Assessing Long-Term Fiscal Developments:
a New Approach[*]

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Abstract

We use a new approach to assess long-term fiscal developments. By analyzing the time-varying behaviour of the two components of government spending and revenue – responsiveness and persistence–, a feature not captured by automatic stabilisers, we are able to infer about the sources of fiscal deterioration (improvement). Drawing on quarterly data, we estimate recursively these components within a system of government revenue and spending equations using a Three-Stage Least Square method for eight European Union countries plus the US. The results suggest that significant changes in the fiscal stance (including those related to the current crisis) are reflected in the estimates of persistence and responsiveness.

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Keywords: Fiscal Deterioration, Fiscal Sustainability.

1. Introduction

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. Standard empirical strategies focus on testing if the first differences of the debt series are stationary or if government spending and revenue are co-integrated. 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 spending in the cointegration relationship between government spending and revenue. This interpretation is based on the work of Hamilton and Flavin (1986), Trehan and Walsh (1988, 1991), Ahmed and Rogers (1995) and Quintos (1995). In this framework, the empirical assessments of fiscal sustainability have been usually carried out on a country basis.

More recently fiscal developments have also been assessed for the OECD and European Union (EU) country groupings, given that several economic and econometric arguments support the use of panel analysis for such purpose. Notably, Afonso and Rault (2008, 2010) used 1st and 2nd generation panel unit root tests as well as recent panel cointegration techniques that allow for correlation to be accommodated both within and between units. Within such strand of research, fiscal policies seem to have been sustainable for the EU panel while estimations point to past fiscal developments being an issue in some countries.

The long-term (i.e. cointegration) relationship between primary budget balances and government debt, essentially a fiscal reaction function, also provides evidence on the sustainability features of public finances.[1] On the other hand, Bohn (2007) argues that rejection of sustainability based on standard (country specific) cointegration tests are

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[1] See Trehan and Walsh (1991), while Afonso (2008) also assesses such type of fiscal reaction functions for primary budget balances in a panel framework for the EU countries.

invalid because the present-value borrowing constraint could be satisfied even if government spending and revenue are not cointegrated nor deficit and debt are difference-stationary. In light of these results, this paper proposes a new approach to assess long-term fiscal behaviour, i.e. possible fiscal deterioration or fiscal improvement. Building upon Afonso et al. (2010), we study the pattern of government spending and revenue and their desegregation in two main components: persistence and responsiveness. Focusing on the difference in responsiveness and persistence (a feature not captured by automatic stabilisers) between government spending and revenue, we infer about budget deficit evolution over time and the existence of possible fiscal deterioration.

Using this approach, we assess long-term fiscal developments for nine countries: Belgium, Finland, France, Germany, Italy, the Netherlands, Spain, the UK and the US For this purpose we use a set of quarterly fiscal data taken from national accounts (in the case of the US and the UK) or computed by drawing on the higher frequency (monthly) availability of fiscal cash data (in the other cases).[2] This is also a novelty with respect to the existing related literature which generally focuses on annual data to analyse a broad set of countries.[3]

The results suggest that significant changes in fiscal positions (including those related to the crisis) are well captured in our estimates of the responsiveness and persistence components of government spending and revenue. In particular, the results show that for Belgium, and the Netherlands, the fiscal improvement has been mainly driven by a higher persistence of government revenue, vis-à-vis government spending. Regarding the more recent period, our results reflect a reduction in the responsiveness of

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[2] The country selection was determined by the practical possibility of using quarterly fiscal data for the EU countries plus the US.

[3] Studies that also use higher frequency data in the context of fiscal sustainability, either quarterly or montly, are: Hakkio and Rush (1991), MacDonald (1992), Haug (1995) and Quintos (1995) for US, Smith and Zin (1991) for Canada, Baglioni and Cherubini (1993) for Italy, and Hatemi-J (2002) for Sweden. Afonso (2005) provides a broader review of empirical evidence.

government revenue to the economic cycle for most countries (compared to the responsiveness of government spending) implying a deterioration of the capacity of the fiscal authorities to use automatic stabilizers to counteract the negative effects of the crisis.

The remainder of the paper is organized as follows. Section 2 presents our empirical methodology used to assess fiscal developments. Section 3 presents the data and how they are constructed. Section 4 reports and discusses the empirical results for assessing fiscal deterioration (or fiscal improvement). Finally, section 5 concludes.

2. Empirical methodology

In order to assess the existence of fiscal deterioration, we estimate recursively for each country i (with $i = 1,...,N$) the following system of structural equations:

$$\begin{cases} \log(G_{i,t}) = \alpha_{ik}^G + \beta_{ik}^G \log(Y_{i,t}) + \gamma_{ik}^G \log(G_{i,t-1}) + \varepsilon_{ik,t}^G & (t = 1,2,...,T) \\ \log(R_{i,t}) = \alpha_{ik}^R + \beta_{ik}^R \log(Y_{i,t}) + \gamma_{ik}^R \log(R_{i,t-1}) + \varepsilon_{ik,t}^R & (t = 1,2,...,T) \end{cases} \quad (1)$$

where G is real government spending, R is real government revenue and Y is real GDP. For each sample of length k (where $k = \bar{k} + h$ and $h = 1,2,...,T - \bar{k}$)[4], the country-specific coefficient β_{ik} measures the responsiveness of fiscal policy, that is, the behaviour of fiscal policy over the business cycle, while the coefficient γ_{ik} represents a measure of fiscal persistence, i.e. the degree of dependence of the current fiscal behaviour from its own past setting.

Difficulties in estimating system (1) are related to the presence of lagged endogenous variables among the explanatory variables. In order to insure consistent

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[4] $\bar{k}$ is the length of the sample window used to initialize the recursive estimation procedure. In our analysis, we set the window size equal to fifteen years, i.e. $\bar{k} = 60$ quarters.

estimates from (1), we use a Three-Stage Least Square (TSLS) method (see e.g. Zellner and Theil, 1962). In particular, to avoid any endogeneity bias due to the simultaneity in the determination of output, government spending and revenue, we instrument for current GDP (Y) with two lags of GDP, the index of oil prices (see e.g. Fatás and Mihov (2003, 2006)), and the lagged value for revenue and spending, respectively in the spending and revenue equation.

After estimating recursively the system (1), we compute, for each country i and for each of the $\left(T - \bar{k} + 1\right)$ sets of parameters estimates (i.e. one set for each sample period), the Wald-statistics to test the following joint restrictions:

$$H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R. \tag{2}$$

Testing jointly for the equality between the parameters of responsiveness and persistence associated to the government spending and revenue equations implies to investigate whether potential episodes of fiscal deterioration occurred throughout time. If we accept the null hypothesis, we conclude that the behaviour of both government spending and revenue evolve dynamically in such a way to avoid any structural change of the fiscal position. On the contrary, rejection of the null hypothesis signals structural changes in the fiscal behaviour towards deterioration or improvement. In particular, in order to discriminate between these two cases, and to assess whether changes in the fiscal position are due to different responsiveness or persistence between government spending and revenue, we test the following single hypothesis:

$$H_0 : \gamma_{ik}^G = \gamma_{ik}^R \qquad H_1 : \gamma_{ik}^G \neq \gamma_{ik}^R \tag{3}$$

$$H_0 : \beta_{ik}^G = \beta_{ik}^R \qquad H_1 : \beta_{ik}^G \neq \beta_{ik}^R. \tag{4}$$

From the analysis of the single tests, and the analysis of the estimates of the parameters we can obtain three possible outcomes: i) fiscal deterioration (due to fiscal persistence and/or to fiscal responsiveness); ii) fiscal improvement (due to persistence and/or responsiveness); iii) indeterminacy, when government spending persistence is bigger than revenue persistence ($\gamma_{ik}^{G} > \gamma_{ik}^{R}$), but spending responsiveness is lower than revenue responsiveness ($\beta_{ik}^{G} < \beta_{ik}^{R}$), and vice versa ($\gamma_{ik}^{G} < \gamma_{ik}^{R}$; $\beta_{ik}^{G} > \beta_{ik}^{R}$).

3. Data

This section provides a summary description of the data employed in the empirical analysis. A detailed description is provided in the appendix.

We use quarterly data for nine countries: Belgium, Finland, France, Germany, Italy, Netherlands, Spain, UK, and US National currency data for all years prior to the switch of the euro area countries to the euro have been converted using the fixed euro conversion rate in order to provide comparable series across time for each country. All variables are seasonally adjusted and are expressed in natural logarithms of real terms.

For the government finance statistics – that is, government spending and government revenue – and, in the case of the euro area countries, we use budgetary data on a cash basis.[5] It normally refers to the Central Government, therefore, with the exclusion of the Local and/or the Regional Authorities. The data are typically disseminated through the monthly publications of the General Accounting Offices, Ministries of Finance, National Central Banks and National Statistical Institutes of the respective countries. The latest figures are also published in the Special Data Dissemination Standard (SDDS) section of the International Monetary Fund (IMF) website, to which EU Member States contribute.

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[5] Onorante et al. (2008) discuss the accounting procedures, the methods of compilation, the timing of recording of transactions, and the coverage of budgets in the case of infra-annual budgetary cash data. The authors show that it can be useful for fiscal forecasting in the euro area.

For the US, we consider the Federal Government spending and revenue, whilst, for the UK, figures correspond to the Public Sector. That is, both for the US and the UK, quarterly fiscal data is available directly from national accounts.

For GDP and GDP deflator, we use the International Financial Statistics from the IMF.

Our analysis covers the following samples: 1980:1-2009:3, for Belgium; 1970:1-2009:3, for Finland; 1970:1-2009:3, for France; 1979:1-2009:3, for Germany; 1980:1-2009:3, for Italy; 1977:1-2009:3, for the Netherlands; 1985:1-2009:3, for Spain; 1955:1-2009:2, for the UK; and, 1967:2-2009:2, for the US[6]

4. Results and Discussion

In this section we report and discuss the estimates of or measures of responsiveness and persistence, as well as the tests discussed in the second section, for each country in our sample. Table 1 summarises the recursive estimates of the responsiveness and persistence coefficients. In addition, Table 2 provides the estimates of those measures for two sub-periods: before and after 1992, for the European Union countries (Maastricht); and with a split in 1987:3 for the US (before and after Greenspan).

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[6] Some infra-annual budgetary cash data is interpolated due to the existence of missing values: for France, January and February of the years of 1970 and 1976-1993. In the case of Germany, we also include: (i) one dummy for the period after 1991:1 (inclusive), corresponding to the German reunification; and (ii) another dummy for 2000:3, to track the spike in government revenue associated with the sale of UMTS (Universal Mobile Telecommunications System) licenses. For Belgium, we add a dummy for the period after 1991:1 (inclusive) to account for the substantial fall in government spending. Finally, for France, we add a dummy to track the spike in government spending in the period 1993: 4.

Table 1
Recursive window estimates for responsiveness and persistence

Country	First 60 quarters							Full sample						
	Responsiveness		Persistence		Wald tests			Responsiveness		Persistence		Wald tests		
	$\hat{\beta}^G$	$\hat{\beta}^R$	$\hat{\gamma}^G$	$\hat{\gamma}^R$	W_β	W_γ	W_{joint}	$\hat{\beta}^G$	$\hat{\beta}^R$	$\hat{\gamma}^G$	$\hat{\gamma}^R$	W_β	W_γ	W_{joint}
BEL	-0.15	0.46***	0.17**	0.18	16.04***	0.01	17.81***	-0.01	-0.43***	0.26***	0.66***	6.14***	12.90***	32.77***
ESP	0.46***	0.80***	0.52***	0.35***	4.27**	1.91	5.18*	0.05	0.05	0.81***	0.78***	0.00	0.09	0.14
FIN	1.03***	1.29***	0.37***	-0.18	0.40	3.68*	35.42**	0.11**	0.56***	0.90***	0.51***	14.4***	16.25***	17.08***
FRA	0.19*	0.07	0.44***	0.33***	2.21	2.12	5.36*	0.48***	0.40***	0.50***	0.48***	2.31	0.23	12.73***
GER	-0.00	0.43***	0.18*	-0.20***	14.93***	10.38***	18.38***	0.05	0.24***	0.22**	0.28***	7.11**	0.38	9.90**
ITA	1.23**	1.26***	-0.03	0.28**	0.01	3.48**	13.66***	0.37***	0.69***	1.84*	0.37***	7.46***	3.96**	38.56***
NLD	0.23**	0.40***	0.68***	0.59***	1.63	0.54	1.80	-0.08**	-0.05	0.68***	0.79***	0.64	3.37*	3.39
UK	0.25***	0.26***	0.83***	0.85***	0.00	0.04	1.13	0.05***	0.05**	0.95***	0.94***	0.00	0.10	3.54
US	0.12	0.33***	0.91***	0.70***	2.71*	4.10**	4.89*	0.02	0.13***	0.98***	0.87***	5.62**	6.82***	8.34**

Notes: W_β - Wald test for $\beta^G = \beta^R$. W_γ - Wald test for $\gamma^G = \gamma^R$. W_{joint} - Wald test for $\beta^G = \beta^R \wedge \gamma^G = \gamma^R$.
*, **, ***, respectively significant at 10%, 5% and 1%.

Table 2
Sub-period estimates for responsiveness and persistence

Country	[..., 1991Q4]							[1992Q1, ...]						
	Responsiveness		Persistence		Wald tests			Responsiveness		Persistence		Wald tests		
	$\hat{\beta}^G$	$\hat{\beta}^R$	$\hat{\gamma}^G$	$\hat{\gamma}^R$	W_β	W_γ	W_{joint}	$\hat{\beta}^G$	$\hat{\beta}^R$	$\hat{\gamma}^G$	$\hat{\gamma}^R$	W_β	W_γ	W_{joint}
BEL	-0.57*	0.38***	0.69***	0.23	6.82***	3.09*	10.91***	0.02	-0.81***	0.28**	0.52***	8.94***	2.58	10.75***
ESP	1.55***	2.08***	-0.33**	-0.11	1.94	1.31	21.82***	-0.01	-0.03	0.77***	0.76***	0.06	0.00	0.06
FIN	0.42***	1.04***	0.73***	0.17	4.94**	7.31***	15.34***	0.10**	0.41***	0.41***	0.54***	4.64**	0.50	19.09***
FRA	0.32***	0.31***	0.40***	0.31***	1.25	1.87	6.35**	0.46***	0.23	0.40***	0.51***	4.02**	1.53	4.06
GER	0.04	0.49***	0.09	-0.28**	15.42***	9.16***	17.98***	0.08*	0.15*	0.53***	0.70***	0.56	1.78	3.66
ITA	0.99***	1.51***	0.21	0.18	1.83	0.02	5.26*	0.06	0.54***	-0.03	0.09	6.67***	0.62	8.75**
NLD	0.23**	0.40***	0.69***	0.62***	1.57	0.37	1.85	-0.17***	-0.15**	0.30***	0.44***	0.16	1.32	1.44
UK	0.08***	0.09**	0.93***	0.92***	0.05	0.15	0.74	0.05**	0.31***	0.97***	0.71***	6.35***	7.87***	9.63***
US	0.05	0.34***	0.96***	0.68***	6.87***	10.21***	12.80***	0.02	0.02	1.00***	0.96***	0.00	0.65	4.99*

Notes: W_β - Wald test for $\beta^G = \beta^R$. W_γ - Wald test for $\gamma^G = \gamma^R$. W_{joint} - Wald test for $\beta^G = \beta^R \wedge \gamma^G = \gamma^R$.
*, **, ***, respectively significant at 10%, 5% and 1%. For the US the two sub-period cut-off date is 1987Q3.

Belgium

The case of Belgium is a particularly interesting one. As it is possible to see from Figure 1d, Belgium has been characterized by fiscal deterioration at the beginning of the 1980s, and by fiscal consolidation until 2007. Our results seem to confirm this evidence. In Figures 1a and 1b, we report the recursive estimates over time of our measures of

persistence and responsiveness for government spending and revenue. We can observe that the estimates of persistence of government revenue are higher than the ones of government spending over the entire period, while the estimates of responsiveness of government revenue are higher until 2002. In particular, Wald tests indicate that the discrepancy in the behaviour of government spending and revenue is highly significant for most of the sample windows (see also Table 1). The analysis confirms the consolidation of public balances and suggests that it has been driven by the higher responsiveness and persistence of government revenue, compared to government spending.

The analysis of the estimates of responsiveness and persistence also signals a potential shift of the fiscal regime due to crises-related developments. In particular, Figures 1a and 1b display a decrease of revenue responsiveness and an increase of spending responsiveness in recent years, which point to fiscal deterioration.

France

France has been characterized by resilient budget deficits over most of the observation period (1970-2009). Indeed, the budget deficit has been relatively stable, with the exception of the beginning of the nineties and in 2009, when it deteriorated significantly (see Figure 2d). This pattern is reflected in the estimates of responsiveness and persistence components of both government revenue and spending.

First, our results suggest that both the persistence and responsiveness of government spending have been higher than the ones of government revenue. The difference in the estimated parameters has been rather constant, reflecting a stable deficit over the time sample. Second, the significant increase in 1993 in the budget deficit corresponds to a substantial increase of the persistence of government spending in the same year. Third, the rising budget deficits, due to the fiscal costs of the crisis, are

reflected in a widening difference between the responsiveness of revenue and spending. As a results, the Wald tests point to a fiscal deterioration in the last quarters of 2009.

Finland

Public finances have been always quite sound during the last three decades (an exception is the fiscal deterioration during the crisis of the first half of the 1990s). Moreover, looking at Figure 3d, we can see that with the exception of the period immediately after the financial crisis in 1991, no major changes in the budget balance seem to have occurred. Our analysis provides similar conclusions, but also shows how this fiscal position has been achieved trough a different behaviour of spending and revenue in terms of responsiveness and persistence (see Figures 3a and 3b). In particular, while government spending persistence has been higher than government revenue persistence, revenue has been more responsive than spending. This is also confirmed by the analysis for the two sub-periods (see Table 1 and 2).

In addition the fiscal turbulence at the beginning of the nineties is reflected in the instability of the estimates of both responsiveness and persistence in those years.

Germany

The pattern of the budget balance depicted in Figure 4d suggests that fiscal balances have been quite stable in the last three decades. This hypothesis has been confirmed by our analysis. In fact, as it is possible to see by the joint and the single tests (see Figures 4a, 4b and 4c), the difference, both in terms of responsiveness and persistence, between government spending and revenue is not statistically significant for most of the sample period. Nevertheless, it is interesting to observe that the fiscal consolidation that occurred in the 90s has been notably related to a higher responsiveness and persistence of government revenue.

Italy

Budget deficits have been considerably high and increasing during the 1970s and the 1980s, and only started decreasing after the beginning of the 1990s (see Figure 5d). Our analysis, which starts in 1980:1, uncovers empirical evidence for fiscal consolidation in the period after the Maastricht Treaty (see Table 2). Moreover, from the analysis of the coefficients and the associated Wald tests, we can argue that fiscal improvements in the second half of the 1990s have been achieved rather trough higher revenue responsiveness (see Figure 5b). Indeed, the null hypothesis of identical government revenue and spending responsiveness is mostly rejected after 1997.

Netherlands

Fiscal balances have improved in the Netherlands in the 1990s, after some deterioration in the 1980s. This is (partly) captured by our analysis, which suggests that fiscal consolidation has been driven by higher persistence of government revenue. In particular, looking at the pattern of the estimates of responsiveness and persistence, we can see that around 1996 government revenue has become more persistent than government spending, after several years where the situation was the opposite (see Figure 6a). In contrast, regarding responsiveness, government revenue and spending do not seem to have differed in statistically significant terms after 1999 (see Figure 6b), when spending responsiveness decreased and the budget position improved (see Figure 6d).

Spain

Analyzing the pattern for fiscal budget balances in Spain, we can see that there has been a process of fiscal consolidation from 1995 onwards. In fact the budget deficit passed from above 6% of GDP in 1995 to a surplus of 2.3% of GDP in 2007. Our analysis points out that the fiscal consolidation has been driven by the higher responsiveness of government revenue than of government spending. Although we are using a short-period

sample, the analysis also suggests some recent changes in fiscal developments. Indeed, government revenue responsiveness (which has been the driver of the fiscal consolidation) seems to have decreased significantly at the end of the sample period, while the responsiveness of government spending was stable, implying fiscal deterioration.

United Kingdom

Fiscal balances in the UK have been quite stable, with the debt-to-GDP ratio decreasing throughout the 1970s and 1980s (see Figure 8d). In particular, except for 2000 and 2001 (due to relatively high GDP growth), and in 2009 (related to the crisis), it is possible to argue that there were not significant changes towards fiscal improvement or deterioration. This was mainly due to the fact that higher government spending and revenue showed a very similar behaviour in terms of persistence and responsiveness (see Figures 8a and 8b). Regarding the most recent years and in view of the widening budget deficit due to the crisis, our analysis signals possible fiscal tensions, as reflected in the joint Wald test that decreases markedly. This result is mainly due to a reduction of the responsiveness of government revenue to the economic cycle, therefore, reflecting a deterioration of the capacity of fiscal policy to use automatic stabilizers to counteract the negative effects of the crisis.

USA

Similarly to the UK, the fiscal balances in the US have been quite stable, although in deficit, with an improvement of the fiscal position between 1992 and 2000 (see Figure 9d). Overall, it is possible to argue that there has not been any significant long-term change towards fiscal consolidation or deterioration. In addition, the somewhat stable budget deficit seems to be driven by the higher persistence of government spending vis-à-vis government revenue, which is partially offset by the higher responsiveness of government spending. The recent increase of the budget deficit, as a result of the

economic and financial crisis, is reflected in the significant drop in the responsiveness of government revenue.

5. Conclusion

In this work, we propose a new approach to assess long-term fiscal developments. By analyzing the time-varying behaviour of the two components of government spending and revenue – that is, responsiveness and persistence –, we are able to infer about the sources of fiscal deterioration and/or fiscal improvement. Drawing on quarterly data we use a Three-Stage Least Square method and recursively estimate those components within a system of government revenue and spending equations.

The estimates of responsiveness and persistence reveal significant changes in fiscal positions (including those related to the crises).

Nevertheless, and in general, the fiscal position has not significantly changed for Finland, France, Germany, the United Kingdom and the US – apart from the more recent years in the sample (the 2009 financial crisis) –, whilst it has improved moderately for Belgium, Spain, Italy, and Netherlands. However, one should notice that the occurrence of the recent crisis deeply reversed the fiscal improvements obtained prior to the crisis, as our analysis clearly highlights.

We show that for Belgium and for the Netherlands, the fiscal improvement has been mainly driven by a higher persistence of government revenue, vis-à-vis government spending. In addition, a higher responsiveness of government revenue relative to government spending was observed in Italy, Finland and Spain. Additionally, for Germany and the UK, the empirical evidence suggests a similar behaviour in terms of the persistence and responsiveness components of government spending and government revenue.

As already mentioned, regarding the more recent period that encompasses the economic and financial crisis, our results reflect a reduction of the responsiveness of government revenue to the economic cycle for most countries, compared to the responsiveness of government spending. Therefore, these results signal a deterioration of the capacity of fiscal authorities to use automatic stabilizers to counteract the negative effects of the crisis.

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Appendix. Data description and sources

A.1 Belgium Data

GDP
The source is the IMF, International Financial Statistics (series "IFS.Q.124.9.9B.B$$.Z.W.$$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1980:1-2009:4.

Price Deflator
All variables were deflated by the GDP deflator (2005=100). The source is the IMF, International Financial Statistics (series IFS.Q.124.9.9B.BIP.Z.F.$$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1980:1-2009:4.

Government Spending
The source is the Belgium Ministry of Finance. Government Spending is defined as State Government expenditure on a cash basis (series "BISM.M.FJHC.BE.91"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1967:1-2009:4.

Government Revenue
The source is the Belgium Ministry of Finance. Government Revenue is defined as State Government revenue on a cash basis (series "BISM.M.FJBC.BE.91"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1967:1-2009:4.

A.2 Finland Data

GDP
The source is the IMF, International Financial Statistics (series " IFS.Q.172.9.9B.B$$.Z.W.$$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3

Price Deflator
All variables were deflated by the GDP deflator (2005=100). The source is the IMF, International Financial Statistics (series "IFS.Q.172.9.9B.BIP.Z.F.$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3.

Government Spending
The source is the IMF via Finnish Ministry of Finance. Government Spending is defined as State Government expenditure on a cash basis (series "IFS.M.17282...ZF..."). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3.

Government Revenue
The source is the IMF via Finnish Ministry of Finance. Government Revenue is defined as State Government revenue on a cash basis (series "IFS.M.17281...ZF..."). We seasonally

adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3.

A.3 France Data

GDP
Data for GDP are quarterly, seasonally adjusted, and comprise the period 1970:1-2009:3. The source is the IMF, International Financial Statistics (series " IFS.Q.132.9.9B.B$C.Z.F.$$$").

Price Deflator
All variables were deflated by the GDP deflator (2005=100). Data are quarterly, seasonally adjusted, and comprise the period 1970:1-2009:3. The source is the IMF, International Financial Statistics (series "IFS.Q.132.9.9B.BIR.Z.F.$$$").

Government Spending
The source is the IMF via French Ministry of Finance. Government Spending is defined as State Government expenditure on a cash basis (series "IFS.M.13282z..ZF..."). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3.

Government Revenue
The source is the IMF via French Ministry of Finance. Government Revenue is defined as State Government revenue on a cash basis (series "IFS.M.13281...ZF..."). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3.

A.4 Germany Data

GDP
Data for GDP are quarterly, seasonally adjusted, and comprise the period 1960:1-2009:3. The source is the IMF, International Financial Statistics (series "IFS.Q.134.9.9B.B$C.Z.F.$$$").

Price Deflator
All variables were deflated by the GDP deflator (2005=100). Data are quarterly, seasonally adjusted, and comprise the period 1960:1-2009:3. The source is the IMF, International Financial Statistics (series "IFS.Q.134.9.9B.BIR.Z.F.$$$").

Government Spending
The source is the Bundesbank and the Monthly Reports released by the German Ministry of Finance. Government Spending is defined as General Government total expenditure on a cash basis. We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1979:1-2009:3.

Government Revenue
The source is the Bundesbank and the Monthly Reports released by the German Ministry of Finance. Government Revenue is defined as General Government total revenue on a cash basis. We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1979:1-2009:3.

A.5 Italy Data

GDP
Data for GDP are quarterly, seasonally adjusted, and comprise the period 1960:1-2009:3. The source is the IMF, International Financial Statistics (series "IFS.Q.136.9.9B.B$C.Z.F.$$$").

Price Deflator
All variables were deflated by the GDP deflator (2005=100). Data are quarterly, seasonally adjusted, and comprise the period 1980:1-2009:3. The source is the IMF, International Financial Statistics (series "IFS.Q.136.9.9B.BIR.Z.F.$$$").

Government Spending
The source is the Bank of Italy and the Italian Ministry of Finance. Government Spending is defined as Central Government primary expenditure on a cash basis. We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1960:1-2009:3.

Government Revenue
The source is the Bank of Italy and the Italian Ministry of Finance. Government Revenue is defined as Central Government total revenue on a cash basis. We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1960:1-2009:3.

A.6 Spain Data

GDP
Data for GDP are quarterly, seasonally adjusted, and comprise the period 1970:1-2009:3. The source is the IMF, International Financial Statistics (series " IFS.Q.184.9.9B.B$C.Z.F.$$$").

Price Deflator
All variables were deflated by the GDP deflator (2005=100). Data are quarterly, seasonally adjusted, and comprise the period 1970:1-2009:3. The source is the IMF, International Financial Statistics (series "IFS.Q.184.9.9B.BIR.Z.F.$$$").

Government Spending
The source is the IMF via Spanish Ministry of Finance. Government Spending is defined as State Government expenditure on a cash basis (series "IFS.M.18482...Zf..."). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1985:1-2009:3.

Government Revenue
The source is the IMF via Spanish Ministry of Finance. Government Revenue is defined as State Government revenue on a cash basis (series "IFS.M.18481...Zf..."). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1985:1-2009:3.

A.7 Netherlands Data

GDP
The source is the IMF, International Financial Statistics (series "IFS.Q.138.9.9B.B$C.Z.W.$$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3.

Price Deflator
All variables were deflated by the GDP deflator (2005=100). The source is the IMF, International Financial Statistics (series "IFS.Q.138.9.9B.BIR.Z.F.$$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1970:1-2009:3.

Government Spending
The source is the IMF via Dutch Ministry of Finance. Government Spending is defined as State Government expenditure on a cash basis (series "IFS.M.138.C.C2.$$$.C.G.$$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1977:1-2009:3.

Government Revenue
The source is the IMF via Dutch Ministry of Finance. Government Revenue is defined as State Government revenue on a cash basis (series "IFS.M.138.C.C1.$$$.C.G.$$$"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1977:1-2009:3.

A.8 UK Data

GDP
Data for GDP are quarterly, seasonally adjusted, and comprise the period 1955:1-2009:2. The source is the Office for National Statistics, Release UKEA, Table A1 (series "YBHA").

Price Deflator
All variables were deflated by the GDP deflator. Data are quarterly, seasonally adjusted, and comprise the period 1955:1-2009:2. The source is the Office for National Statistics, Release MDS, Table 1.1 (series "YBGB").

Government Spending
The source is the Office for National Statistics (ONS), Release Public Sector Accounts. Government Spending is defined as total current expenditures of the Public Sector ESA 95 (series "ANLT") less net investment (series "ANNW"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1947:1-2009:2.

Government Revenue
The source is the Office for National Statistics (ONS), Release Public Sector Accounts. Government Revenue is defined as total current receipts of the Public Sector ESA 95 (series "ANBT"). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1947:1-2009:2.

A.9 US Data

GDP
The source is Bureau of Economic Analysis, NIPA Table 1.1.5, line 1. Data for GDP are quarterly, seasonally adjusted, and comprise the period 1947:1-2009:3.

Price Deflator
All variables were deflated by the GDP deflator. Data are quarterly, seasonally adjusted, and comprise the period 1967:1-2009:3. The source is the Bureau of Economic Analysis, NIPA Tables 1.1.5 and 1.1.6, line 1.

Government Spending
The source is Bureau of Economic Analysis, NIPA Table 3.2. Government Spending is defined as total Federal Government Current Expenditure (line 39). Data are quarterly, seasonally adjusted, and comprise the period 1960:1-2009:2.

Government Revenue
The source is Bureau of Economic Analysis, NIPA Table 3.2. Government Revenue is defined as government receipts at annual rates (line 36). Data are quarterly, seasonally adjusted, and comprise the period 1947:1-2009:2.

1a - Recursive estimates for γ (significance level of 5%), persistence
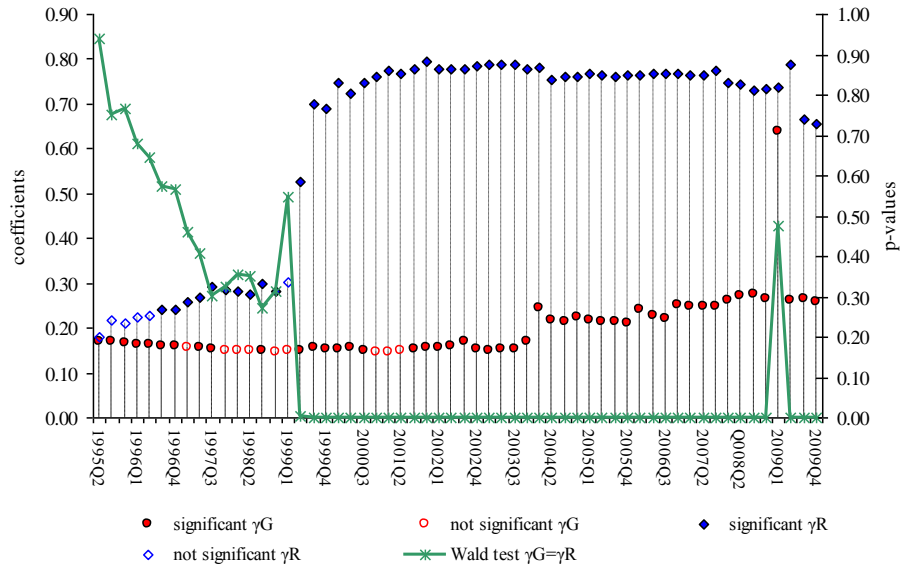
- significant γG
- not significant γG
- significant γR
- not significant γR
- Wald test γG=γR
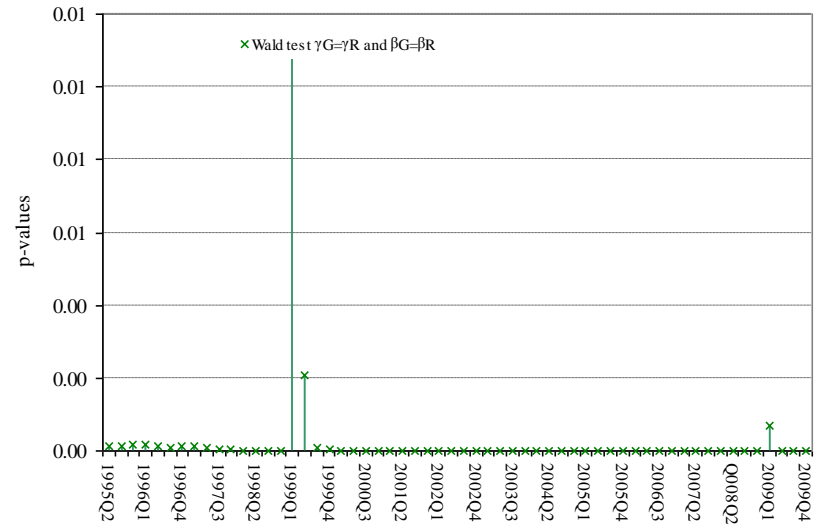
1b - Recursive estimates for β (significance level of 5%), responsiveness

- significant βG
- not significant βG
- significant βR
- not significant βR
- Wald test βG=βR
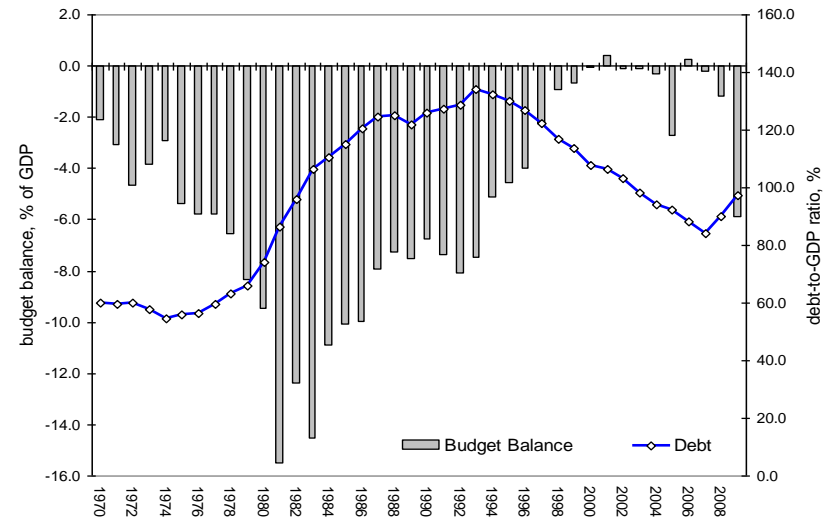
Fig. 1. Belgium (1980:1-2009:4).

1c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$

× Wald test γG=γR and βG=βR

1d - Debt and budget balance ratio

- Budget Balance
- Debt

Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

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2a - Recursive estimates for γ (significance level of 5%), persistence

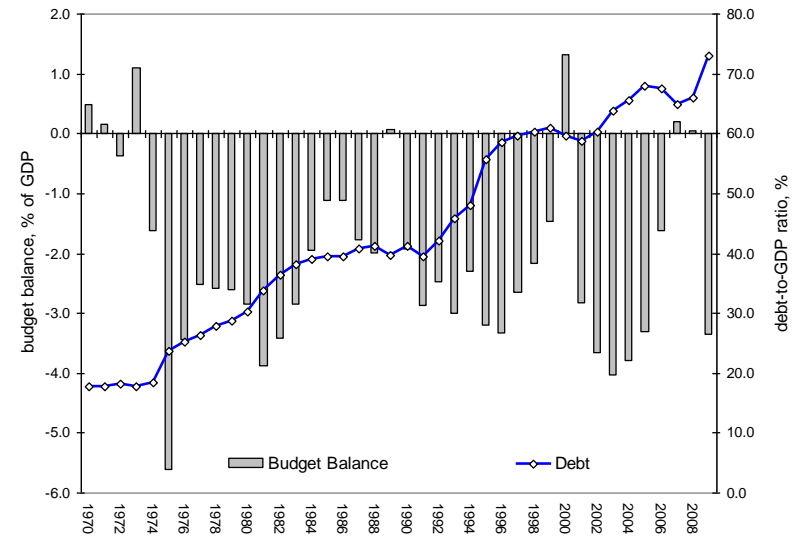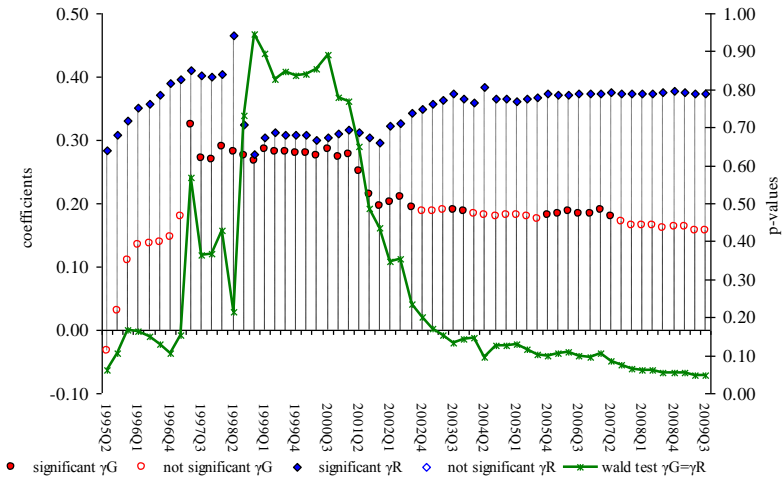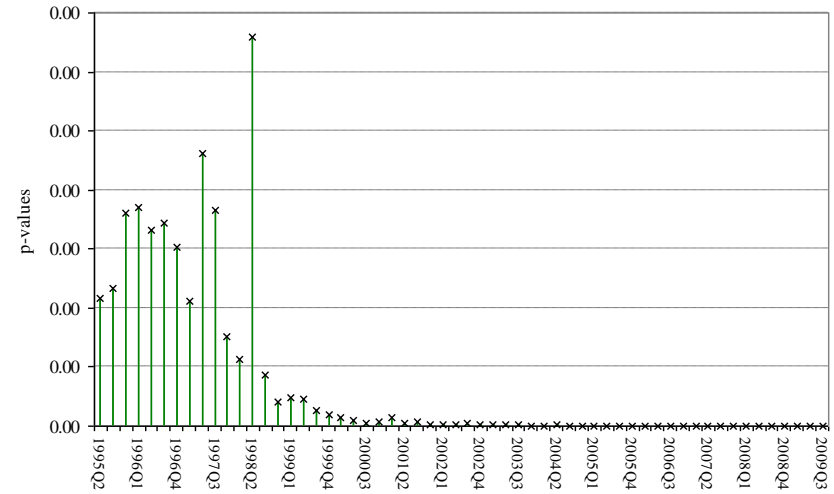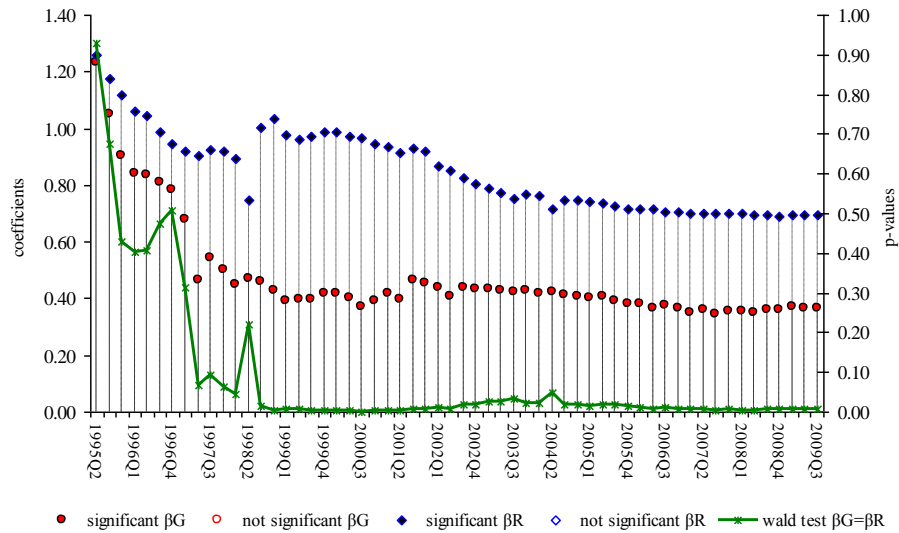2c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$
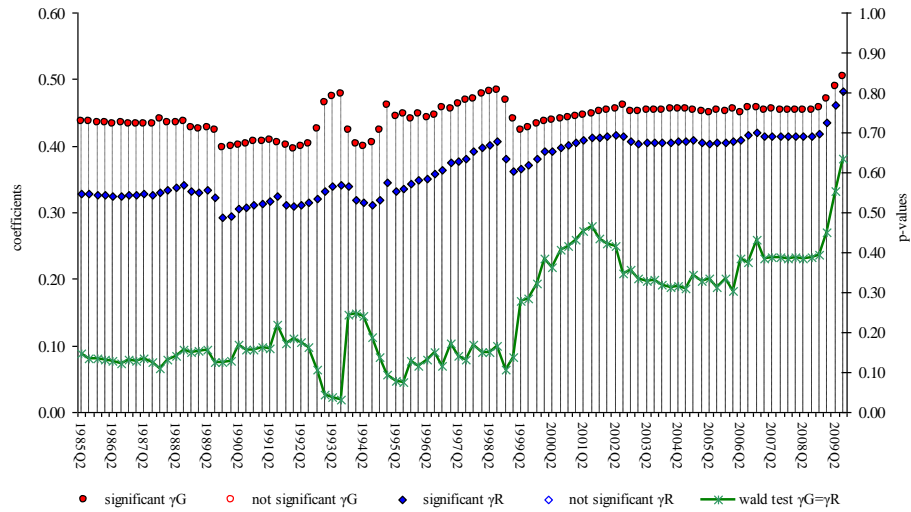
- significant γG   ○ not significant γG   ◆ significant γR   ◇ not significant γR   —✳— wald test γG=γR
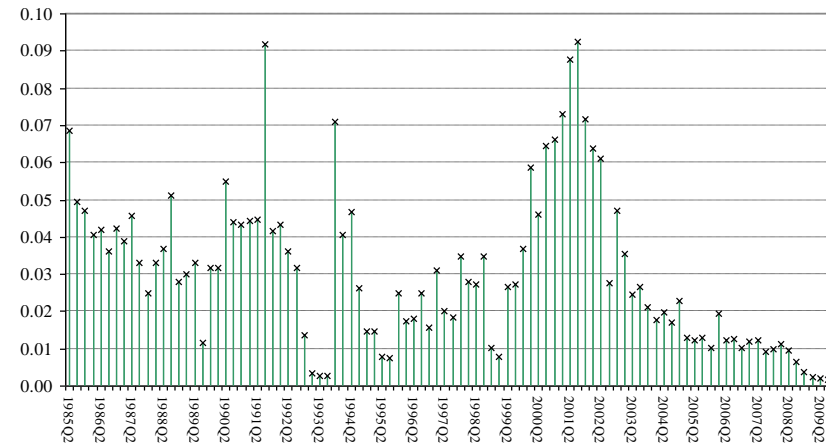
2b - Recursive estimates for β (significant level of 5%), responsiveness

2d - Debt and budget balance ratio

- significant βG   ○ not significant βG   ◆ significant βR   ◇ not significant βR   —✳— wald test βG=βR
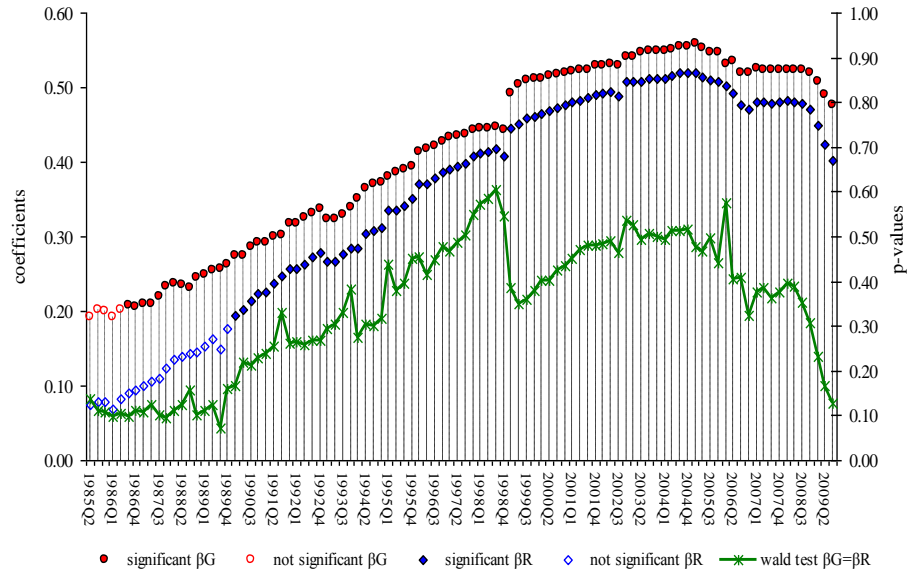
Budget Balance   Debt
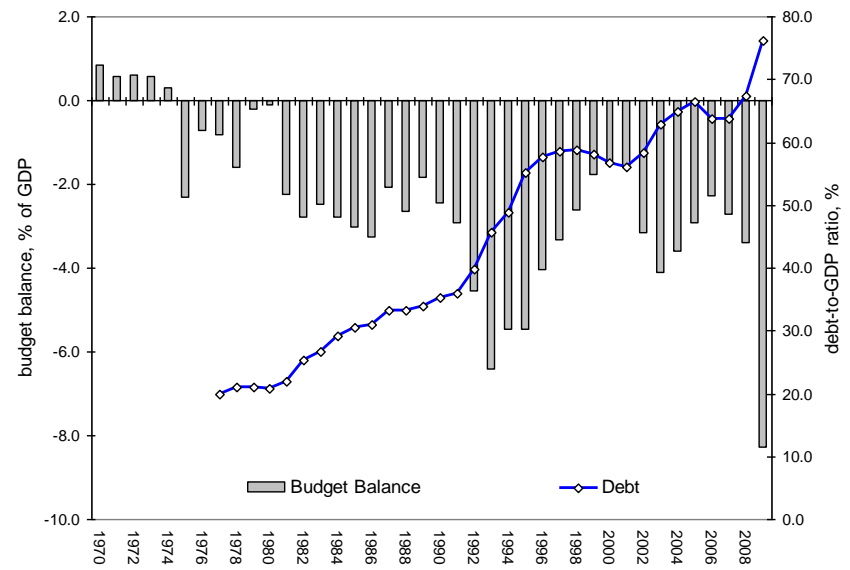
Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

Fig. 2. France (1970:2-2009:3).

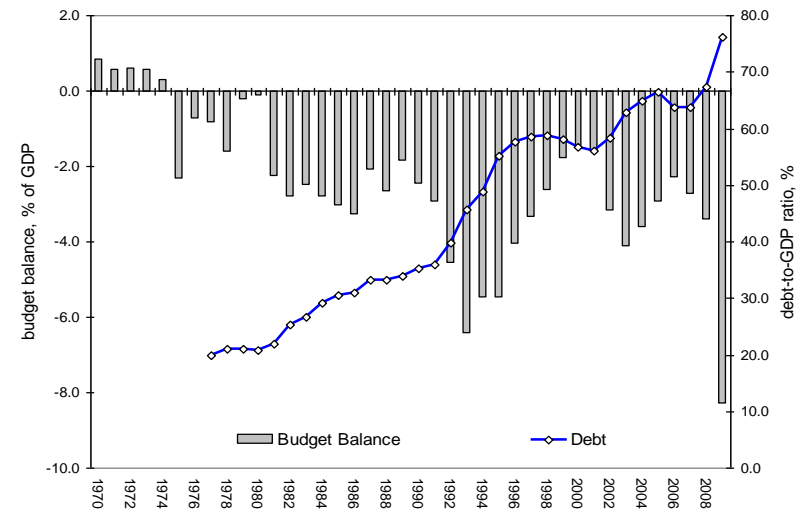3a - Recursive estimates for γ (significance level of 5%), persistence
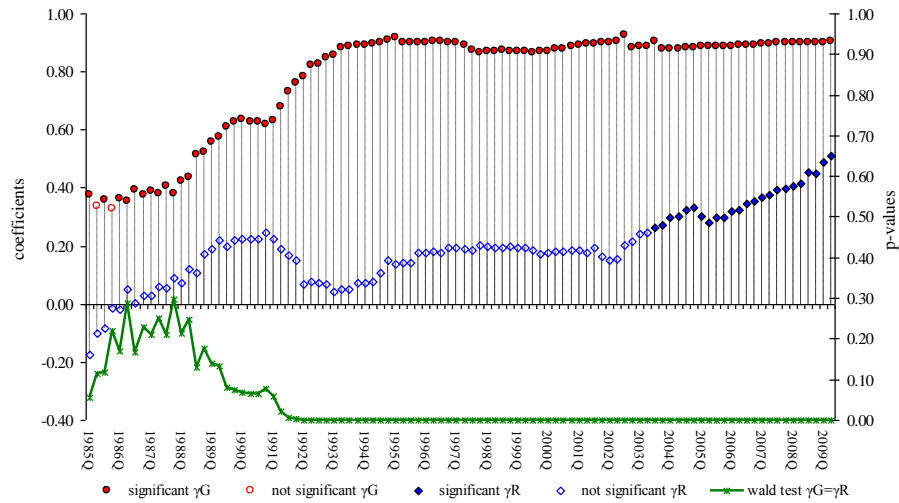
3c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$
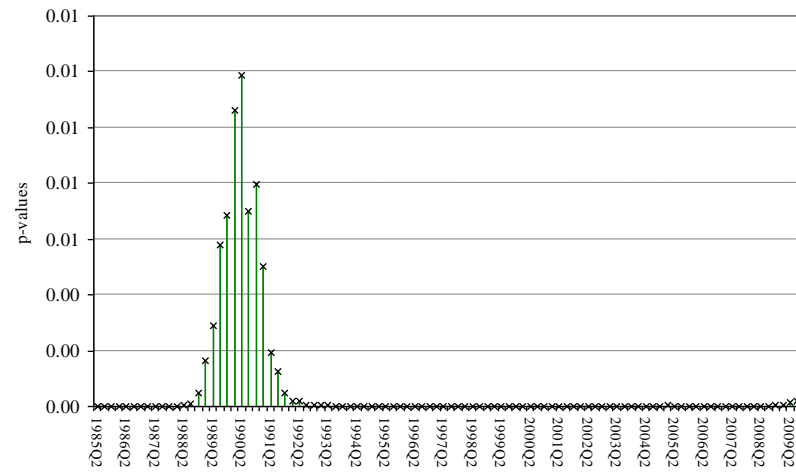
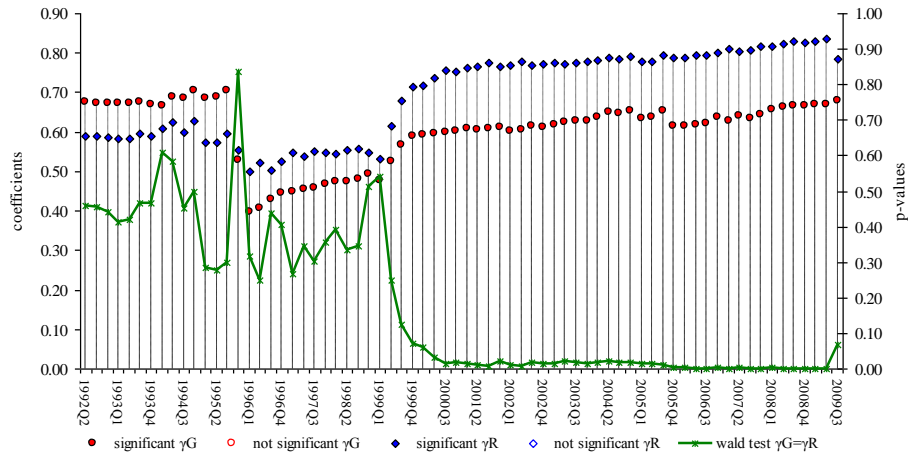3b - Recursive estimates for β (significant level of 5%), responsiveness
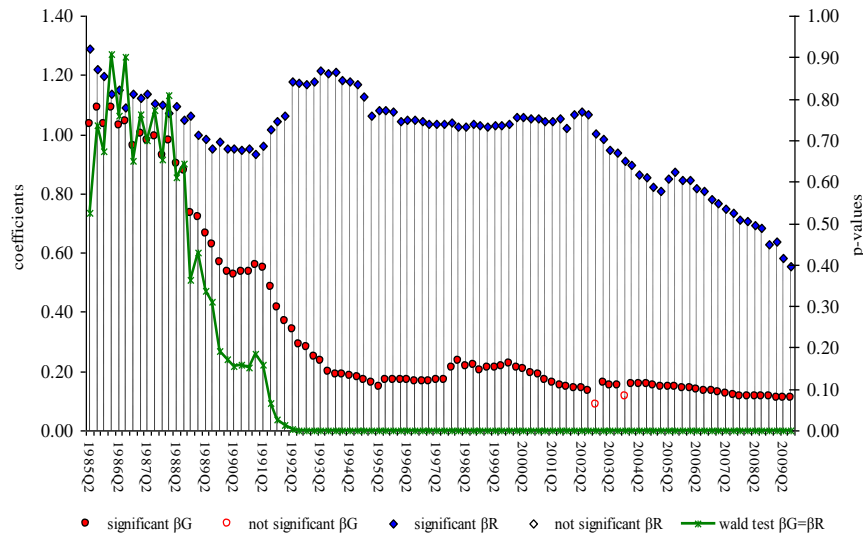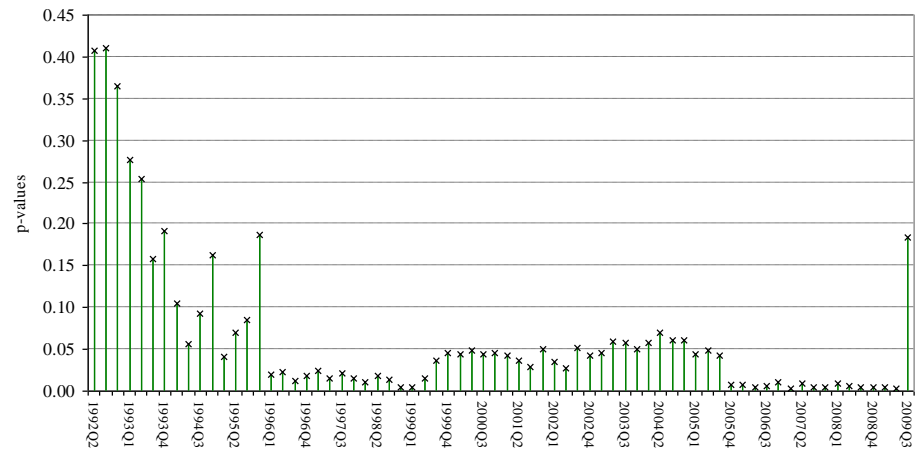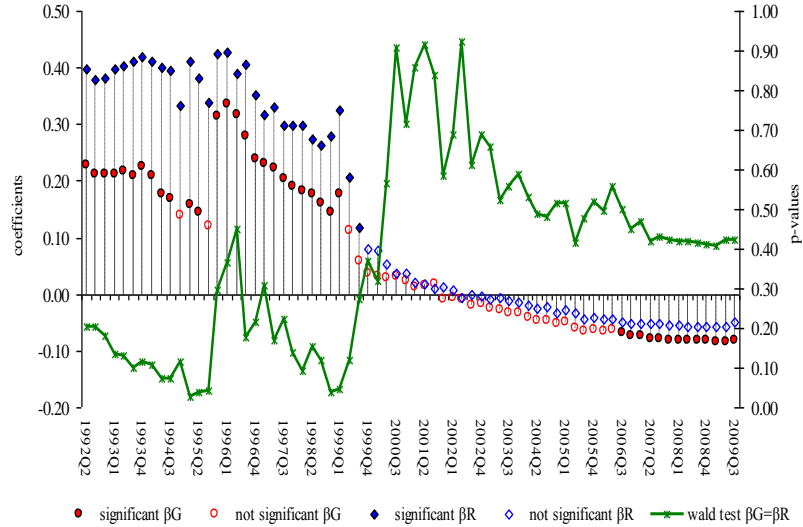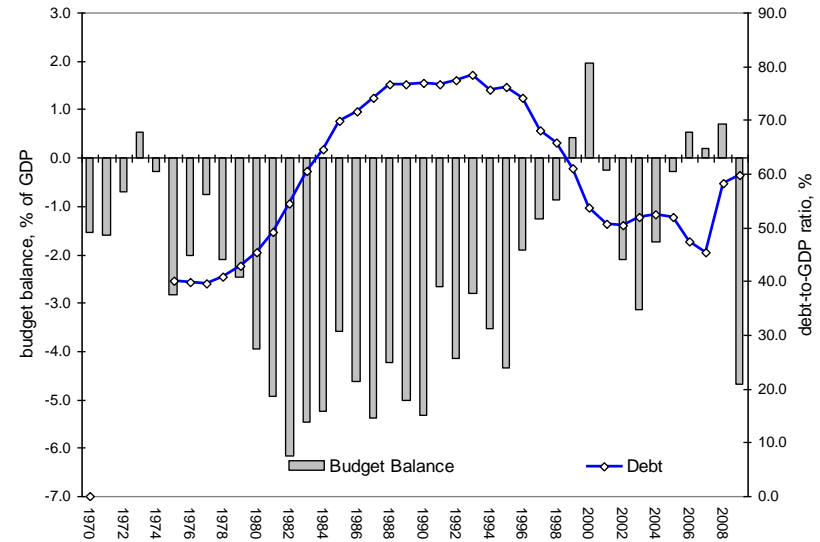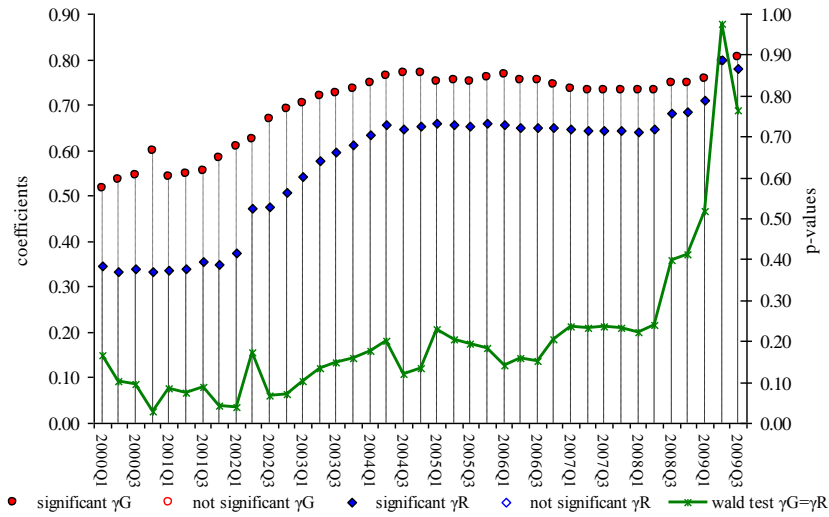

3d - Debt and budget balance ratio
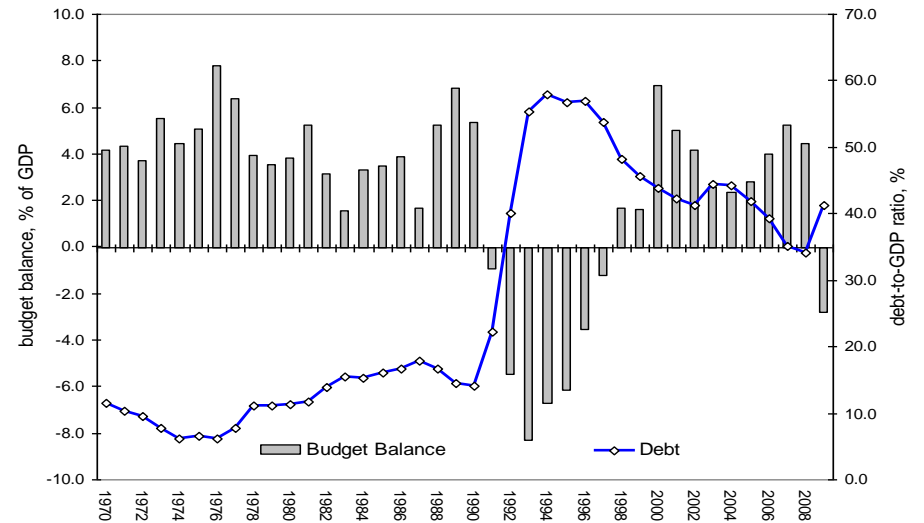
Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

Fig. 3. Finland (1970:1-2009:3).

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4a - Recursive estimates for γ (significance level of 5%), persistence
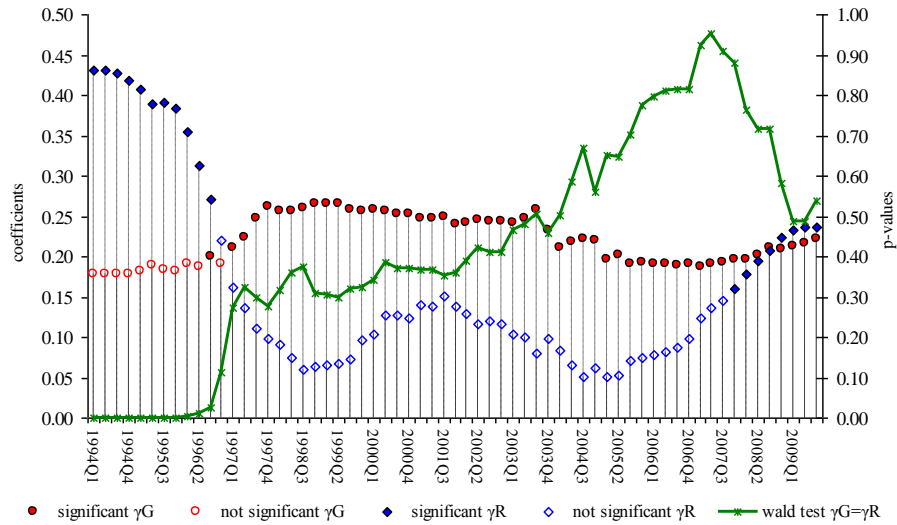
- ● significant γG   ○ not significant γG   ◆ significant γR   ◇ not significant γR   ✳─ wald test γG=γR
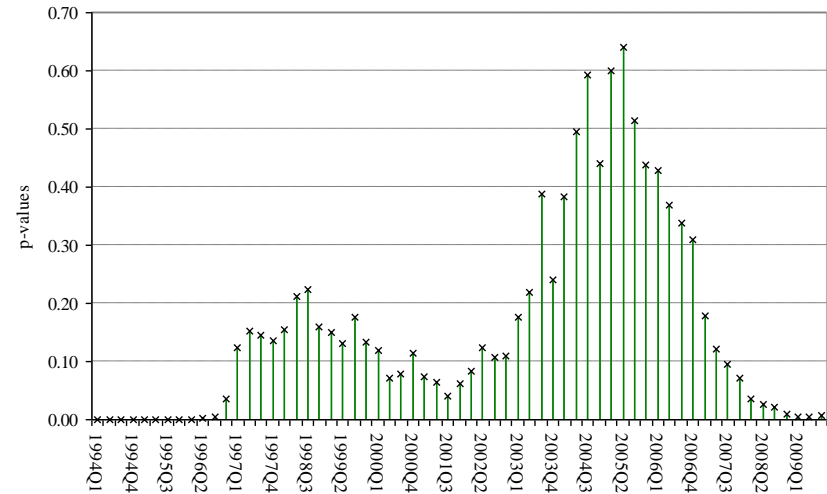
4b - Recursive estimates for β (significance level of 5%), responsiveness

- ● significant βG   ○ not significant βG   ◆ significant βR   ◇ not significant βR   ✳─ wald test βG=βR
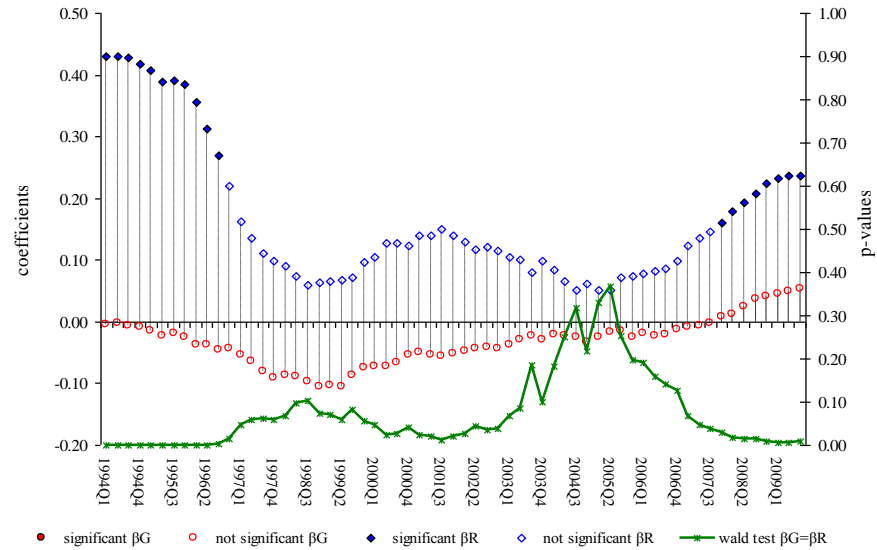
Fig. 4. Germany (1979:1-2009:3).

4c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$

4d - Debt and budget balance ratio

☐ Budget Balance   ◇ Debt

Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

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5a - Recursive estimates for γ (significance level of 5%), persistence

significant γG   ○ not significant γG   ◆ significant γR   ◇ not significant γR   —✳— wald test γG=γR

5b - Recursive estimates for β (significance level of 5%), responsiveness

significant βG   ○ not significant βG   ◆ significant βR   ◇ not significant βR   —✳— wald test βG=βR

Fig. 5. Italy (1980:1-2009:3).

5c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$

5d - Debt and budget balance ratio

▭ Budget Balance   —◇— Debt
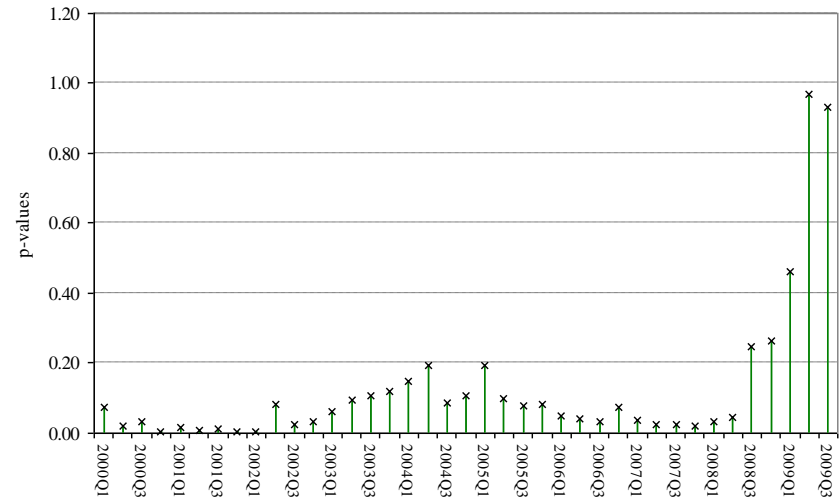
Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

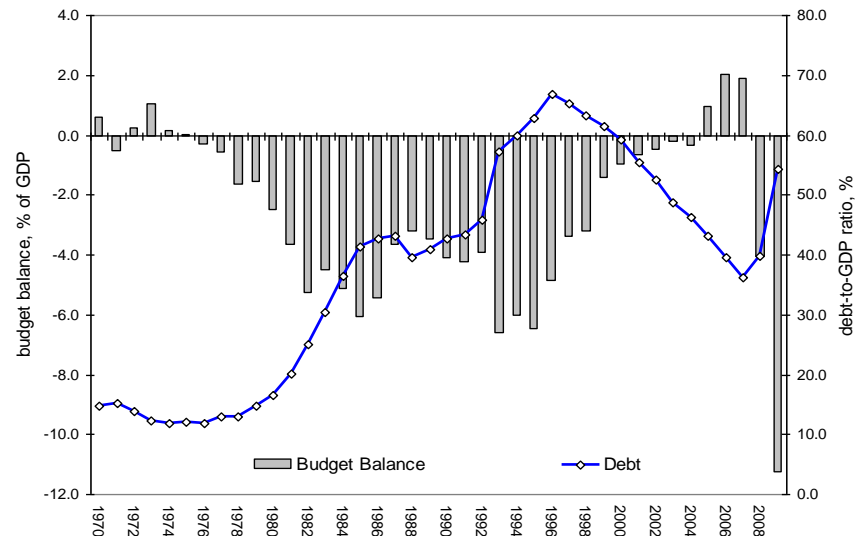6a - Recursive estimates for γ (significance level of 5%), persistence

● significant γG ○ not significant γG ◆ significant γR ◇ not significant γR ━✶━ wald test $\gamma G=\gamma R$

6b - Recursive estimates for β (significance level of 5%), responsiveness

● significant βG ○ not significant βG ◆ significant βR ◇ not significant βR ━✶━ wald test $\beta G=\beta R$

Fig. 6. Netherlands (1977:1-2009:3).

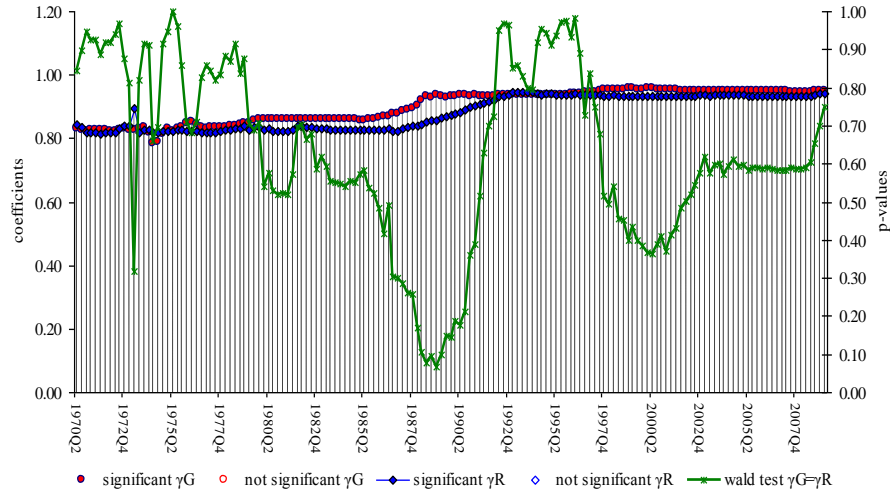6c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$
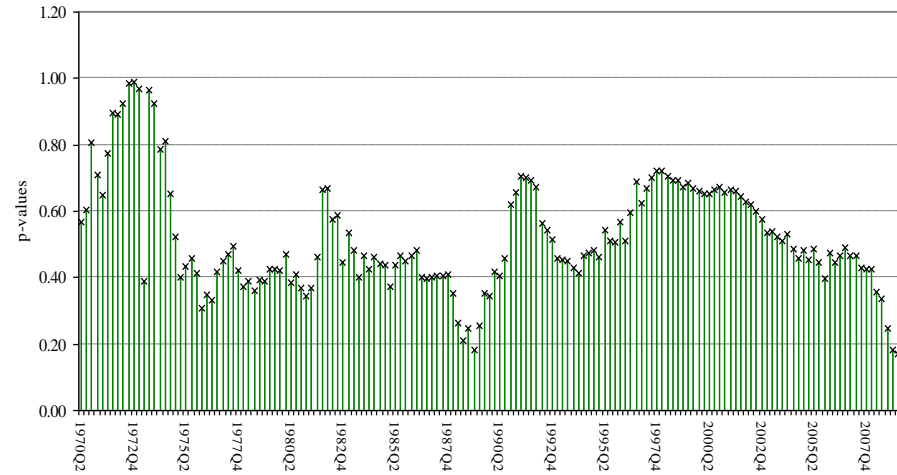

6d - Debt and budget balance ratio

Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

7a - Recursive estimates for γ (significance level of 5%), persistence

Legend: ● significant γG ○ not significant γG ◆ significant γR ◇ not significant γR ✱— wald test $\gamma G=\gamma R$

7b - Recursive estimates for β (significance level of 5%), responsiveness

Legend: ● significant βG ○ not significant βG ◆ significant βR ◇ not significant βR ✱— wald test $\beta G=\beta R$

Fig. 7. Spain (1985:1-2009:3).

7c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$
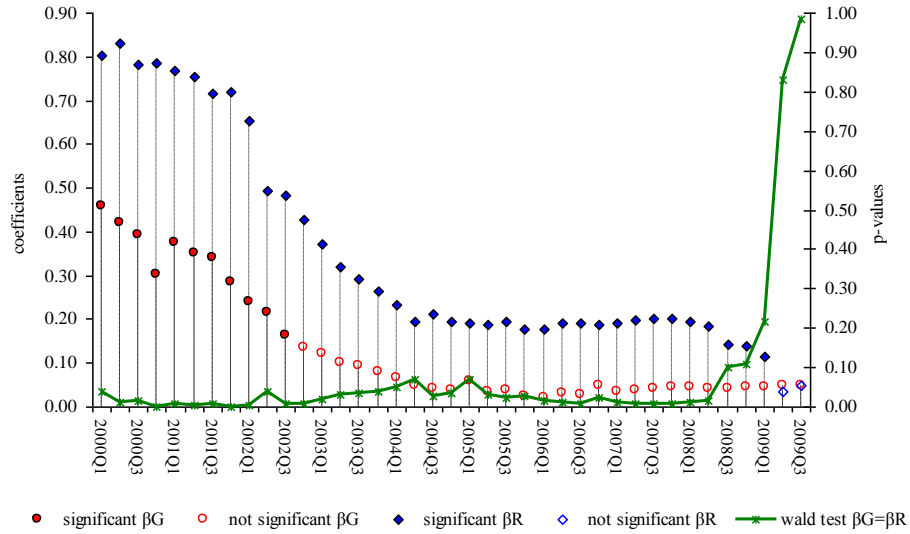
7d - Debt and budget balance ratio

Legend: Budget Balance   Debt

Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

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8a - Recursive estimates for γ (significance level of 5%), persistence
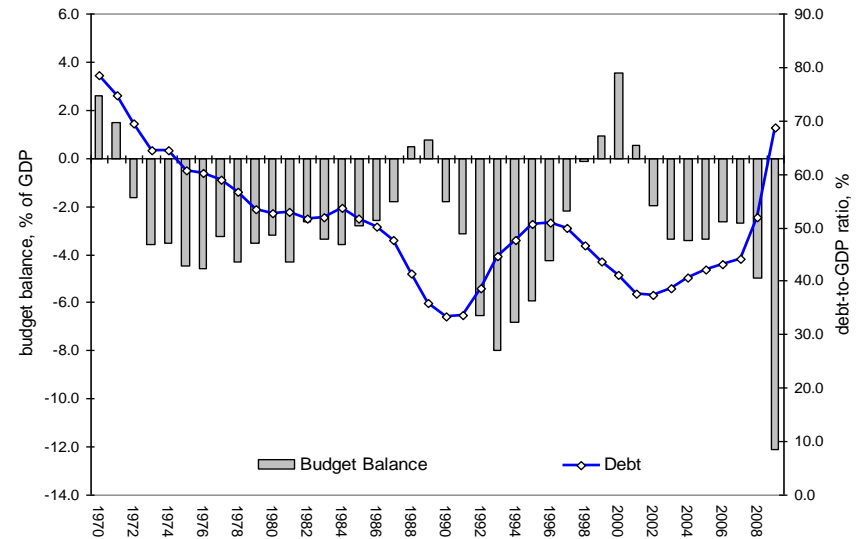

8c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$

8b - Recursive estimates for β (significance level of 5%), responsiveness
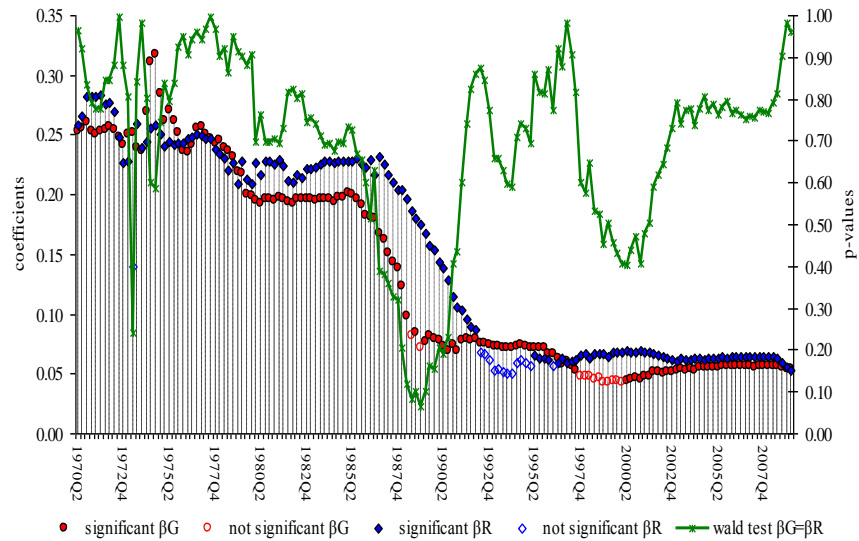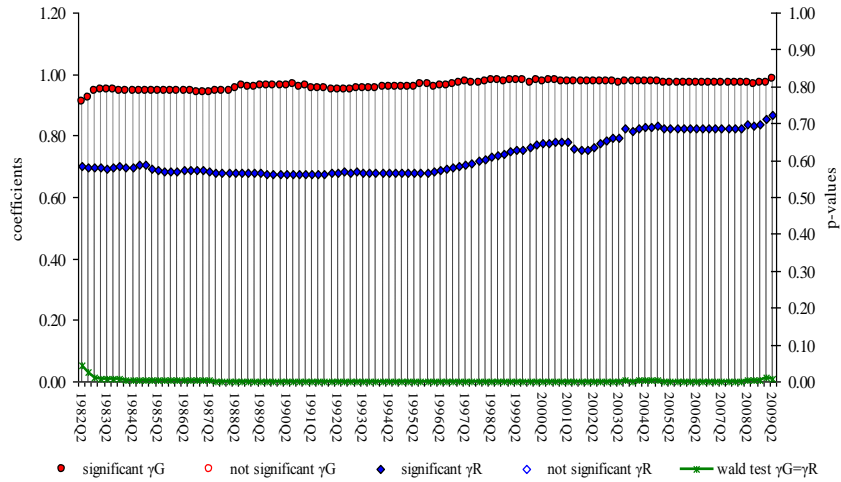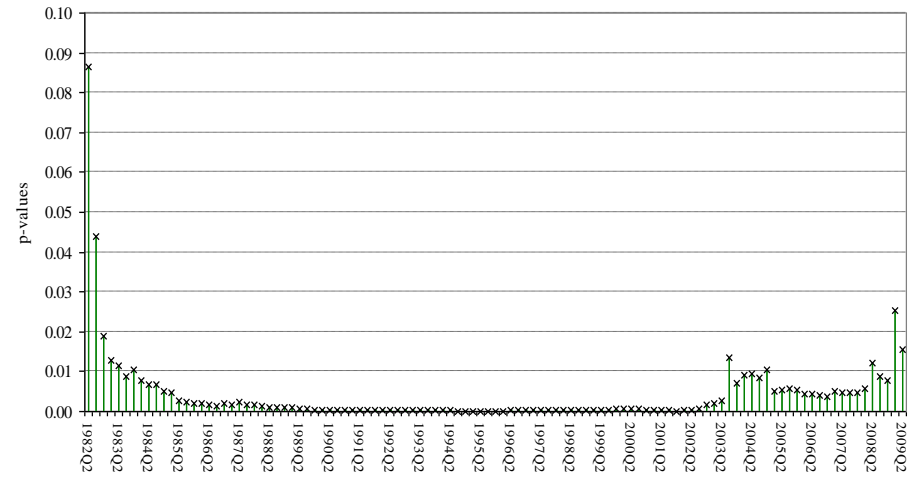

8d - Debt and budget balance ratio

Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.
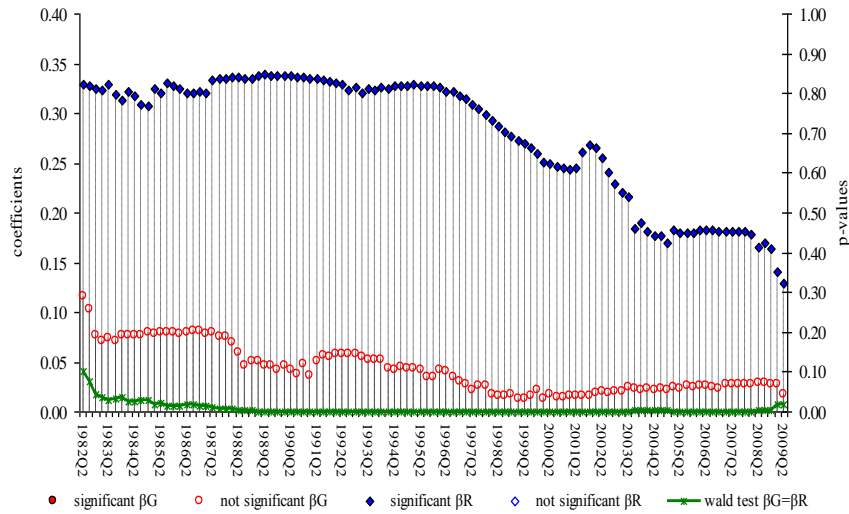
Fig. 8. United Kingdom (1955:2-2009:2).

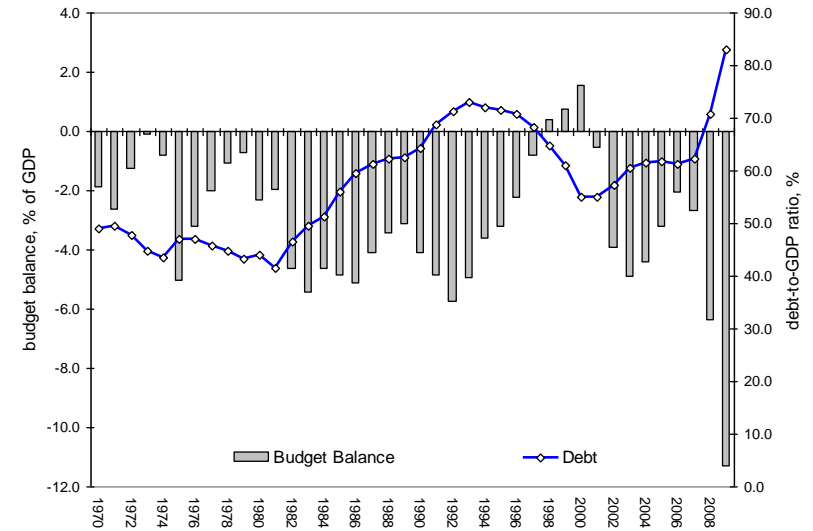9a - Recursive estimates for γ (significance level of 5%), persistence

9c - Joint Wald test $H_0 : \gamma_{ik}^G = \gamma_{ik}^R \wedge \beta_{ik}^G = \beta_{ik}^R$

9b - Recursive estimates for β (significance level of 5%), responsiveness

9d - Debt and budget balance ratio

Source: EC, Ameco database and EC Economic Forecasts Autumn 2009.

Fig. 9. United States (1967:2-2009:2).