamura, Y. (2006) Specification tests with instrumental variables and rank deficiency,  
6 in *Econometric theory and practice: Frontiers of analysis and applied research*, edited  
7 by D. Corbae, Durlauf, S.N. and Hansen, B.E., Cambridge University Press, Cambridge,  
8 pp. 59-81.
- 9 Kollias, C. and Paleologou, S-M. (2006) Fiscal policy in the European Union: Tax and  
10 spend, spend and tax, fiscal synchronization or institutional separation? *Journal of*  
11 *Economic Studies*, 33, 108-20.
- 12 Koren, S. and Stiasny, A. (1998) Tax and spend, or spend and tax? An international  
13 study, *Journal of Policy Modeling*, 20, 163-91.
- 14 Li, X. (2001) Government revenue, government expenditure and temporal causality:  
15 Evidence from China, *Applied Economics*, 33, 485-97.
- 16 Meltzer, A. and Richard, S. (1981) A rational theory of the size of government, *Journal*  
17 *of Political Economy*, 89, 914-27.
- 18 Miller, S. and Russek, F. (1990) Co-integration and error-correction models: The  
19 temporal causality between government taxes and spending, *Southern Economic*  
20 *Journal*, 56, 221-29.
- 21 Musgrave, R. (1966) Principles of budget determination, in *Public finance: Selected*  
22 *readings*, edited by H. Cameron and W. Henderson, Random House, New York, pp.  
23 15-27.
- 24 Narayan, P. and Narayan, S. (2006) Government revenue and government expenditure  
25 nexus: Evidence from developing countries, *Applied Economics*, 38, 285-291.
- 26 Owoye, O.(1995), The causal relationship between taxes and expenditures in the G7  
27 countries: Cointegration and error-correction models, *Applied Economics Letters*, 2, 19-  
28 22.
- 29 Payne, J.E. (2003) A survey of the international empirical evidence on the tax-spend  
30 debate, *Public Finance Review*, 31, 302-24.
- 31 Payne, J.E., Mohammadi, H. and Cak, M. (2008) Turkish budget deficit sustainability  
32 and the revenue-expenditure, *Applied Economics*, 40, 823-30.
- 33 Peacock, A. and Wiseman, J. (1961) *The growth of public expenditures in the United*  
34 *Kingdom*, Princeton University Press, Princeton, NJ.
- 35 Peacock, A. and Wiseman, J. (1979) Approaches to the analysis of government  
36 expenditure growth, *Public Finance Quarterly*, 7, 3-23.
- 37 Ram, R. (1988) Additional evidence on causality between government revenue and  
38 government expenditure, *Southern Economic Journal*, 54, 763-69.
- 39 Sargan, J.D. (1958) The estimation of economic relationships using instrumental  
40 variables, *Econometrica*, 26, 393-415.
- 41 Vamvoukas, G.A. (1997a) A note on budget deficits and interest rates: Evidence  
42 from a small open economy, *Southern Economic Journal*, 63, 803-811.
- 43 Vamvoukas, G.A. (1997b) Budget expenditures and revenues: An application of error-  
44 correction modelling, *Public Finance*, 52, 125-38.
- 45 Von Furstenberg, G., Green, R. and Jeong, J. (1986) Tax and spend, or spend and tax?  
46 *Review of Economics and Statistics*, 68,179-88.
- 47 Wansbeek, T. and Kapteyn, A. (1989) Estimation of the error components model with  
48 incomplete panels, *Journal of Econometrics*, 41, 341-61.
- 49 Wildavsky, A. (1975) *The politics of the budgetary process*, Little, Brown & Company,  
50 Boston.
- 51 Zapf, M. and Payne, J.E. (2009) Asymmetric modelling of the revenue-expenditure  
52 nexus: Evidence from aggregate state and local government in the US, *Applied*  
53 *Economics Letters*, 16, 871-876.
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Table 1. Panel GTSLS results, 1970-2006

Explanatory Variables	Group A		Group B		Group C	
	G <sub>it</sub>	R <sub>it</sub>	G <sub>it</sub>	R <sub>it</sub>	G <sub>it</sub>	R <sub>it</sub>
<i>Fixed effects</i>						
Constant	9.373 (10.026)	3.742 (6.464)	27.578 (13.492)	1.342 (0.179)	8.212 (8.646)	3.313 (5.834)
R <sub>it</sub>	0.849 (37.661)	-	0.451 (9.494)	-	0.868 (37.443)	-
G <sub>it</sub>	-	0.846 (65.159)	-	0.887 (5.570)	-	0.860 (66.269)
R <sup>2</sup>	0.815	0.790	0.833	0.698	0.827	0.804
F	48.2	26.8	9.9	15.9	38.4	32.7
WF	15.9	22.5	31.2	28.6	25.4	27.1
obs	444	444	111	111	333	333
<i>Random effects</i>						
Constant	8.557 (6.733)	4.587 (7.550)	21.846 (10.023)	4.009 (1.761)	7.332 (5.711)	4.684 (8.170)
R <sub>it</sub>	0.869 (34.994)	-	0.584 (12.726)	-	0.890 (34.412)	-
G <sub>it</sub>	-	0.827 (63.359)	-	0.831 (16.810)	-	0.828 (62.301)
R <sup>2</sup>	0.725	0.730	0.500	0.635	0.749	0.752
F	1166.9	1197.1	108.7	189.3	989.8	1004.5
HOU	0.240	0.014	2.739	0.142	0.178	1.144
WF	20.5	27.4	36.8	35.1	33.2	41.9
obs	444	444	111	111	333	333
<i>Fixed effects</i>						
Constant	5.724 (6.325)	5.720 (9.638)	19.304 (7.648)	6.688 (1.821)	5.022 (5.148)	18.034 (12.585)
R <sub>it</sub>	0.872 (43.464)	-	0.529 (9.654)	-	0.891 (41.648)	-
G <sub>it</sub>	-	0.863 (65.012)	-	0.942 (12.189)	-	0.513 (13.400)
U <sub>it</sub>	0.399 (11.773)	-0.407 (10.021)	0.669 (3.815)	-1.078 (7.937)	0.348 (9.577)	0.071 (1.364)
R <sup>2</sup>	0.839	0.818	0.862	0.774	0.847	0.953
F	55.4	48.0	11.8	17.5	42.8	126.6
WF	16.2	19.8	17.6	30.7	32.4	25.8
obs	444	444	111	111	333	333
<i>Random effects</i>						
Constant	5.252 (5.001)	5.324 (9.311)	16.718 (7.639)	-0.790 (0.274)	4.249 (3.960)	5.324 (9.596)
R <sub>it</sub>	0.878 (43.012)	-	0.563 (10.902)	-	0.901 (41.692)	-
G <sub>it</sub>	-	0.868 (65.727)	-	1.027 (14.812)	-	0.866 (66.091)
U <sub>it</sub>	0.437 (12.999)	-0.380 (10.810)	0.826 (9.179)	-0.603 (5.495)	0.406 (11.462)	-0.356 (10.144)
R <sup>2</sup>	0.772	0.762	0.777	0.600	0.788	0.782
F	746.4	705.4	188.4	80.8	614.9	590.2
HOU	0.218	1.778	2.359	0.178	2.768	0.936
WF	16.8	18.1	22.8	24.4	18.2	17.2
obs	444	444	111	111	333	333

Notes: Group A includes the EMU member states, Belgium, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, Netherlands, Austria, Portugal and Finland. Group B includes Germany, France and Italy, that is, the larger economies of EMU. Group C includes Belgium, Ireland, Luxembourg, Netherlands, Austria, Finland, Greece, Portugal and Spain, that is, the smaller member states of EMU. Absolute values of t-statistics are in parentheses. R<sup>2</sup> is the within-R<sup>2</sup> for fixed effects and overall-R<sup>2</sup> for random effects. The F tests evaluate the joint significance of the fixed or random effects estimates in GTSLS specifications. WF is the Wald F-statistic which is used to test the original idiosyncratic errors for autocorrelation. HOU is the Hausman statistic which evaluates the null hypothesis that there is no misspecification in the random effects estimation. Obs is the number of observations overall.

**Table 2. Panel GTSLS results, 1970-2006**

Explanatory variables	Group A		Group B		Group C	
	G <sub>it</sub>	R <sub>it</sub>	G <sub>it</sub>	R <sub>it</sub>	G <sub>it</sub>	R <sub>it</sub>
<i>Fixed effects</i>						
Constant	22.292 (17.007)	10.780 (6.788)	26.161 (13.858)	11.001 (24.247)	19.653 (12.489)	8.390 (4.160)
GC <sub>it</sub>	-	1.066 (8.510)	-	1.236 (14.176)	-	0.870 (5.393)
GF <sub>it</sub>	-	0.907 (3.524)	-	-0.260 (1.011)	-	0.829 (4.283)
G0 <sub>it</sub>	-	0.829 (5.271)	-	-1.262 (12.993)	-	1.154 (6.342)
RI <sub>it</sub>	0.802 (9.534)	-	0.495 (2.431)	-	0.739 (7.802)	-
RD <sub>it</sub>	0.768 (10.540)	-	0.870 (7.549)	-	0.791 (10.726)	-
R0 <sub>it</sub>	0.899 (8.743)	-	1.656 (2.273)	-	1.290 (12.073)	-
R <sup>2</sup>	0.588	0.711	0.902	0.989	0.655	0.720
F	14.8	25.4	17.1	554.0	14.2	20.1
WF	35.1	39.4	23.1	27.1	26.8	37.2
obs	444	444	111	111	333	333
<i>Random effects</i>						
Constant	21.758 (12.902)	9.066 (5.526)	23.508 (14.401)	11.819 (8.622)	18.759 (9.584)	9.047 (3.616)
GC <sub>it</sub>	-	1.109 (9.107)	-	1.078 (25.617)	-	0.853 (10.333)
GF <sub>it</sub>	-	0.963 (3.816)	-	-0.984 (2.536)	-	0.904 (2.298)
G0 <sub>it</sub>	-	0.902 (5.855)	-	-1.182 (15.054)	-	1.406 (13.786)
RI <sub>it</sub>	0.783 (9.606)	-	0.349 (1.737)	-	0.736 (8.061)	-
RD <sub>it</sub>	0.781 (10.818)	-	1.030 (10.970)	-	0.798 (11.237)	-
R0 <sub>it</sub>	1.038 (10.102)	-	1.129 (3.275)	-	1.468 (13.299)	-
R <sup>2</sup>	0.570	0.627	0.572	0.815	0.542	0.659
F	109.2	233.2	45.0	216.5	122.5	203.6
HOU	2.024	1.735	0.468	2.087	1.149	2.648
WF	36.2	30.4	41.2	39.1	28.5	32.5
obs	444	444	111	111	333	333

Notes: See Table 1 for details

Table 3. Panel GTSLS results, 1970-2006

Explanatory variables	Group A		Group B		Group C	
	$G_{it}$	$R_{it}$	$G_{it}$	$R_{it}$	$G_{it}$	$R_{it}$
<i>Fixed effects</i>						
Constant	19.407 (13.619)	12.534 (6.296)	10.336 (2.760)	13.493 (9.782)	17.058 (10.282)	11.558 (6.677)
$GC_{it}$	-	1.101 (18.311)	-	1.216 (11.293)	-	0.853 (16.146)
$GF_{it}$	-	0.859 (2.033)	-	-0.598 (1.645)	-	0.898 (15.412)
$G0_{it}$	-	0.882 (16.597)	-	0.977 (6.785)	-	0.916 (17.104)
$RI_{it}$	0.817 (9.835)	-	0.436 (2.325)	-	0.790 (8.867)	-
$RD_{it}$	0.765 (10.363)	-	1.145 (6.796)	-	0.767 (10.526)	-
$R0_{it}$	0.986 (11.160)	-	1.346 (3.793)	-	0.994 (12.137)	-
$U_{it}$	0.362 (9.902)	-0.400 (6.979)	0.834 (5.146)	-0.184 (1.351)	0.303 (7.742)	-0.391 (6.543)
$R^2$	0.588	0.748	0.920	0.966	0.651	0.790
F	21.8	29.7	20.4	49.7	27.4	27.8
WF	17.1	20.8	35.2	39.6	29.9	21.8
obs	444	444	111	111	333	333
<i>Random effects</i>						
Constant	18.321 (10.572)	11.101 (3.934)	22.848 (10.803)	13.055 (11.070)	15.085 (7.814)	11.197 (4.231)
$GC_{it}$	-	1.138 (16.977)	-	1.036 (17.432)	-	0.827 (12.931)
$GF_{it}$	-	0.875 (1.928)	-	-0.785 (3.761)	-	0.853 (2.063)
$G0_{it}$	-	0.896 (16.301)	-	-0.759 (2.395)	-	1.056 (14.127)
$RI_{it}$	0.767 (10.262)	-	0.219 (1.325)	-	0.786 (9.879)	-
$RD_{it}$	0.760 (10.389)	-	0.884 (7.343)	-	0.752 (10.953)	-
$R0_{it}$	1.185 (13.741)	-	1.321 (3.429)	-	1.049 (15.310)	-
$U_{it}$	0.484 (9.277)	-0.322 (5.193)	0.619 (3.923)	-0.368 (1.725)	0.453 (8.253)	-0.259 (3.902)
$R^2$	0.499	0.650	0.668	0.814	0.591	0.675
F	100.3	192.7	48.3	115.9	108.5	160.6
HOU	0.024	0.799	3.214	1.415	2.069	2.875
WF	17.7	20.4	37.1	34.0	45.2	55.1
obs	444	444	111	111	333	333

Notes: See Table 1 for details

Table 4. Panel GMM estimates, 1970-2006

Explanatory variables	Group A		Group B		Group C	
	$\Delta G_{it}$	$\Delta R_{it}$	$\Delta G_{it}$	$\Delta R_{it}$	$\Delta G_{it}$	$\Delta R_{it}$
<i>Panel I</i>						
Constant	0.023 (0.444)	0.012 (0.173)	-0.195 (1.097)	0.176 (1.505)	0.009 (0.091)	0.088 (1.789)
$\Delta R_{it}$	0.809 (9.226)	-	0.868 (5.886)	-	0.894 (8.341)	-
$\Delta G_{it}$	-	0.662 (9.564)	-	0.626 (9.390)	-	0.562 (6.613)
$\Delta R_{it-1}$	-0.782 (8.817)	-0.091 (2.350)	0.875 (1.726)	-0.108 (2.738)	-0.225 (2.815)	-0.091 (2.096)
$\Delta G_{it-1}$	0.871 (13.285)	0.096 (2.311)	-0.607 (1.756)	0.105 (3.459)	0.251 (2.771)	0.097 (2.072)
R <sup>2</sup>	0.515	0.669	0.468	0.658	0.550	0.601
F	89.2	74.5	75.9	59.1	48.4	41.6
J	0.053	0.004	1.788	0.977	0.871	2.224
AR(1)	2.178	1.612	2.881	3.805	0.587	3.107
AR(2)	1.659	1.436	1.972	2.814	0.953	2.901
obs	444	444	165	165	259	259
<i>Panel II</i>						
Constant	-0.018 (0.258)	-0.002 (0.027)	-0.004 (0.125)	0.007 (0.039)	-0.047 (0.602)	0.142 (2.321)
$\Delta R_{it}$	0.637 (4.668)	-	0.952 (45.233)	-	0.646 (7.079)	-
$\Delta G_{it}$	-	0.899 (9.522)	-	0.994 (45.658)	-	0.402 (5.459)
$\Delta U_{it}$	0.911 (2.315)	-0.775 (3.883)	0.775 (11.746)	-0.620 (7.712)	0.947 (5.307)	0.290 (1.860)
$\Delta R_{it-1}$	0.104 (1.650)	-0.093 (1.591)	0.029 (1.793)	-0.068 (4.211)	0.099 (1.769)	-0.060 (1.823)
$\Delta G_{it-1}$	-0.127 (1.866)	0.128 (1.691)	0.076 (6.906)	-0.090 (6.890)	-0.163 (2.352)	0.077 (2.353)
$\Delta U_{it-1}$	-0.259 (1.920)	0.060 (0.605)	-0.159 (5.139)	0.379 (5.401)	0.012 (0.096)	-0.157 (1.973)
R <sup>2</sup>	0.676	0.570	0.653	0.492	0.683	0.738
F	32.7	46.8	62.8	47.5	34.4	55.1
J	0.014	0.011	0.221	1.098	1.772	2.105
AR(1)	0.968	0.554	5.770	6.251	8.554	4.955
AR(2)	1.014	0.563	5.114	5.882	9.288	5.802
obs	444	444	165	165	259	259

Notes: Taking into account the suggestion of an anonymous referee for this Journal to determine the various subgroups of EMU countries according to GDP, we consider groups B and C adopting the methodology of Purchasing Power Parities (PPPs). Group A includes the EMU member states, Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. Group B includes Greece, Ireland, Italy, Portugal and Spain. Group C includes Austria, Belgium, Finland, France, Germany, Luxembourg and the Netherlands. Assuming that the average GDP of EMU equals index 100, Groups B and C contain respectively those EMU countries whose average current GDP at PPP standards over 1970-2006 was below or above 100. t-statistics in parentheses.  $\Delta$  is the difference operator. Cross section fixed effects are employed by performing Arellano-Bond 2-step estimation. The standard errors were calculated using Arellano and Bond (1991) robust estimators that permit for heteroskedastic residuals. The instruments in the GMM estimates are the first two lags of explanatory variables. R<sup>2</sup> is the coefficient of multiple determination. With the F-statistic we evaluate the null-hypothesis that the lagged explanatory variables are redundant. J is the Sargan statistic from a validity test of the instruments. AR(1) and AR(2) are LM tests of first-and second-order serial correlation following asymptotically the X<sup>2</sup> distribution. Obs is the number of observations. It should be noted that choosing different sample ranges such as 1970-1991, 1992-2006 and 1998-2006, the GMM results for EMU countries are supportive of the fiscal synchronization hypothesis (GMM results are available upon request).