

# Testing Long-term Fiscal Developments in Europe: Evidence from Three-Stage Least Square Method

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*We use a Three-Stage Least Square (TSLS) method and a system of equations to estimate two components of fiscal policy -responsiveness and persistence- and to infer the sources of fiscal deterioration (improvement). Using annual data from 1971-2010, we examine the responsiveness and persistence of government expenditures and revenues in Denmark, the Netherlands and the United Kingdom. Empirical results suggest that (i) in Denmark government expenditures and revenues are not affected by policies which either increase or decrease output, (ii) in all three countries, government expenses and revenues are largely determined by their own lagged values, (iii) in the Netherlands and the United Kingdom, contrary to Denmark, government expenditures exhibits higher persistence than government revenues and (iv) there is no structural change in the fiscal position of the three countries over time.*

**JEL Codes:** E32, E62 and H50

## 1. Introduction

Over the last decades, several studies have addressed the issue of the sustainability of public finances, usually assessing whether government expenditures and revenues display a sustainable equilibrium pattern. The issue is important since any inadequate fiscal policy may destabilize the relationship between government expenditures and revenues, producing conditions for potential “fiscal deterioration” and lack of public finances sustainability.

In this paper we contribute to the literature by using an approach developed by Afonso and Sousa (2011) and Kasimati (2011) to assess fiscal developments in Denmark, The Netherlands and the United Kingdom. More specifically, we examine the extent to which two main characteristics of fiscal policy behaviour, (i) the sensitivity of fiscal variables to economic developments and the (ii) dependence of fiscal behaviour on its own past developments, impact on the patterns of both government spending and revenue, thereby determining conditions of fiscal sustainability or fiscal deterioration. In order to address the problem and following the empirical works by Afonso et al. (2008) and Fatas and Mihov (2003), we decompose government spending and government revenue into two components: responsiveness and persistence. The former can be defined as the response of fiscal policy to output, while persistence reflects the likely autocorrelation on budgetary policy decisions.

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## Kasimati

We improve upon the work of Afonso et al. (2008) who extend the analysis of Fatas and Mihov (2006) by using the instrumental variables method, but estimate separately the equations for government expenditure and revenue. Given that we are interested to test whether and to what extent the time-varying behaviour of the fiscal policy characteristics may simultaneously influence the patterns of both expenditure and revenue and eventually determine conditions of fiscal deterioration, we estimate a system including both the expenditure and revenue conditions. To this purpose we use annual data from 1971-2010 taken from national accounts.

The rest of the paper is structured as follows. Section 2 presents a brief review of the related empirical literature. Section 3 describes the model to be estimated and the methodology used to assess fiscal developments in Europe. Section 4 presents the data and discusses the empirical results for assessing fiscal deterioration or fiscal improvement. The last section provides concluding remarks.

### 2. Literature Review

Unit root and cointegration tests are commonly used to examine the sustainability of public finances and the possibility of fiscal deterioration if past fiscal policies are to be kept in the future. The analyses focus on testing if the first differences of the debt series are stationary or if the government expenditures and revenues are cointegrated. Common practice is to interpret rejection of these tests as evidence against either strong or weak fiscal sustainability, depending on how far from unity is the coefficient for government expenditures in the cointegration relationship between government expenditures and revenues. Such analyses have been carried out on a country basis (Hamilton and Flavin, 1986; Trehan and Walsh, 1991; Ahmed and Rogers, 1995; Quintos, 1995).

More recently fiscal developments have also been assessed for the OECD and EU country groupings (Kasimati, 2011; Afonso and Rault, 2007), given that several economic and econometric arguments support the use of panel analysis for such purpose. Afonso and Rault (2007) used first and second generation panel unit root tests as well as panel cointegration techniques that allow for correlation to be accommodated both within and between units.

The long-term (cointegration) relationship between primary budget balances and government debt, basically a fiscal reaction function, also provides evidence on the sustainability features of public finances. However, it has been argued that the rejection of sustainability based on standard cointegration tests is invalid because the present-value borrowing constraint could be satisfied even if government expenditures and revenues are not cointegrated or deficit and debt are difference-stationary (Bohn, 2007).

Focusing only on government spending, Fatas and Mihov (2003, 2006) identify three fiscal policy characteristics explaining their evolution: responsiveness, persistence and discretionary. Afonso et al. (2008) extend the analysis of Fatas and Mihov (2006) by estimating separately two regression models relating government expenditures and

## Kasimati

revenues to the same common set of fiscal policy characteristics defined above. However, the use of a single equation estimation approach does not allow to assess whether, and to what extent, the time-varying behaviour of the fiscal policy characteristics many simultaneously influence the patterns of both expenditure and revenue and change their structural long-run relationship. In this respect, the empirical strategy used in this paper, based on the simultaneous estimation of both expenditure and revenue equations, which helps overcome this problem.

### 3. Methodology

The empirical methodology used to analyse the role of responsiveness and persistence in determining fiscal developments is based on the estimation of the following system of structural equations:

$$\left\{ \begin{array}{l} \ln(EXP_{i,t}) = \beta_i^{EXP} + \gamma_i^{EXP} \ln(GDP_{i,t}) + \delta_i^{EXP} \ln(EXP_{i,t-1}) + \varepsilon_{i,t}^{EXP} \\ (t = 1, 2, \dots, T) \\ \ln(REV_{i,t}) = \beta_i^{REV} + \gamma_i^{REV} \ln(GDP_{i,t}) + \delta_i^{REV} \ln(REV_{i,t-1}) + \varepsilon_{i,t}^{REV} \\ (t = 1, 2, \dots, T) \end{array} \right. \quad (1)$$

Where,

EXP: total real government expenditures,

REV: total real government revenues,

GDP: real Gross Domestic Product

i: represents the country (i.e. Denmark, Netherlands, United Kingdom)

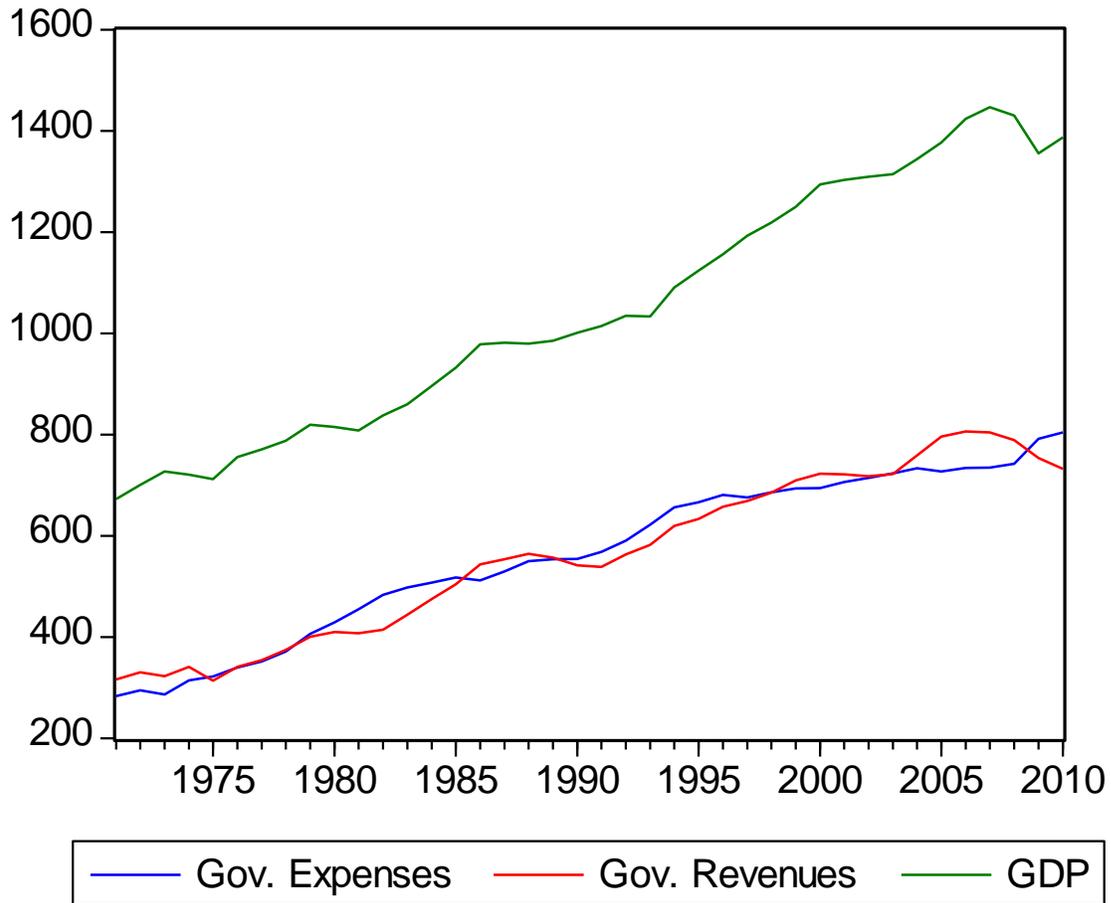
$\gamma_i$ : measures the responsiveness of fiscal policy for each of the two countries,

$\delta_i$ : measures the fiscal persistence, that is, the degree of dependence of the current fiscal behaviour on its own past setting.

The variables in System 1 are expressed in levels (see Figures 1, 2 and 3) for two main reasons. First, as also done by Afonso and Sousa (2011), Kasimati (2011) and Fatas and Mihov (2003, 2006), it is necessary to include in the regressions the level of the current and lagged value of government expenditure and revenue in order to capture the persistence of fiscal policy. Second, once the lagged dependent variable is used in levels, and considering the fact that the series employed are not stationary, the inclusion of output expressed in first differences may lead to a situation where the coefficient of the lagged variable converges to one and the coefficient of the stationary series (output expressed in differences) converges to zero (Wirjanto and Amano, 1996).

## Kasimati

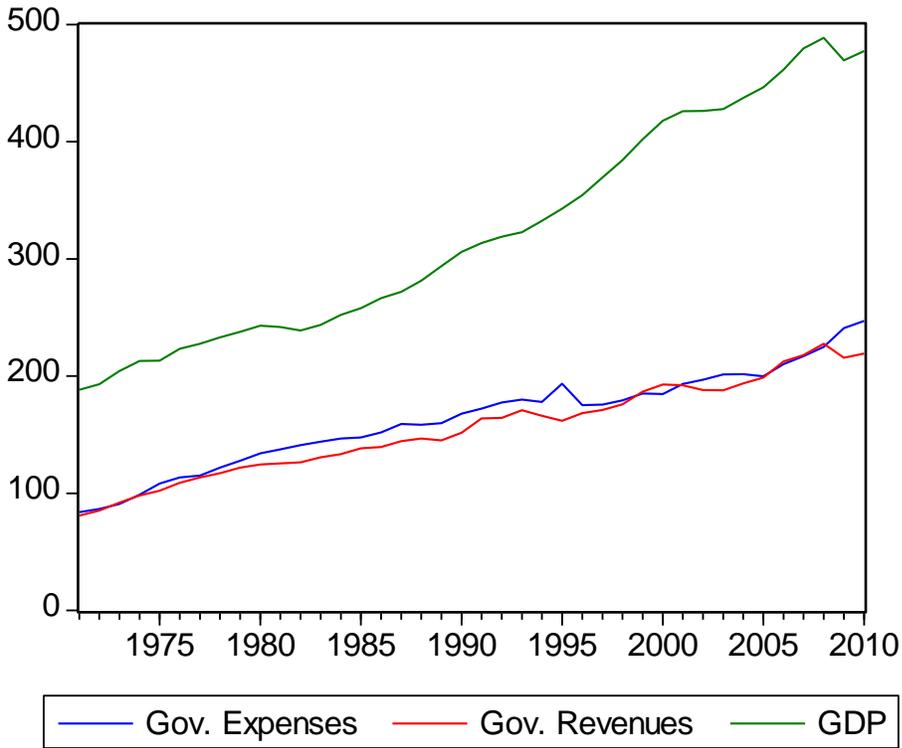
**Figure 1:** Denmark's government expenditure, government revenues and GDP (1971-2010)



Source: AMECO

## Kasimati

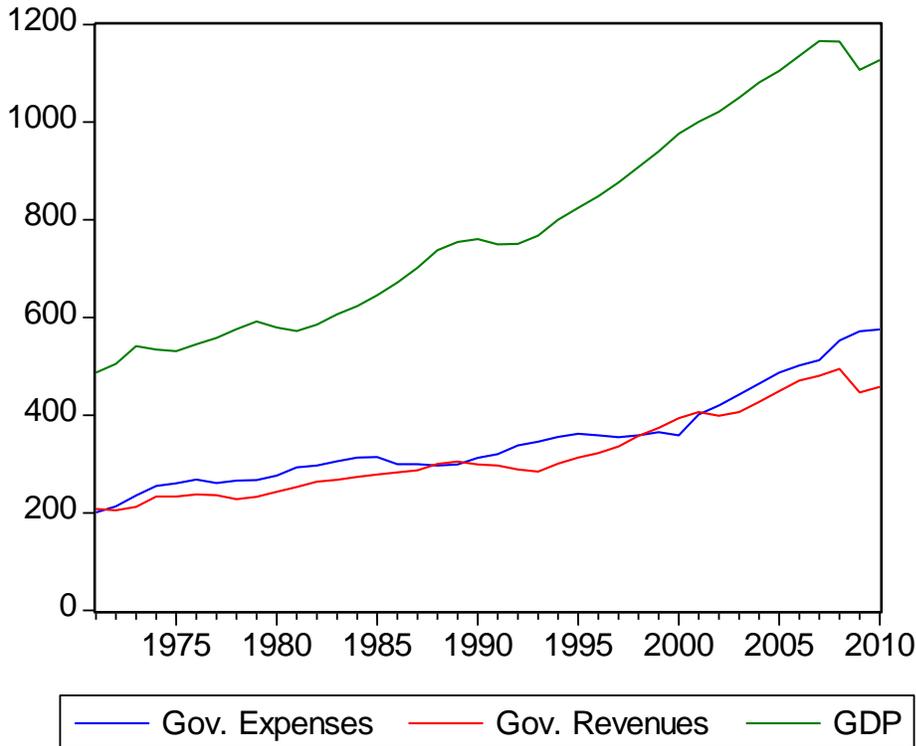
**Figure 2:** The Netherlands' government expenditure, government revenues and GDP (1971-2010)



**Source:** AMECO

## Kasimati

**Figure 3:** The United Kingdom's government expenditure, government revenues and GDP (1971-2010)



**Source:** AMECO

The estimation of System 1 is challenged by the presence of lagged endogenous variables among the explanatory variables. Therefore, we use a Three-Stage Least Square (TSLS) specification (Zellner and Theil, 1962), which provides consistent estimates. In addition, to avoid any endogeneity bias because of the simultaneity in the determination of our variables, GDP is instrumented with two lags of GDP, the index of oil prices [as in Afonso and Sousa (2011), Kasimati (2011) and Fatas and Mihov (2006)] and the lagged value for revenues and expenditures, in the expenditures and revenues equation respectively.

Once system 1 is estimated for each of the three countries, we compute the corresponding Wald statistics to test the following joint restrictions:

$$H_0 : \delta_i^{EXP} = \delta_i^{REV} \wedge \gamma_i^{EXP} = \gamma_i^{REV} \quad (2)$$

As it is followed by Afonso and Sousa (2011) and Kasimati (2011), acceptance of the null hypothesis implies that the behaviour of both government expenditure and revenues evolve dynamically in a way that avoids any structural change of the fiscal position. A rejection of the null hypothesis reports structural changes in the fiscal behaviour towards deterioration or improvement. Specifically, in order to assess

## Kasimati

whether changes in the fiscal position are due to differences in responsiveness or persistence between government expenditures and revenues, we test the following single hypothesis:

$$H_0 : \delta_i^{EXP} = \delta_i^{REV} \quad H_1 : \delta_i^{EXP} \neq \delta_i^{REV} \quad (3)$$

$$H_0 : \gamma_i^{EXP} = \gamma_i^{REV} \quad H_1 : \gamma_i^{EXP} \neq \gamma_i^{REV} \quad (4)$$

From the analysis of the single tests and the analysis of the estimates of the parameters, one can obtain three possible outcomes: (i) fiscal deterioration (due to fiscal persistence and/or fiscal responsiveness); (ii) fiscal improvement (due to persistence and/or responsiveness) and (iii) indeterminacy, when government expenditure persistence is higher than revenue persistence ( $\delta_i^{EXP} > \delta_i^{REV}$ ), but expenditure responsiveness is lower than revenue responsiveness ( $\gamma_i^{EXP} < \gamma_i^{REV}$ ), and vice versa ( $\delta_i^{EXP} < \delta_i^{REV}; \gamma_i^{EXP} > \gamma_i^{REV}$ ).

### 4. Data Description and Empirical Analysis

In our study we use annual data for Denmark, Holland and the United Kingdom covering the period 1971-2010. A sub-period from 1971-2000 is also examined (just before the introduction of euro currency) to identify potential structural changes. As far as Holland is concerned, national currency data for all years before the switch to the euro have been converted using the fixed euro conversion rate to provide comparable series across time. All variables are expressed in natural logarithms of real terms. The data are provided by Bloomberg and the annual national accounts data of the European Commission AMECO (Annual Macro-Economic Data) database. The government finance items are deflated by the GDP deflator (2000=100).

## Kasimati

**Table 1.** Estimates through a TSLS method for responsiveness & persistence

	Responsiveness		Persistence	
	$\hat{\gamma}^{EXP}$	$\hat{\gamma}^{REV}$	$\hat{\delta}^{EXP}$	$\hat{\delta}^{REV}$
<b>DENMARK</b>				
<i>Full Sample</i> (1971-2010)	0.063 (0.715) [0.477]	-0.665 (-1.432) [0.157]	0.909 (13.494) [0.000]	1.472 (4.207) [0.000]
<i>Sub-Sample</i> (1971-2000)	-0.048 (-0.363) [0.719]	0.272 (0.405) [0.687]	0.988 (11.585) [0.000]	0.812 (1.739) [0.088]
<b>NETHERLANDS</b>				
<i>Full Sample</i> (1971-2010)	0.065 (1.289) [0.202]	0.105 (1.618) [0.110]	0.891 (15.927) [0.000]	0.842 (11.805) [0.000]
<i>Sub-Sample</i> (1971-2000)	0.007 (0.099) [0.922]	0.166 (2.647) [0.011]	0.911 (14.493) [0.000]	0.790 (12.593) [0.000]
<b>UNITED KINGDOM</b>				
<i>Full Sample</i> (1971-2010)	-0.001 (-0.001) [0.992]	0.150 (1.072) [0.287]	1.018 (12.218) [0.000]	0.832 (5.534) [0.000]
<i>Sub-Sample</i> (1971-2000)	0.010 (1.052) [0.298]	0.248 (1.296) [0.201]	0.763 (5.556) [0.000]	0.710 (2.911) [0.005]
<p><b>Notes:</b> 1) t-statistic in parentheses. Probabilities in brackets.</p> <p>2) Estimated Equations</p> $\left\{ \begin{array}{l} \ln(EXP_{i,t}) = \beta_i^{EXP} + \gamma_i^{EXP} \ln(GDP_{i,t}) + \delta_i^{EXP} \ln(EXP_{i,t-1}) + \varepsilon_{i,t}^{EXP} \\ \text{Instruments : } \ln(GDP_{i,t-1}), \ln(GDP_{i,t-2}), (OILPRICE_t), \ln(REV_{i,t-1}) \\ \ln(REV_{i,t}) = \beta_i^{REV} + \gamma_i^{REV} \ln(GDP_{i,t}) + \delta_i^{REV} \ln(REV_{i,t-1}) + \varepsilon_{i,t}^{REV} \\ \text{Instruments : } \ln(GDP_{i,t-1}), \ln(GDP_{i,t-2}), (OILPRICE_t), \ln(EXP_{i,t-1}) \end{array} \right.$				

Table 1 summarises the estimates for the coefficients of responsiveness  $\gamma$  and persistence  $\delta$  for each country for the full sample and for the sub-period 1971-2000. We do not estimate separately the sub-period 2001–2010 due to the limited number of observations.

As far as Denmark is concerned, the coefficients of responsiveness  $\gamma$  are not statistically significant at all levels of significance, both for the full and the sub periods. Conclusively, changes in GDP do not affect either government expenses or revenues. On the contrary, the coefficients of persistence  $\delta$  for expenses are statistically significant at all levels of significance both for the full and the sub

## Kasimati

periods. If we focus on the coefficient of persistence  $\delta$  for revenues, it is statistically significant at all levels for the full period and only at 10% for the sub-period. Moreover, our Wald tests in Table 2 indicate that they are not different than one for both periods we examine. This suggests that government revenues and expenses in Denmark have been largely determined by their own lagged values throughout time.

<b>Table 2: Wald Tests (Chi-square) for the coefficient <math>\delta</math></b>		
	$W_\delta$ ( $\delta^{EXP} = 1$ )	$W_\delta$ ( $\delta^{REV} = 1$ )
<b>DENMARK</b>		
<i>Full sample</i> (1971 – 2010)	1.805 [0.179]	1.818 [0.178]
<i>Sub-sample</i> (1971 – 2000)	0.018 [0.892]	0.162 [0.687]
<b>NETHERLANDS</b>		
<i>Full sample</i> (1971 – 2010)	3.790 [0.052]	4.878 [0.027]
<i>Sub-sample</i> (1971 – 2000)	2.012 [0.156]	11.229 [0.000]
<b>UNITED KINGDOM</b>		
<i>Full sample</i> (1971 – 2010)	0.047 [0.829]	1.252 [0.263]
<i>Sub-sample</i> (1971 – 2000)	2.974 [0.085]	1.414 [0.235]
<b>Notes:</b> Probabilities in brackets.		

As far as the Netherlands is concerned, the coefficient of responsiveness  $\gamma$  for expenses, is not statistically significant at all levels for both periods (Table 1). If we focus on the coefficient of responsiveness for revenues, it is not statistically significant at all levels for the full period. However for the sub-period it is statistically significant at 5% and 10%. This suggests that the initial responsiveness of revenues towards output fluctuations was seriously diminished following the introduction of the euro currency. The coefficients of persistence  $\delta$  are statistically significant at all levels for both periods. However, contrary to Denmark, our Wald tests indicate that the coefficient for persistence of revenues is statistically lower to one. Therefore, the Netherlands displays a lower persistence than Denmark for its fiscal finances.

The United Kingdom displays a coefficient for responsiveness which is not statistically significant at all levels for both periods. On the contrary, the

## Kasimati

coefficients of persistence  $\delta$  are statistically significant at all levels of significance both for the full and the sub periods. Moreover, our Wald tests in Table 2 indicate that they are not different than one for both periods we examine. This suggests that government revenues and expenses in the United Kingdom have been largely determined by their own lagged values throughout time. In addition, government spending has been more persistent than government revenue.

Finally, it seems that for the whole period, we accept the null hypothesis for the joint restriction (2) for all countries. The only exception is the sub-sample for the UK. However in both the individual restrictions (3) and (4) we accept the null hypothesis and accordingly we conclude in favour of overall acceptance. Therefore, we conclude that no significant structural change has taken place in the fiscal position of the three countries over time.

<b>Table 3: Wald Tests (Chi-square) based on System (1)</b>			
	$W_\gamma$	$W_\delta$	$W_{joint}$
<b>DENMARK</b>			
<i>Full Sample (1971-2010)</i>	2.435 [0.119]	2.561 [0.109]	2.740 [0.254]
<i>Sub-Sample (1971-2000)</i>	0.239 [0.624]	0.151 [0.698]	3.274 [0.195]
<b>NETHERLANDS</b>			
<i>Full Sample (1971-2010)</i>	0.207 [0.649]	0.248 [0.619]	0.256 [0.879]
<i>Sub-Sample (1971-2000)</i>	2.663 [0.103]	1.637 [0.201]	3.164 [0.206]
<b>UNITED KINGDOM</b>			
<i>Full Sample (1971-2010)</i>	0.974 [0.324]	1.264 [0.261]	1.734 [0.420]
<i>Sub-Sample (1971-2000)</i>	0.499 [0.479]	0.037 [0.846]	7.798 [0.020]
<b>Notes:</b> $W_\gamma$ - Wald test for $\gamma^{EXP} = \gamma^{REV}$ . $W_\delta$ - Wald test for $\delta^{EXP} = \delta^{REV}$ . $W_{joint}$ - Wald test for $\gamma^{EXP} = \gamma^{REV} \wedge \delta^{EXP} = \delta^{REV}$ . Probabilities in brackets.			

### 5. Conclusions

In this article, we use the approach used by Afonso and Sousa (2011) and Kasimati (2011) to assess long-term fiscal developments for three European countries, and more specifically for Denmark, the Netherlands and the United Kingdom. We used annual data and a TSLS specification to estimate the responsiveness and the persistence of the government expenditure and revenue within a system of equations.

As far as Denmark is concerned, the coefficients of responsiveness are not statistically significant at all levels of significance, both for the full and the sub periods. Conclusively, changes in GDP do not affect either government expenses or revenues. On the contrary, the coefficients of persistence for expenses are statistically significant at all levels of significance both for the full and the sub periods. The United Kingdom displays a coefficient for responsiveness which is not statistically significant at all levels for both periods, while the coefficients of persistence are statistically significant at all levels of significance both for the full and the sub-periods. Finally, as far as the Netherlands is concerned, the coefficient of responsiveness for expenses is not statistically significant at all levels for both periods, while the coefficients of persistence are statistically significant at all levels for both periods.

Therefore, the empirical results indicate that (i) in Denmark government expenditures and revenues are not affected by policies which either increase or decrease output, (ii) in all three countries, government expenses and revenues are largely determined by their own lagged values, (iii) in the Netherlands and the United Kingdom, contrary to Denmark, government expenditures exhibits higher persistence than government revenues and (iv) there is no structural change in the fiscal position of the three countries over time.

Concluding, we believe that our empirical findings can be useful for fiscal authorities and government policy-makers in their attempt to stabilise the economies, as the persistence of government spending is large.

### References

- Afonso, A Agnello, A and Furceri, D 2008, 'Fiscal policy responsiveness, persistence and discretion', ECB Working Paper No. 954.
- Afonso, A and Rault, C 2007, 'What do we really know about fiscal sustainability in the EU? A panel data diagnostic', ECB working paper No. 820.
- Afonso, A and Sousa, RM 2011, 'Assessing long-term fiscal developments: evidence from Portugal', *Applied Economics Letters*, vol. 18, pp.1-5.
- Ahmed, S and Rogers, J 1995, 'Government budget deficits and trade deficits. Are present value constraints satisfied in long-term data?', *Journal of Monetary Economics*, vol. 36, pp. 351-74.

## Kasimati

- Bohn, H 2007, 'Are stationarity and cointegration restrictions really necessary for the intertemporal budget constraint?', *Journal of Monetary Economics*, vol. 54, pp. 1837-47.
- Fatas, A and Mihov, I 2003, 'The Case for Restricting Fiscal Policy Discretion', *Quarterly Journal of Economics*, vol. 118, pp. 1419-1447.
- Fatas, A and Mihov, I 2006, 'The macroeconomics effects of fiscal rules in the US states', *Journal of Public Economics*, vol. 90, pp. 101-17.
- Hamilton, J and Flavin, M 1986, 'On the limitations of Government Borrowing: A framework for empirical testing', *American Economic Review*, vol. 76, pp. 808-816.
- Kasimati, E 2011, 'Assessing Long-term fiscal dynamics: Evidence from Greece and Belgium', *International Review of Business Research Papers*, Vol. 2, no. 6, pp. 33-45.
- Quintos, C 1995, 'Sustainability of the deficit process with structural shifts', *Journal of Business and Economic Statistics*, vol. 13, pp. 409-17.
- Trehan, B and Walsh, C 1991, 'Testing intertemporal budget constraints: theory and applications to US federal budget and current account deficits', *Journal of Money, Credit, and Banking*, vol. 23, pp. 206-23.
- Wirjanto, T and Amano, R 1996, 'Nonstationary regression models with a lagged dependent variable', *Communications in statistics. Theory and methods*, vol. 25, no. 7, pp. 1489-1503.
- Zellner, A and Theil, H 1962, 'Three stage least squares: simultaneous estimation of simultaneous equations', *Econometrica*, vol. 30, pp. 54-78.