

THE ELUSIVE CHARACTER OF FISCAL SUSTAINABILITY

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The opinions expressed herein are those of the authors and do not necessarily reflect the views of their employers.

- Introduction
- Literature
- Theoretical framework
- Stylised facts
- Empirical analysis
- Conclusion

In this paper we...

- investigate the sustainability of fiscal policy in a set of **18 OECD countries**, using annual data over the period **1970-2010**;
- are also interested, among other things, in ascertaining the causal direction between government expenditures and revenues;
- In our empirical approach we perform a systematic analysis of:
 - the stationarity properties of the first-differenced stock of government debt;
 - the relation between government revenues and expenditures;
 - the relation between primary balances and debt.

- Evidence suggests stronger effects running from revenues to expenditures.
- In 6 cases we have causality running from expenditures to revenues (*the “spend and tax” hypothesis*), meaning that the majority of fiscal authorities are not able to generate the revenues required to finance the planned expenditures.
- All in all, we **cannot** say that fiscal policy has been sustainable for most countries in our sample.

- Several studies tackle explicit government liabilities (mainly US and European cases).
- Hamilton and Flavin (1986); Hakkio and Rush (1991); MacDonald (1992); Quintos (1995); Makrydakis et al. (1999); Fève and Henin (2000); Hatemi-J (2002); Afonso (2005), Mendoza and Ostry (2007); Arghyrou and Luintel (2007); Afonso and Rault (2010, 2014); Afonso and Jalles (2011, 2014), Camarero et al. (2014).
- Bohn (2007) provides a challenge to the time series literature on fiscal policy, emphasizing whether a country's primary balance responds positively to debt as an indicator of sustainability (as Trehan and Walsh, 1991, and Afonso, 2008).

- The literature usually tests for the possibility of both public expenditures and revenues continuing their historical growth patterns.
- The government budget constraint can be used to derive the PVBC:

$$G_t + (1 + r_t)B_{t-1} = R_t + B_t$$

- Rewriting for the subsequent periods, and recursively solving leads to the intertemporal budget constraint:

$$B_t = \sum_{s=1}^{\infty} \frac{R_{t+s} - G_{t+s}}{\prod_{j=1}^s (1 + r_{t+j})} + \lim_{s \rightarrow \infty} \prod_{j=1}^s \frac{B_{t+s}}{(1 + r_{t+j})}$$

- For empirical tests one assumes that the real interest rate is stationary.
- After some manipulations, we get the PVBC:

$$B_{t-1} = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (R_{t+s} - E_{t+s}) + \lim_{s \rightarrow \infty} \frac{B_{t+s}}{(1+r)^{s+1}} \quad [E_t = G_t + (r_t - r)B_{t-1}]$$

- A sustainable fiscal policy should ensure that the present value of the stock of public debt goes to zero in infinity, i.e., the debt grows no faster than the real interest rate (no *Ponzi games*). (It is also possible to derive the solvency condition in % of GDP)

To assess empirically the absence of Ponzi games, we:

- i) test the stationarity of the first difference of the stock of public debt;
- ii) the cointegration between primary balance (s) and the (lagged) stock of the public debt (B) (Bohn, 1998, 2007), using the following cointegration regression:

$$s_t = \alpha + \gamma B_{t-1} + u_t$$

- “*Backward-looking*” approach: an increase in the previous level of debt would result in a larger primary balance today.
- In the FTPL the distinction is between a Ricardian (Monetary dominant) regime and a non-Ricardian (Fiscal dominant) regime.

iii) It is also possible to assess fiscal sustainability through cointegration between government revenues and expenditures.

$$E_t = G_t + (r_t - r)B_{t-1} \qquad GG_t = G_t + r_t B_{t-1}$$

Using E and the intertemporal budget constraint becomes:

$$GG_t - R_t = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s-1}} (\Delta R_{t+s} - \Delta E_{t+s}) + \lim_{s \rightarrow \infty} \frac{B_{t+s}}{(1+r)^{s+1}}$$

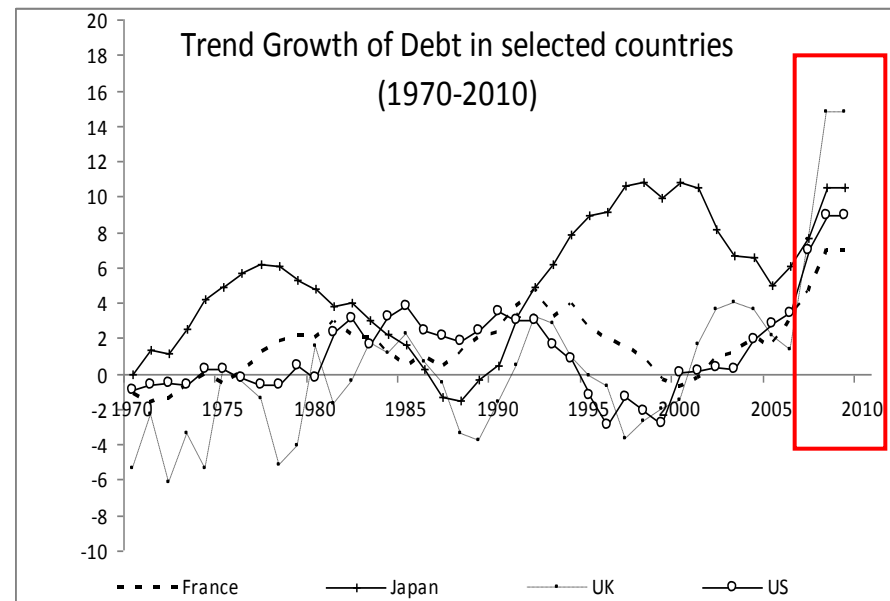
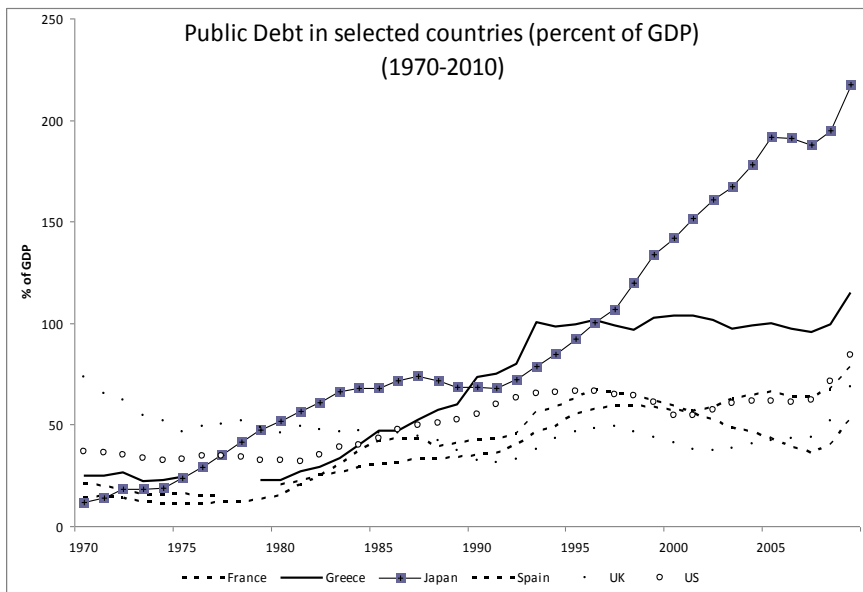
and with the no-Ponzi game condition, GG and R must be co-integrated of order one for their first differences to be stationary.

$$R_t = \alpha + \beta GG_t + u_t$$

Data Overview

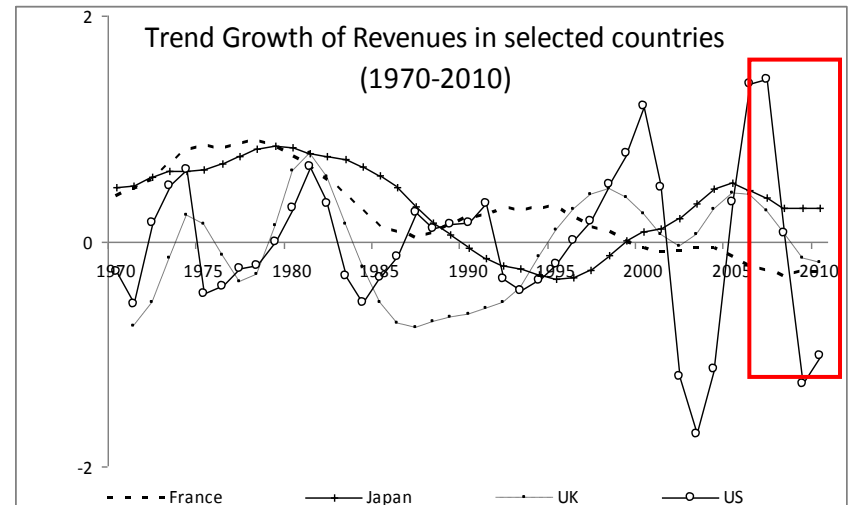
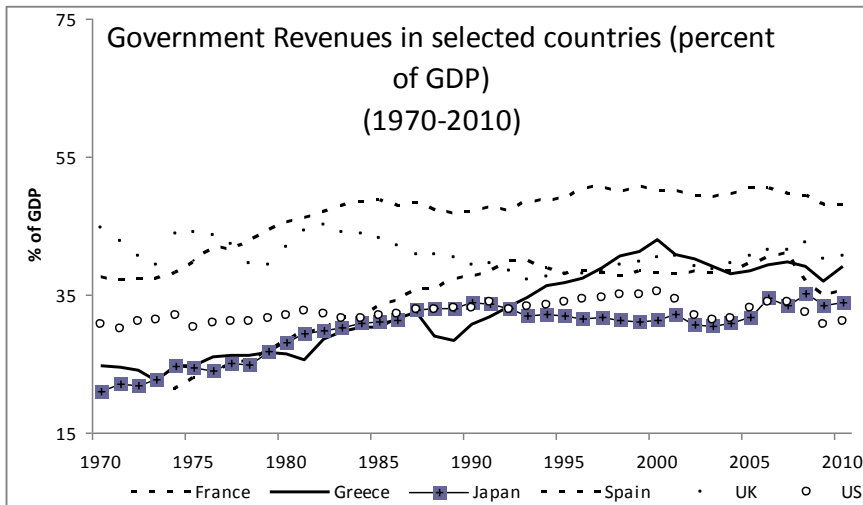
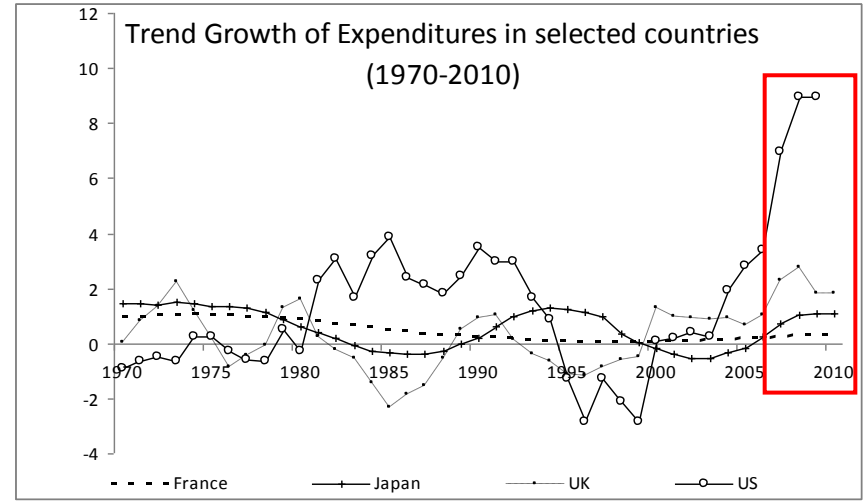
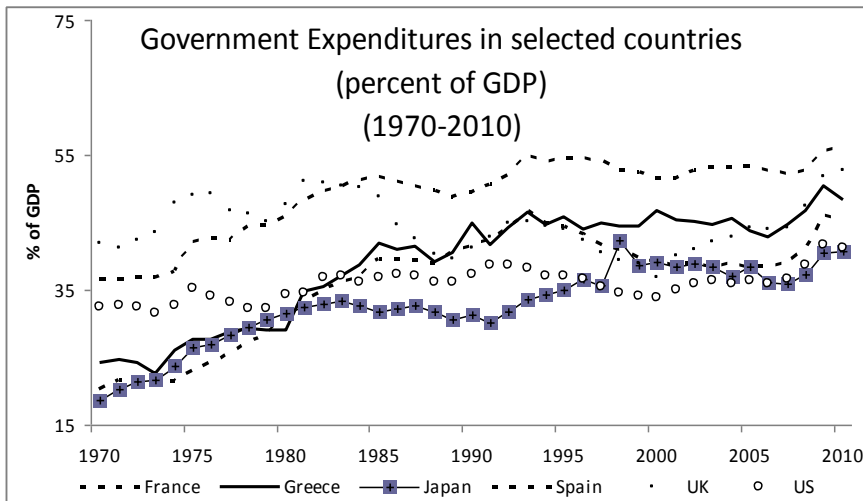
Stylised facts (1/2)

- Most data from the EC AMECO database, for **1970-2010** for **18 OECD countries**.
- For Australia, Canada, Japan and the USA, primary balance (% of GDP) data are from the OECD database.
- Government debt (% of GDP) series are retrieved from Abbas et al. (2010) dataset.



Data Overview

Stylised facts (2/2)



Econometric approaches

- In addition to standard Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests we also conduct:

1. The four tests (M-tests) proposed by Ng and Perron (2001) (NP) based on modified information criteria (MIC): the modified Phillips-Perron test (MZa); the modified Sargan-Bhargava test (MSB); the modified point optimal test; and the modified Phillips-Perron (MZt);
2. Unit root tests allowing for breaks and we begin with Zivot-Andrews (1992) (ZA).
3. We complement with the modified ADF test proposed by Vogelsang and Perron (1998) (VP).
4. Two-break unit root test described by Clemente, Montanes and Reyes (1998) (CMR).
5. Finally, Perron and Yabu (2009) (PY) unit root test.

Stationarity: Unit root Tests for First-Differenced Debt

Analysis (1.1/4)

Countries	ADF	PP	NP			
			MZa	MZt	MSB	MPT
	(1)	(2)	(3)	(4)	(5)	(6)
Australia	-4.98***	-4.98***	-3.66	-1.30	0.35	24.02
Austria	-2.15	-2.42	-8.34	-1.99	0.23	11.07
Belgium	-1.89	-1.78	-6.78	-1.69	0.24	13.53
Canada	-3.25*	-3.39*	-13.81	-2.57	0.186	6.92
Denmark	-2.18	-2.20	-9.55	-1.91	0.20	10.56
Finland	-4.05**	-2.09	-31.86***	-3.99***	0.12***	2.86***
France	-3.04	-3.07	-11.45	-2.37	0.20	8.05
Germany	-3.96**	-3.96**	-16.12	-2.83	0.17	5.65
Greece	-4.95***	-5.03***	-16.11*	-2.83*	0.17*	5.67*
Ireland	-3.25*	-3.19	-14.80*	-2.40	0.16**	7.90
Italy	-3.34*	-3.41*	-13.99	-2.61	0.18	6.70
Japan	-3.04	-3.28*	-4.92	-1.56	0.31	18.51
Netherlands	-3.04	-3.12	-15.4*	-2.50	0.16**	7.41
Portugal	-1.56	-4.28**	-21.06**	-3.21**	0.15**	4.51**
Spain	-2.73	-2.79	-11.39	-2.32	0.20	8.32
Sweden	-2.80	-2.93	-10.66	-2.30	0.21	8.54
United Kingdom	-3.25*	-3.34*	-12.03	-2.35	0.19	8.08
United States	-2.24	-2.23	-11.19	-2.08	0.18	9.48

- ADF and PP results allow the (strong) rejection of the null of a unit root only in Australia, Germany and Greece (and weakly in Canada, Italy and UK).
- Therefore the series of the first difference of government debt might be $I(0)$ and the solvency condition would be satisfied in those cases since non-stationarity can be rejected.

Stationarity: Unit root Tests for First-Differenced Debt

Countries	ADF	PP	NP				ZA	VP(AO)	VP(IO)	CMR(AO)	CMR(IO)	PY2009
	(1)	(2)	MZa	MZt	MSB	MPT						
	(3)	(4)	(5)	(6)	(7)	(8)						
Australia	-4.98***	-4.98***	-3.66	-1.30	0.35	24.02	2002	2005	2004**	1998, 2005	2004, 2008**	1995***
Austria	-2.15	-2.42	-8.34	-1.99	0.23	11.07	1992	2003	1999	1988, 2002	1990, 1999**	2002
Belgium	-1.89	-1.78	-6.78	-1.69	0.24	13.53	1990	1989	1979	1985, 2002	1980, 1996	1993***
Canada	-3.25*	-3.39*	-13.81	-2.57	0.186	6.92	1992	1988**	1981	1988, 2002	1981, 2002	1991***
Denmark	-2.18	-2.20	-9.55	-1.91	0.20	10.56	1983	1987**	2004	1984, 2003	1980, 2004	1980***
Finland	-4.05**	-2.09	-31.86***	-3.99***	0.12***	2.86***	1993**	1995	1990**	1985, 1995	1980, 1990**	1990***
France	-3.04	-3.07	-11.45	-2.37	0.20	8.05	1994	1998	1991	1984, 1995	1981, 1991	2003***
Germany	-3.96**	-3.96**	-16.12	-2.83	0.17	5.65	1996	1998	1992	1984, 1997	1974, 1992	2003***
Greece	-4.95***	-5.03***	-16.11*	-2.83*	0.17*	5.67*	1991	1990	1983	1984, 1991	1983, 1989	2000
Ireland	-3.25*	-3.19	-14.80*	-2.40	0.16**	7.90	1987	1989	1996	1984, 1998	1981, 1996	1995***
Italy	-3.34*	-3.41*	-13.99	-2.61	0.18	6.70	1993	1987	1980	1987, 1995	1981, 1990	1999
Japan	-3.04	-3.28*	-4.92	-1.56	0.31	18.51	1989	2007	1994	1983, 2001	1992, 1997	2003***
Netherlands	-3.04	-3.12	-15.4*	-2.50	0.16**	7.41	1982	1994	1995	1985, 2003	1981, 1998**	1998***
Portugal	-1.56	-4.28**	-21.06**	-3.21**	0.15**	4.51**	1982	1983	1980	1973, 1983	1974, 1980	2003***
Spain	-2.73	-2.79	-11.39	-2.32	0.20	8.32	1994	1987	1980	1989, 1993	1980, 1989**	1995***
Sweden	-2.80	-2.93	-10.66	-2.30	0.21	8.54	1997	1984	1979	1984, 2006	1979, 2002	1998***
United Kingdom	-3.25*	-3.34*	-12.03	-2.35	0.19	8.08	1990	1977	1978	1977, 1989	1988, 1992	2003
United States	-2.24	-2.23	-11.19	-2.08	0.18	9.48	1986	1988	1981	1988, 1994	1984, 1989	1990***

Analysis (1.1/4)

- ADF and PP results allow the (strong) rejection of the null of a unit root only in Australia, Germany and Greece (and weakly in Canada, Italy and UK).
- Therefore the series of the first difference of government debt might be I(0) and the solvency condition would be satisfied in those cases since non-stationarity can be rejected.
- Considering structural breaks, the overwhelmingly conclusion is that most series are I(1), apart from Australia, Canada, Denmark and Finland for the ZA, VP and CMR tests.
- For government expenditures, government revenues and the primary balance, we find similar results, with the non-rejection of the null of unit root in levels for most countries (apart from Australia in the case of expenditures and primary balance, and Germany and Sweden in the case of the primary balance).

Cointegrating-relationship regressions:

$$s_t = \alpha + \gamma B_{t-1} + \varepsilon_t$$

$$R_t = \alpha + \beta G_t + u_t$$

- Cointegrating relations between government revenues and expenditures (primary balance and government debt) using Johansen and Juselius (1990).
- Following Gregory and Hansen (1996), we study the hypothesis of a structural shift in the co-integration relationships.
- The parameters are estimated by Stock and Watson's (1993) Dynamic Ordinary Least Squares (DOLS) following Shin (1994).
- By taking a VAR approach, we can use test for Granger-causality.
- For robustness purposes, we employ Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) approach for Granger causality (we follow Rambaldi and Doran (1996) in formulating these tests).

Cointegration: Johansen-Juselius

Analysis (2.1/4)

Country\relation	Revenues and Expenditures	(lagged) Debt and Primary Balance
Australia	Yes	No
Austria	Yes	Yes
Belgium	No	No
Canada	No	Yes
Denmark	Yes	No
Finland	No	No
France	No	Yes
Germany	Yes	Yes
Greece	No	No
Ireland	No	No
Italy	No	No
Japan	Yes	Yes
Netherlands	Yes	Yes
Portugal	No	No
Spain	No	Yes
Sweden	No	No
United Kingdom	No	Yes
United States	No	No

- One cointegrating relationship between government revenues and expenditures in 6 countries (Australia, Austria, Denmark, Germany, Japan and Netherlands);
- One cointegrating relationship between the primary balance and (lagged) debt in 8 countries (Austria, Canada, France, Germany, Japan, Netherlands, Sweden and the UK).
- Using the Gregory and Hansen (1996) procedure, we get for the revenues-expenditure relationship, rejections of the null of no cointegration in 9 countries; similarly for the balance-(lagged) debt relationship, we reject the null in only 4 countries.
- For the period 1970-2010, government expenditures, in half of the countries, exhibited a higher growth rate than public revenues, challenging therefore the hypothesis of fiscal policy sustainability.

Cointegration: Stock-Watson DOLS

Analysis (2.2/4)

Country\relation	Revenues and Expenditures			(lagged) Debt and Primary Balance		
	β	\bar{R}^2	C_μ	γ	\bar{R}^2	C_μ
Australia	-0.02	0.77	34.25***	-0.03	0.30	3.43
Austria	0.67***	0.92	14.27***	-0.07	0.45	1.36
Belgium	-0.11	0.41	53.25***	0.06**	0.92	-3.21
Canada	0.33***	0.76	26.44***	0.14***	0.95	-10.81***
Denmark	0.70***	0.88	16.05**	0.10	0.87	-0.90
Finland	0.63***	0.90	20.37***	-0.05***	0.93	6.69***
France	0.69***	0.95	13.03***	0.01	0.84	-0.34
Germany	0.84***	0.72	4.94	-0.02	0.67	1.78*
Greece	0.61***	0.82	10.42	0.12***	0.73	-11.22**
Ireland	0.38**	0.64	21.52***	0.13**	0.66	-7.33**
Italy	-0.30	0.50	52.92***	0.12***	0.89	-10.64***
Japan	0.37**	0.69	18.75***	0.02***	0.90	1.15**
Netherlands	0.67***	0.93	14.36***	0.01	0.52	0.38
Portugal	0.98***	0.92	3.94	-0.13	0.57	7.17
Spain	0.89***	0.96	1.32	0.04***	0.88	-1.23**
Sweden	0.61***	0.79	21.83***	-0.04	0.82	6.93**
United Kingdom	0.56***	0.58	15.52**	0.04	0.89	-0.99
United States	0.46***	0.66	16.22***	0.03	0.81	-1.60

- Null of deterministic cointegration is rejected.
- Estimates of β : 15 out of 18 are positive and statistically significant for the revenues-expenditures relationship.
- Always <1 , for each pp of GDP increase in public expenditures, for instance in Denmark and in Canada, public revenues only increase by respectively 0.70 and 0.33 p.p. of GDP.
- For the primary balance-debt relationship, positive and statistically significant estimates of γ out of 18 cases.

Granger-causality tests.

- 2 variables' VAR for: i) government revenues and expenditures; and ii) primary balance and (lagged) debt).
- The system is estimated via the seemingly unrelated regression (SUR) method.

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = A_0 + A_1 \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + A_2 \begin{bmatrix} y_{1t-2} \\ y_{2t-2} \end{bmatrix} + A_3 \begin{bmatrix} y_{1t-3} \\ y_{2t-3} \end{bmatrix} + \begin{bmatrix} e_{y_1} \\ e_{y_2} \end{bmatrix}$$

Hypotheses, causal nexus of gov. revenue and expenditure

1. *One way causation from expenditures to revenues*: the government adjusts revenues to the level of the planned expenditures (Barro, 1979).
2. *One way causation from revenues to expenditures*: authorities adjust their expenditures to the level of the revenue so that control over revenues leads to limited growth in the public sector (Friedman, 1978).
3. *Bidirectional causality (fiscal synchronization)*: classical hypothesis based on the equivalence of marginal cost and marginal revenue that the utility-maximizing suppliers and demanders of the public services make (Musgrave, 1966).
4. *No causality*: authorities can set the level of expenditures and revenues by rule of thumb, reflecting the institutional separation of allocation and taxation functions of the government (Hoover and Sheffrin, 1992). Consistent with no cointegration and potential fiscal unsustainability.

Granger-causality and Toda-Yamamoto Causality Tests

Analysis (4.1/4)

Country\relation	Standard Granger causality				Toda-Yamamoto			
	$GG \rightarrow R$	Yes/No	$R \rightarrow GG$	Yes/No	$GG \rightarrow R$	Yes/No	$R \rightarrow GG$	Yes/No
Australia	3.58	No	5.21*	Yes	2.88	No	6.86**	Yes
Austria	6.01**	Yes	0.88	No	4.21	No	2.56	No
Belgium	1.74	No	0.22	No	0.30	No	1.30	No
Canada	6.02**	Yes	15.48***	Yes	1.50	No	10.25***	Yes
Denmark	1.03	No	13.08***	Yes	0.56	No	1.51	No
Finland	1.15	No	5.07*	Yes	7.40**	Yes	2.20	No
France	1.66	No	4.85*	Yes	1.37	No	6.29**	Yes
Germany	4.46	No	7.56**	Yes	5.09*	Yes	9.73***	Yes
Greece	0.09	No	5.16*	Yes	0.16	No	2.58	No
Ireland	3.15	No	6.21**	Yes	5.08*	Yes	3.06	No
Italy	1.85	No	2.58	No	9.60***	Yes	0.43	No
Japan	0.14	No	1.34	No	0.20	No	2.72	No
Netherlands	7.95**	Yes	4.52	No	8.78**	Yes	8.37**	Yes
Portugal	6.95**	Yes	3.00	No	11.82***	Yes	2.11	No
Spain	4.84*	Yes	3.48	No	1.23	No	17.22***	Yes
Sweden	3.02	No	5.09*	Yes	1.69	No	1.13	No
United Kingdom	1.87	No	0.50	No	1.75	No	2.85	No
United States	9.16**	Yes	2.48	No	3.49	No	1.22	No

- In Canada, two-way causality is found, “fiscal synchronization”;

- 6 cases: causality running from expenditures to revenues (the “spend and tax” hypothesis).

- Similar conclusions from the Toda-Yamamoto test (Germany and Netherlands, two-way causality).

Country\relation	Standard Granger causality				Toda-Yamamoto			
	$B_{t-1} \rightarrow s$	Yes/No	$s_{t-1} \rightarrow B$	Yes/No	$B_{t-1} \rightarrow s$	Yes/No	$s_{t-1} \rightarrow B$	Yes/No
Australia	1.06	No	3.71	No	0.33	No	0.52	No
Austria	2.09	No	0.33	No	4.16*	Yes	0.19	No
Belgium	14.99***	Yes	1.78	No	15.48***	Yes	0.45	No
Canada	13.35***	Yes	2.53	No	6.42**	Yes	0.96	No
Denmark	5.29*	Yes	1.69	No	8.81**	Yes	2.83	No
Finland	4.31	No	9.14**	Yes	4.84*	Yes	3.95	No
France	1.09	No	3.50	No	9.77***	Yes	2.86	No
Germany	2.68	No	1.53	No	2.12	No	1.01	No
Greece	12.98***	Yes	3.05	No	9.94***	Yes	0.16	No
Ireland	6.37**	Yes	2.27	No	0.62	No	9.25***	Yes
Italy	17.04***	Yes	4.58*	Yes	5.73*	Yes	3.91	No
Japan	1.15	No	6.79**	Yes	6.04**	Yes	12.59***	Yes
Netherlands	0.65	No	2.10	No	13.23***	Yes	5.35*	Yes
Portugal	1.60	No	1.87	No	1.95	No	2.06	No
Spain	5.90*	Yes	1.77	No	1.31	No	7.01**	Yes
Sweden	4.70*	Yes	2.53	No	12.2***	Yes	3.32	No
United Kingdom	3.77	No	12.56***	Yes	2.09	No	16.09***	Yes
United States	1.24	No	2.02	No	10.44***	Yes	2.93	No

- Granger-causality from primary balance to debt in 4/5 countries only.

- Granger-causality from debt to primary balance found in 12 countries – evidence of Ricardian regimes.

1. Non-stationarity of the first-differenced debt series for most countries suggesting that the solvency condition would not be satisfied.
2. We find similar results for government expenditures, government revenues and the primary balance series, with the non-rejection of the null of unit root (in levels) for most countries.
3. Evidence suggests one cointegrating relationship in only 6 countries between revenues and expenditures. However, the overall test results allow the rejection of the cointegration hypothesis in both relationships.
4. In half of the countries government expenditures exhibited a higher growth rate than public revenues, challenging fiscal policy sustainability.
5. Estimating the cointegrating coefficient we get 15 out of 18 cases positive and statistically significant estimates for the revenues-expenditures relationship and these are always less than one.

6. Evidence suggests stronger effects running from revenues to expenditures. In 6 cases we have causality running from expenditures to revenues (*the “spend and tax” hypothesis*), meaning that the majority of fiscal authorities are not able to generate the revenues required to finance the planned expenditures.
7. Granger causality from government debt to the primary balance is found for 12 countries, which can be seen as evidence of Ricardian regimes.
8. Even though we find that long-run causality seems to run from lagged debt to the primary balance, on average the marginal long-run impact is zero.
9. All in all, we cannot say that fiscal policy has been sustainable for most countries in our sample.

Original series	Ameco codes
Total expenditure: general government, Excessive deficit procedure (% of GDP at market prices)	1.0.319.0.UUTGF, 1.0.319.0.UUTGE
Total revenue: general government, Excessive deficit procedure (% of GDP at market prices)	1.0.319.0.URTGF, 1.0.319.0.URTGE
General government consolidated gross debt, excessive deficit procedure (based on ESA 1995) and former definition (linked series) (% of GDP at market prices)	1.0.319.0.UDGGF, 1.0.319.0.UDGGL
Primary Balance (% GDP at market prices)	1.0.319.0.UBLGI, for EU countries; OECD database for Australia, Canada, Japan, US and

