FISCAL SUSTAINABILITY: ANOTHER LOOK AT THE EUROPEAN CASE*

1. INTRODUCTION

In a recent paper, Afonso (2005) concluded that fiscal policy in European Union (EU) countries may not have been on a sustainable path during 1970-2003. This conclusion was based mainly on estimates of the cointegrating relation between government expenditure and revenue from time series tests. While the empirical methodology used is common in the literature, the reliability of the estimates that it produces is questionable because the unit root and cointegration tests employed have low power in small samples Banerjee (1999). In this paper, we re-examine the issue of fiscal sustainability in the EU countries using panel cointegration techniques that make it possible to estimate consistently the long-run association between government revenue-expenditure. Specifically, we use the panel unit root tests proposed by Levin *et al*. (2002) and Im *et al*. (2003) to test the stationarity of the government revenue and expenditure series, and the multivariate residual panel techniques of pioneered by Pedroni (2004) to test for cointegration between government revenue and expenditure. In addition, we adopt the dynamic OLS (DOLS) model proposed by Kao and Chiang (2001) to estimate the panel-cointegrating vector for government revenue and expenditure to resolve the issues of 'strong' versus 'weak' fiscal sustainability. We find that government revenue and expenditure are non-stationary and cointegrated series and, in contrast to Afonso (2005), that the long-run cointegrating relation between revenue and expenditure is consistent with strong fiscal sustainability.

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2. Data, methodology and results

As in Afonso (2005), we examine annual data for general government revenue and expenditure in relation to GDP. However, we extend the sample period to 2005 and exclude Luxembourg from the EU-15 dataset because of difficulties in obtaining a consistent revenue and expenditure series for the full sample period[1]. The first step is to analyze the time series properties of the data in order to determine the persistence of the pooled revenue and expenditure series. The panel unit root tests proposed by Levin *et al*. (2002) and Im *et al.* (2003) are constructed by averaging individual augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) t-statistics across cross-section units. The Levin *et al*. (2002) test allows for heterogeneity of the intercepts across members of the panel and tests of the null hypothesis that each individual time series in the panel is integrated versus the alternative hypothesis that all individual time series are stationary. It is based on the following pooled ADF equation:

$$\Delta y_{it}=\alpha_{0it}+\alpha_{1it}+\delta y_{it-1}+\sum_{L=1}^{Pi}\beta_{ij}\Delta y_{it-L}+\varepsilon_{it} \quad (1)$$

where a common $\delta = \rho-1$ is assumed, α_{0i} and α_{1i} represent country-specific fixed effects and deterministic trends, respectively, and p_i is the required country-specific degree of lag augmentation to make the residuals white noise that is determined by the conventional step-down procedure. The null of H_0: $\delta = 0$ under the assumption that $\delta_i = \delta$ for all i is tested against the alternative hypothesis H_1: $\delta < \delta_i$ for all i. The test is based on a technique that removes autocorrelation as well as deterministic components.

The Im *et al*. (2003) test allows for heterogeneity in intercepts as well as in the slope coefficients and test takes the form:

$$\Delta y_{it}=\alpha_{0it}+\alpha_{1it}+\theta_t+\delta y_{it-1}+\sum_{j=1}^{Pi}\beta_{ij}\Delta y_{it-j}+\varepsilon_{it} \quad (2)$$

where p_i, α_{0i} , and α_{1i} are as in equation (1) and θ_t represents the time dummies used to account for cross-sectional correlation that could result from common shocks affecting all countries in the panel in the period. The null of H_0: $\delta_i = 0$ for all i (i.e., all series have a unit root) is tested against the alternative H_1: $\delta_i < 0$ for i =1,2, ..., N_1 and $\delta_i = 0$, for i = N_1 + 1, N_1 +2, ..., N. On the assumption that the N cross-section units are independently distributed, the t-statistic can be

[1] Data are from the AMECO database of the EU Commission.

computed as an average of the individual ADF t-statistics such that:

$$t_{NT}(p,\rho) = \sum_{i=1}^{N} t_{iT}(p_{i,}\rho_i)/N \quad (3)$$

where $t_{iT}(p_i,\rho_i)$ is the t-statistic for testing $\delta_i = 0$ in each individual ADF regression. In a further step, the above t-bar statistic is standardized so that it converges to a standard normal distribution, as N increases. A key strength of the test is that δ_i is allowed to differ across countries and only a fraction of panel members is required to be stationary under the alternative hypothesis. The results of the two types of unit root tests are reported in Table 1. It shows that the null of the unit roots for the panel data for the revenue and expenditure series cannot be rejected by either test for the panel of EU countries. Therefore, we can implement a test for panel cointegration between government revenue and expenditure.

The next step is to test for cointegration between government

TABLE 1 - *Panel Unit Root Tests for Government Revenue and Expenditure, 1970-2005*

	Revenue	Expenditure
Levin *et al.* (2002)		
With individual effects and linear trends	-1.2242	-0.6976
P-values	(0.1104)	(0.2427)
Im *et al.* (2003)		
With individual effects and linear trends	-1.2015	-1.6563
P-values	(0.8852)	(0.9512)

Notes: Government revenue and expenditure in are percent of GDP.
The null hypothesis in all tests is that all individual series are non-stationary.

revenue (REV) and expenditure (EXP) in the data panel. The available techniques for panel cointegration tests are in essence an application of the Engle and Granger (1987) cointegration analysis. For this study, we follow Kao (1999) and Pedroni (2004), who propose a range of statistics that can be used to determine the presence of cointegration in heterogeneous panels. In each case, the test statistics are constructed using the residuals from the following hypothesized cointegrating equation:

$$REV_{it} = \alpha_i + \beta_i EXP_{it} + \varepsilon_{it} \quad (4)$$

where α allows the cointegrating regression to include country-specific fixed effects, β is the slope parameter, and ε is a residual term. Kao (1999) tests the residuals $\hat{e}_{it}$ of the OLS panel estimation by applying DF- and ADF-type tests:

$$\hat{e}_{it} = \hat{e}_{it}\rho_{it-1} + v_{it} \tag{5}$$

and

$$\hat{e}_{it} = \hat{e}_{it}\rho_{it-1} + \sum_{j=1}^{P} \phi_j \Delta\hat{e}_{it-j} + \upsilon_{it} \tag{6}$$

The null hypothesis of no cointegration, H_0: ρ=1, is tested against the alternative hypothesis of stationary residuals, H_1: ρ<1. Kao presents five DF and ADF types of cointegration tests in the panel data, the asymptotic distributions of which converge to a standard normal distribution N(0,1). The test statistics are DF-$_{roh}^{*}$, DF$_t^{*}$ and ADF, which are for cointegration with the endogenous regressors, and DF$_{roh}$ and DF$_t$ which are based on assuming strict endogeneity of the regressors. Pedroni (2004) suggests a Phillips-Perron-type panel cointegration test, which implies less strict assumptions with respect to the distribution of the error terms than do the DF and ADF tests described above. He provides two test statistics, PC$_1$ and PC$_2$, which converge to a standard normal distribution. First, under the null hypothesis of no cointegration, the panel autoregressive coefficient estimator $\hat{\rho}_{N,T}$ can be constructed as follows:

$$\hat{\rho}_{N,T-1} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\left(\hat{e}_{it-1}\Delta\hat{e}_{it} - \hat{\lambda}_i\right)}{\left(\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it-1}^2\right)} \tag{7}$$

where $\hat{\lambda}_i$ acts as a scalar equivalent to the correlation matrix, Γ, and corrects for any correlation effect. Pedroni provides the limiting distribution of two test statistics:

$$PC_1 = \frac{T\sqrt{N}\left(\hat{\rho}_{N,T-1}\right)}{\sqrt{2}} \Rightarrow N(0,1) \tag{8}$$

and

$$PC_2 = \frac{\sqrt{NT(T-1)}\left(\hat{\rho}_{N,T-1}\right)}{\sqrt{2}} \Rightarrow N(0,1) \tag{9}$$

The results of the cointegration tests between government revenue and expenditure are reported in Table 2 and indicate that the null hypothesis of no cointegration between the series can be rejected at conventional significance levels in all cases.

TABLE 2 - *Panel Cointegration Tests, 1970-2005*

Kao (1999)					Pedroni (2004)	
DF-rho	DF-t	DF-rho*	DF-t*	ADF	PC_1	PC_2
-30233	-1.8867	-9.4016	-2.8113	-3.1512	-16.587	-16.352
(0.0013)	(0.0296)	(0.0000)	(0.0025)	(0.0008)	(0.0000)	(0.0000)

Notes: p-values are in paranthesis.
The DF test statistics are analogous to the parametric Dickey-Fuller test for non-stationary time series. The DF-rho and DFt statistics assume strict exogeneity of the regressors with respect to errors and no autocorrelation. DF-rho* and DF-t* statistics are based on endogenous regressors. These tests depend on consistent estimates of the long-run variance-covariance matrix to correct for nuisance parameters once the limiting distribution has been found. The ADF test is analogous to the Augmented Dickey-Fuller test for non-stationary time series.
PC1 and PC2 are the non-parametric Phillips-Perron tests.

Finally, as the null hypothesis of no cointegration has been rejected, the coefficient of the long-run relation between government revenue and expenditure can be estimated. Quintos (1995) distinguishes between a strong and weak definition of fiscal sustainability. Assuming that government revenue and expenditure are both *I*(*1*) and cointegrated, strong solvency occurs if the slope coefficient β in equation (4) is equal to unity, and weak solvency occurs when β is less than unity. In the context of government revenue and expenditure ratios to GDP, Hakkio and Rush (1991) and Cipollini (2001) argue that only the strong condition is appropriate to assess fiscal sustainability as under the weak condition the government might have difficulty financing a fiscal deficit if the expenditure-to-GDP ratio continuously exceeds the revenue-to-GDP ratio. We estimate the long-run coefficient using the dynamic ordinary least squares (DOLS) developed by Kao and Chiang (2001), which is designed for non-stationary panels and corrects the standard pooled OLS for serial correlation and endogeneity of regressors that are normally present in long-run economic relationships[2]. The DOLS procedure involves running the following regression:

$$REV_{i,t} = \alpha_i + \beta_i EXP_{i,t} + \sum_{j=-q}^{q} c_{i,t} \Delta EXP_{i,t+j} + \varepsilon_{it} \qquad (10)$$

where $t=1,\ldots,T$ and $i=1,\ldots,N$. Equation (10) includes the leads

[2] Kao and Chiang (2001) demonstrate the superiority of the dynamic OLS estimator with respect to OLS and full modified OLS in estimating panel regressions.

and lags of ΔEXP_{it} in the cointegrating regressions in order to produce asymptotically unbiased estimators. The estimates of the long-run coefficient are reported in Table 3. We also test whether the cointegration coefficient β is significantly different from 0 and insignificantly different from 1. The estimated β is 0.95, which is very close to unity, and while the null hypotheses of $\beta = 0$ is rejected, that null hypothesis that $\beta = 1$ cannot be rejected at conventional significance levels. Thus, our results indicate that government revenue and expenditure are non-stationary and cointegrated, and that the long-run cointegrating relation is consistent with strong fiscal sustainability.

TABLE 3 - *DOLS Estimates of the Long-Run Coefficients*

H0: β=0	0.9547
t-ratio	25.1925
H0: β=1	0.9547
t-ratio	-1.1954

3. CONCLUSIONS

Recent research using time series cointegration techniques has suggested that fiscal policy in the EU-15 countries may have been on unsustainable path during 1970-2003. However, the time series techniques employed are know to have low power in small samples, which casts doubt on the reliability of the results. We employed recently developed panel cointegration techniques that have higher power in small samples to a data panel for 1970-2005 and found that government revenue and expenditure were non-stationary and cointegrated series in these countries and that the long-run cointegrating relation was consistent with 'strong' fiscal sustainability.

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ABSTRACT

Recent research using time series cointegration techniques has suggested that fiscal policy in the EU-15 countries may have been on unsustainable path during 1970-2003. However, the time series techniques employed are know to have low power in small samples. The results from employing panel cointegration techniques that have higher power in small samples indicate that government revenue and expenditure in these countries were non-stationary and cointegrated series, and that the long-run cointegrating relation was consistent with 'strong' fiscal sustainability.

Keywords: European Union, Fiscal Policy Sustainability, Panel Cointegration

JEL Classification: H62, H63

RIASSUNTO

Sostenibilità fiscale: un altro sguardo al caso europeo

Una recente ricerca basata su tecniche *time series* di cointegrazione evidenzia che la politica fiscale nell'Unione a 15 potrebbe essere stata non sostenibile durante il periodo 1970-2003. In ogni caso, è risaputo che tali tecniche *time series* hanno scarsa funzionalità se utilizzate su piccoli campioni. L'utilizzo di tecniche *panel cointegration*, che hanno maggior funzionalità su piccoli campioni, indica, invece, che le entrate e le uscite nei paesi considerati costituivano serie non stazionarie e cointegrate e che la relazione di cointegrazione di lungo periodo era coerente con una sostenibilità fiscale "forte".