Spend-and-Tax Adjustments and the Sustainability of the Government's Intertemporal Budget Constraint

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Abstract

We apply non-linear error-correction models to the empirical testing of the sustainability of the government's intertemporal budget constraint. Our empirical analysis, based on Italy, shows that the Italian government is meeting its intertemporal budget constraint, in spite of the high levels of public debt. Nevertheless, the burden of correcting budgetary disequilibria is entirely carried out by changes in the average tax rate, with a weakly exogenous government spending, possibly determined by the political process. We document some rigidities of the tax instrument, in terms of downward inflexibility of the average tax rate, not only with respect to its long-run level, but also during periods of decreasing economic growth. Further, we provide some evidence in favour of a non-linear adjustment towards a sustainable long-run equilibrium, as the average tax rate adjusts faster the farther away it is from the equilibrium.

JEL-Code: C32, C51, C52, H20, H50.

Keywords: intertemporal budget constraint, sustainability, non-linear error-correction, fiscal reaction function.

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1 Introduction

The Treaties governing the European Monetary Union impose some relevant constraints on the fiscal policy of member states, limiting their autonomy in creating excessive debts and deficits[1], as fiscal disequilibria in one state can impose relevant negative externalities on the stability of the other member countries, as well as on the overall credibility of the common monetary policy. On the other hand, given the common monetary policy, the correction of idiosyncratic shocks is assigned to the fiscal instrument alone, imposing further pressures on the fiscal policy of member countries.

The issue of the sustainability of the public finances of the EMU member countries has consequently received an increasing attention, but less attention has been paid to the issue of how the sustainability is achieved, that is, how do budgetary authorities adjust fiscal policies to achieve/maintain a sustainable path of public debt and deficit. Focussing on this adjustment by applying linear and non-linear error-correction models is the main purpose of our paper.

Our empirical analysis is based on Italy, which provides an interesting case as it joined the European Monetary Union in 1999, in spite of a stock of public debt of around 113% of nominal GDP (against the 60% level required by the Maastricht Treaty), and whose public accounts are often under scrutiny for struggling to comply with the European Stability and Growth Pact[2], as well

[1] Article 104 of the Maastricht Treaty (1993) imposes a ceiling to debt and deficit of 60% and 3% of domestic GDP, respectively, as conditions for the admissions to the EMU. The European Stability and Growth Pact (ESGP), signed in 1999 and revised in 2005, reinforces the 3% ceiling for the government deficit of member countries, establishing an excessive deficit procedure for violations of the rule.

[2] In particular, in July 2005 the Council of the European Union concluded, under the excessive deficit procedure, that Italy had an excessive deficit and reccomended a correction by 2007. In June 2008 the Council closed the procedure, as the Italian deficit had "been brought below the 3% threshold in a credible and sustainable manner" (10127/1/09/REV1). In October 2009, a new procedure has been opened (IP/09/1428).

as for subsequent downgradings of its sovereign debt by the main credit ratings agencies[3].

In this paper, we address three main relevant policy questions. First, is the Italian government's intertemporal budget constraint respected? Second, is the process of fiscal adjustment equally shared by changes in revenues and changes in government spending? Third, does fiscal adjustment vary with the sign and magnitude of disequilibria and/or with the state of the economy?

Our proposed approach provides a number of interesting findings.

The Italian government's intertemporal budget constraint is formally respected, in spite of the high levels of public debt. Nevertheless, the burden of correcting budgetary disequilibria is entirely carried by changes in the average tax rate, rather than changes in government spending or policy mixes. Government spending is shown to be weakly exogenous, pointing to a "spend-and-tax" adjustment, where the level of spending appears to be determined by the political process. We also find that taxes adjust more rapidly when deviations from the equilibrium level get larger, as well as provide some evidence of downward inflexibility of taxes, when these are above their long-run level. Further, taxes increase rapidly during periods of accelerating economic growth, but are downward inflexible during periods of decreasing economic growth.

The paper is organised as follows. Section 2 discusses the theoretical background of the sustainability of the government's intertemporal budget constraint. Section 3 presents our long-run sustainability analysis, while Section 4 reports the fiscal authorities' reaction function to fiscal disequilibria. Section 5 presents the main conclusions of the paper, as well as suggestions for further

[3] Standard & Poor's now rates the Italian long term sovereign debt with an A+ and Fitch with a A–, against the AA rating of 1998.

research.

2 The Sustainability of the Government's Intertemporal Budget Constraint.

Following Walsh (2003) and Bohn (2008), the nominal one-period consolidated government-sector budget identity is given by:

$$G_t + i_{t-1}B_{t-1} = T_t + (B_t - B_{t-1}) \tag{1}$$

Where G_t represents the general government expenditure, net of interest payments, B_t is the stock of government bonds sold to the private market, $i_{t-1}B_{t-1}$ are the interest payments on the outstanding debt[4], and T_t are the tax revenues. All variables are in nominal terms, and, for simplicity, we ignore the effect of seigniorage and surprise inflation.

As all policy debates are in terms of GDP shares, we divide equation (1) by nominal output, Y_t, obtaining:

$$\frac{G_t}{Y_t} + \frac{i_{t-1}B_{t-1}}{Y_t}\frac{Y_{t-1}}{Y_{t-1}} = \frac{T_t}{Y_t} + \frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_t}\frac{Y_{t-1}}{Y_{t-1}} \tag{2}$$

Letting μ_t be the output growth rate, and π_t the inflation rate, and rearranging, we obtain the following compact debt dynamics:

$$b_t = g_t - t_t + \left(1 + \bar{r}_{t-1}\right) b_{t-1} \tag{3}$$

where the lowercase letters denote the corresponding variables in real to GDP terms, and $\bar{r}_{t-1} \equiv \frac{1+i_{t-1}}{(1+\mu_t)(1+\pi_t)} - 1$.

[4] We assume the debt to be one-period in maturity, so that debt issued in period $t-1$ earns the nominal interest rate i_{t-1}.

Assuming a positive r, and constant over time, and taking the conditional expectations of the variables, the path of the public debt for an arbitrary sequence of future government spending and taxes is given by:

$$E_t\left[b_{t+n}\right]=\sum_{j=0}^{n}\left(1+r\right)^{n-j}E_t\left[g_{t+n}\right]-\sum_{j=0}^{n}\left(1+r\right)^{n-j}E_t\left[t_{t+n}\right]+(1+r)^n b_t^* \quad (4)$$

where $b_t^*=(1+r)b_{t-1}$ is the debt at the start of period t.

Rearranging, we obtain:

$$b_t^*=\sum_{j=0}^{n}\left(1+r\right)^{n-j-n}E_t\left[t_{t+n}\right]-\sum_{j=0}^{n}\left(1+r\right)^{n-j-n}E_t\left[g_{t+n}\right]+(1+r)^{-n}E_t\left[b_{t+n}\right] \quad (5)$$

Assuming this discounted sum converges and taking the limit $n\rightarrow\infty$, we get:

$$b_t^*=\sum_{j=0}^{\infty}\left(1+r\right)^{-j}E_t\left[t_{t+n}\right]-\sum_{j=0}^{\infty}\left(1+r\right)^{-j}E_t\left[g_{t+n}\right]+\lim_{n\rightarrow\infty}(1+r)^{-n}E_t\left[b_{t+n}\right] \quad (6)$$

Equation (6) represents the government's intertemporal budget constraint (IBC).

Defining the primary deficit as $\Delta_t=(g_t-t_t)$, we obtain from the above:

$$b_t^*=-\sum_{j=0}^{\infty}E_t\left[\Delta_{t+n}\right]\left(1+r\right)^{-j}+\lim_{n\rightarrow\infty}(1+r)^{-n}E_t\left[b_{t+n}\right] \quad (7)$$

The IBC is met when the initial debt equals the expected present value of future surpluses. This implies the imposition of the following transversality condition:

$$\lim_{n\rightarrow\infty}\frac{b_{t+n}}{(1+r)^n}=0 \quad (8)$$

i.e. that the government does not adopt Ponzi games, by continuously relying on the issue of new debt to pay the interest on the old debt.

The above condition can be interpreted as a bondholders' transversality condition to be willing to hold public debt, as it reassures them about the solvency of the government.

The empirical testing of the sustainability of the government's IBC is generally based on the analysis of the past behaviour of the fiscal policy variables, and several empirical tests have been suggested in the literature, based on the stationarity of debt/deficit and/or on the cointegration between public revenues and expenditures (see, e.g., .Hamilton and Flavin, 1986, Trehan and Walsh, 1988 and 1991, Wilcox, 1989, Hakkio and Rush, 1991, Quintos, 1995, Uctum and Wickens, 2000, and Bohn, 2006). More recent work by Chortoreas et al. (2008) introduces a non-linear stationary model as alternative hypothesis, while a panel unit root/cointegration approach is used by Afonso and Rault (2008) and a multicointegration approach is used by Leachman *et al.* (2005).

Following Afonso (2005), we initially test for cointegration between the GDP shares of government spending and revenues, i.e. GOV and TAX. TAX is the nominal general government revenues on nominal GDP, GOV denotes the government share (i.e. nominal general government expenditure on nominal GDP):

$$TAX_t = a + bGOV_t + u_t \tag{9}$$

We do not transform our variables into logs, as this will affect the cointegration (Banerjee et al., 1993). Taking logs of a series magnifies its fluctuations near zero, whereas sustainability is primarily concerned on how fiscal policy recovers from high values of debt and outlays (Bohn, 2008). Given that both revenues and spending are highly dependent on aggregate income, our short-run models of Section 4 also allow for additional effects from nominal GDP.

In case the null of no cointegration between TAX and GOV cannot be rejected at conventional levels of statistical significance, then the governemnt's IBC is not met and consequently the fiscal policy is considered unsustainable. In case TAX and GOV result cointegrated, with and estimated $b = 1$, then the government's IBC is respected. In case there is cointegration between TAX and GOV, but $b < 1$, then government spending grows faster than government revenues, and the fiscal policy in this case might not be sustainable.

There are nevertheless some shortcomings associated with the empirical testing of the sustainability of the government's IBC in a cointegration/unit root analysis. All the sustainability tests are necessarily backward looking, as they look at the past behaviour of the public finance variables. We might argue, on the other hand, that the fact that a country has consistently conducted its public finances in a sustainable way can provide a good indicator for its future behaviour. Further, the sustainability tests do not take into account the assets owned by the government, which in principle could be sold to the private market. Finally, the sustainability tests implicitly consider the interest rate as stationary.

Previous empirical evidence on the sustainability of the Italian IBC is controversial: Feve and Henin (2000), Afonso (2005) and Galli and Padovano (2008), all find that the Italian government finances are on an unsustainable path. A different conclusion is reached by Greiner *et al.* (2007) and Uctum *et al.* (2006), who provide evidence in favour of the sustainability of the Italian government's IBC, in spite of the high levels of public debt.

3 The empirical model: The long-run analysis.

3.1 Data and empirical methodology.

Given the discussion above, we empirically model the budgetary decisions of Italy, based on annual Italian data over the period 1960 to 2008[5]. Our use of low frequency data allows us to capture the discretionary changes in budgetary policy, that would be ruled out by higher frequency data (see e.g. Blanchard and Perotti, 2002). Further, higher frequency data, that would provide higher degrees of freedom in our estimates, are only available for a much shorter time span.

Figure 1 plots TAX, GOV and $\Delta TAX, \Delta GOV$. We notice that both the revenues and expenditures shares on GDP have considerably grown over time, reaching their peaks in the Nineties. In particular, at the start of our sample, tax revenues accounted for 27% of national GDP, peaking in the late Ninenities at around 47% of GDP. Government spending has followed a similar ascending pattern, accounting for 28% of GDP at the start of our sample, and peaking in the early Nineties at 56% of GDP. Preliminary analysis using different unit root tests suggests that both the revenue and the expenditure series are non-stationary in levels[6].

In order to test for cointegration between revenues and expenditures, we estimate a Vector Error Correction Model (VECM; see Johansen, 1988) of the form:

[5] The dataset is taken from AMECO and a full description of the variables can be found in the Data Appendix.

[6] We have conducted the following unit root tests: Augmented Dickey-Fuller (Dickey and Fuller, 1979), Phillips-Perron (1998), Kwiatkoski-Phillips-Schmidt-Shin (1992), and Ng-Perron (2001). To save space, we do not report in the paper these results, but are available on request from the authors.

$$\Delta y_t = \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-1} + \Pi y_{t-1} + \mu + \varepsilon_t \tag{10}$$

where $y_t = [TAX, GOV]'$ is the set of non-stationary I(1) variables discussed above, $\varepsilon_t \sim niid(0, \Sigma), \mu$ is a drift parameter, and Π is a $(p * p)$ matrix of the form $\Pi = \alpha\beta'$, where α and β are $(p * r)$ matrices of full column rank, with β containing the r cointegrating vectors and α carrying the corresponding loadings in each of the r vectors. The VAR approach is preferred here as it provides the advantage of allowing to model both revenues and expenditures as potentially endogenous.

We set the lag length k equal to 2 based on the Akaike Information Criterion. We test for cointegration between revenues and expenditures using Johansen's (1988) maximal eigenvalue (λ-max) and trace (λ-trace) statistics. To account for our small sample, both tests use a small sample correction (for exact mathematical formulas, see e.g. Doornik and Hendry, 2000, p.282). Both the λ-max and the λ-trace statistics reject the null of no cointegration in favor of one cointegrating vector between revenues and expenditures[7].

We can now test some relevant policy questions, namely: (a) is the Italian government's IBC respected? (b) is the burden of correcting budgetary disequilibria equally shared by changes in revenues and changes in government spending?, and (c) what is the speed of the process of correcting budgetary disequilibria?

Hypotheses (a) and (b) can be tested via a Likelihood Ratio (LR) test, which is distributed as a $\chi^2(1)$ under the null hypotheses of (i) proportionality between revenues and expenditures and (ii) equal adjustment coefficients,

[7] The λ-max and λ-trace statistics are equal to 10.23 (p-value=.07) and 13.82 (-value=.02), respectively. The empirical evidence in favour of one cointegrating vector is therefore stronger for theλ-trace test. The p-values are taken from MacKinnon et al. (1999).

respectively.

The first hypothesis is not rejected, as the LR gives a value of 0.954 (p-value=0.33). The second hypothesis is rejected, as the LR gives a value of 7.35 (p-value=0.00).

Given that the adjustment coefficient on GOV is insignificantly different from zero at 5 percent, as the LR test gives a value of 2.44 (p-value = 0.12), government share is weakly exogenous in our model.

To check the robustness of the estimated long-run results, we also used the fully modified (semi-parametric) OLS method of Phillips and Hansen (1990) for estimation of a single cointegrating vector when there is endogeneity between the TAX and GOV variables. The Phillips and Hansen (1990) procedure provided almost identical results; in particular, the estimate on GOV was equal to 0.951 (standard error=0.066). Figure 2 plots the deviations from the estimated (restricted) relationship. Deviations appear at times quite persistent, suggesting the possibility of non-linear error-correction adjustment, discussed later.

Recursive estimation is used to examine the stability of our cointegrating results and therefore assess any changes over time in the estimated relationship between the tax revenue and government shares of GDP. Figure 3 plots the recursively estimated λ-trace and λ-max test statistics divided by the corresponding 5% critical values. Values of these fractions greater than one indicate stability of the cointegration results over time. The recursively estimated λ-trace test suggests cointegration in all cases but one. On the other hand, the recursively estimated λ-max test indicates cointegration only up to 1995; however, from 2000 onwards the fraction value reverts back to one slowly, signalling a higher attention towards IBC sustainability.

Recursive estimation is also used to assess how the coefficient on GOV

has changed over time. Figure 4 plots the recursively estimated coefficient $\pm 2\times$standard errors. The time-path of the coefficient on the government share of GDP indicates that long-run revenue movements have been less sensitive to expenditure movements in the mid 1980s and mid 1990s, after which one-by-one movements become a norm, confirming the higher attention paid to the IBC in recent years.

The speed of the fiscal consolidation process (question (c) above), can be inferred from the analysis of the impulse response of the cointegrating relationship to system-wide shocks (this is the "persistence profile analysis" in Pesaran and Shin, 1996). From Figure 5, this converges to zero rather slowly with 90 percent of the adjustment completed after 6 years. Deviations from the estimated cointegrating relationship are therefore eliminated very slowly, rendering the process of fiscal consolidation rather slow.

3.2 Policy implications of the long-run analysis

What are the economic implications of the above statistical tests? The presence of cointegration with a cointegrating vector of $(1, -1)$ points to a stable long-run co-movement of the revenues and expenditure shares of GDP, which is generally interpreted, as discussed in Section 2, as an evidence for the sustainability of fiscal policy, that is, for the ability of the Italian government to meet its IBC.

Weak exogeneity of government spending implies that the short-run adjustment to correct budgetary disequilibria is done by changes in tax policy rather than changes in government spending or even policy mixes. Government spending appears therefore to be exogenously decided by the political process, with taxes adjusting consequently. This result is consistent with the spend-and-tax adjustment studied by Peacock and Wiseman (1979), and in line with previous studies on Italy, adopting a different specification of the model (see, e.g. Koren and Stiassny 1998, Alesina and Perotti, 1996).

A slow fiscal adjustment process operating through changes in taxes rather than changes in government spending could be related to public expenditure rigidities, not only due to multi-annual contracts and planning, but also due to strong resistance against expenditure reductions arising both from the demand-side and bureaucratic powers (see OECD, 2005, and Legrenzi and Milas, 2002). The political instability of the country, typically associated with multi party coalition governments[8] and frequent general elections[9], renders problematic the achievement of the necessary consensus to politically unpopular spending cuts, favoring therefore the prevalence of the adjustment via the tax-system, rather than a policy mix. The necessary reforms of the welfare state, and of the pensions system in particular, although debated for several years, are very slowly put into place, due to strong public opposition in the form of widespread general strikes (Reviglio, 2001). The low level of independence of the Italian Central Bank for most of the sample considered, also resulted in a soft-budget constraint for the central government, favoring expenditure growth (see Koren and Stiassny, 1998).

A burden of fiscal consolidation entirely carried by taxes can have a serious detrimental impact on the economy. Daveri and Tabellini (2000) identify tax increases on labour and profits as the main cause of declining economic growth and expansion of the shadow economy. This is certainly true for Italy where

[8] For a more detailed analysis of the link between coalition governments and lower fiscal responsibility, see Roubini and Sachs (1989), Grilli et al. (1991) and Alesina and Perotti (1995).

[9] It is interesting to notice that in the time span considered here, Italian political life saw 47 governments and 14 general elections.

the black market economy accounted for 25.8% of official GDP in 1994, against 12.4% for the UK, 14.3% for France and 9.4% for the US (see Schneider and Enste, 2000). Further, Alesina and Ardagna (1998) show that fiscal consolidations based on tax increases alone are short-lived, unlike fiscal consolidations based on spending cuts. Bertola and Drazen (1993), Sutherland (1997) and Ardagna (2004) also argue that spending cuts can have an expansionary (non-Keynesian) effect on the economy, as opposed to increases in taxes.

4 The Adjustment towards Sustainability

4.1 Linear adjustment

As the null of cointegration between the tax and the expenditure shares of GDP cannot be rejected at conventional levels of statistical significance, we proceed to estimate the corresponding error-correction model, to understand how year-to-year changes in taxes adjust the economy back towards a sustainable long-run equilibrium, conditional on government spending which resulted weakly exogenous in the previous section. We can intepret this error-correction model as the fiscal authorities' reaction function to budgetary disequilibria, in the sense of deviations of taxes and spending from their long run equilibrium which embeds a sustainable government's IBC.

We initially estimate the short-run adjustment of taxes within a linear error correction model To account for the possibility of European Monetary Union effects, we also tried a dummy variable, taking the value of 1 from 1993 (when the Maastricht Treaty was agreed) onwards and 0 elsewhere. The dummy variable turned out to be statistically insignificant, implying that the adjustment of the Italian public finances did not take place through structural changes in the revenue-expenditure patterns[10].

To capture the effects of economic and accelerating economic growth we also considered current and lagged values of ΔGDP_{t-1} and $\Delta^2 GDP_{t-1}$ as extra regressors. We found some weak effect from $\Delta^2 GDP_{t-1}$ only in the non-linear error correction model reported in the following section.

The OLS estimates of the parsimonious linear error-correction model are reported in Table 1(i).We tested and found significant non-linearities in the residuals of the linear error correction model, using the Brock, Dechert and Sheinkman (BDS, 1996) test statistic. The test is also discussed in Escribano (2004)[11]. For this reason, we proceed to re-estimate the error-correction model by allowing for asymmetric and non-linear error correction adjustment[12].

4.2 Asymmetric and Non-linear Adjustment

The asymmetric error correction model is obtained by taking the deviations of the cointegrating vector CV_{t-1} around its mean value, and partitioning them into their positive and negative components (denoted by $\text{CV}^{+}_{t-1}$and CV^{-}_{t-1}, respectively). Results for the parsimonious asymmetric error-correction model are reported in Table 1(ii). The results indicate that the speed of adjustment varies depending on whether the estimated relationship is above or below its equilibrium. The point estimates suggest that when taxes are lower than equilibrium, they increase rapidly. On the other hand, when taxes are higher than equilibrium, they fall slowly. Notice that the coefficient on CV^{-}_{t-1} is more than

[10] Italy qualified to the European Monetary Union despite failing the debt criterion. Economic adjustment was mainly driven by changes in monetary policy. In 1997, a "European tax" was imposed on private households, as a one-off measure, and some "budgetary gimmicks" were used in order to qualify for the deficit criterion (see e.g. Reviglio, 2001).

[11] Results available on request.

[12] Asymmetric and non-linear error correction models have been introduced by Escribano (1986). See also Granger and Lee (1989), Escribano and Granger (1998), Escribano and Pfann (1998), Escribano and Aparicio (1999), and Escribano and Mira (2002), amongst others.

twice as large (in absolute value) as the coefficient on CV^{+}_{t-1}. Nevertheless, equality of the coefficients on $\text{CV}^{+}_{t-1}$and CV^{-}_{t-1} is not rejected based on an F-test (p-value= 0.38). Hence, in economic terms our results point to downward inflexibility of taxes. Nevertheless, in terms of statistical tests, these results are not clear-cut.

To obtain the non-linear error correction model, we add to the linear model of Table 1(i) the squared and cubed values of the error-correction regressor, that is, $\text{CV}^{2}_{t-1}$and CV^{3}_{t-1}. This type of non-linearities allows for a faster adjustment when deviations from the equilibrium level get larger. Results for the parsimonious non-linear error correction are reported in Table 1(iii). The p-value of the F test for the statistical significance of the CV^{3}_{t-1} regressor is equal to 0.00, and the p-value of the F test for the joint significance of the $\text{CV}^{2}_{t-1}$and CV^{3}_{t-1} regressors is equal to 0.01, indicating (at the 5 percent level of statistical significance) that adjustment back to equilibrium is stronger for large disequilibrium deviations. We also report a weak positive effect on taxes from lagged accelerating economic growth, possibly capturing the built-in progressivity of the fiscal system. We return to this issue more in detail below.

A comparison of the regression standard errors across models indicates that the non-linear model has a better fit. This is also confirmed by recursive parameter stability tests (available by the authors on request).

Figure 6a and Figure 6b plot the asymmetric and non-linear adjustments against the cointegrating vector, respectively. Figure 6a shows an asymmetric adjustment of taxes, as deviations above equilibrium are corrected slower compared to deviations below equilibrium. On the other hand, we notice from Figure 6b that once disequilibrium deviations get larger, adjustment back to equilibrium becomes stronger.

To assess further the differences amongst the estimated models, we take a closer look at the contribution of the error correction terms to changes in the tax share of GDP. To do this, we plot in Figure 7 the values of the error correction components of the linear, asymmetric and non-linear equations across time. The linear model appears to be correcting more slowly with respect to the asymmetric and non-linear ones, both when above and when below the equilibrium. Of the three models, the non-linear one embeds a faster adjustment.

The presence of these asymmetries suggests the opportunity of analyzing further the behavior of taxes in different phases of the economic cycle. In particular, we investigate the possibility of asymmetric effects from accelerating and decreasing economic growth on taxes, given the weak positive effect from lagged accelerating growth ($\Delta^2\text{GDP}_{t-1}$) on taxes reported in Table 1(iii). For this purpose, we partition $\Delta^2\text{GDP}_{t-1}$ into its positive and negative components (denoted by $\Delta^2\text{GDP}^+_{t-1}$ and $\Delta^2\text{GDP}^-_{t-1}$, respectively). Then we re-estimate the non-linear model of Table 1(iii) where we replace $\Delta^2\text{GDP}_{t-1}$with $\Delta^2\text{GDP}^+_{t-1}$ and $\Delta^2\text{GDP}^-_{t-1}$ as separate regressors. The coefficient on $\Delta^2\text{GDP}^+_{t-1}$ is estimated at 0.110 (t-ratio = 1.22). The coefficient on $\Delta^2\text{GDP}^-_{t-1}$ is estimated at 0.040 (t-ratio = .16) whereas the estimates of the remaining regressors are almost identical to those of Table 1(iii). GDP symmetry is not rejected based on an F-test (F=0.41, p-value = 0.53). On the other hand, the joint hypothesis of symmetric GDP effects and linear error correction adjustment (in terms of zero effects from CV^2_{t-1} and CV^3_{t-1}) is rejected at 10 percent (F=2.86, p-value= 0.07). Hence, there is some evidence of downward inflexibility of taxes during periods of decreasing economic growth as the coefficient on $\Delta^2\text{GDP}^-_{t-1}$ is four times lower than the coefficient on $\Delta^2\text{GDP}^+_{t-1}$, which in turn is statistically insignificant. We believe that this result deserves more attention and possibly further analysis in the direction of planning an adequate strategy of tax-smoothing, to avoid taxes to become more pressing during economic downturns.

This result strengthens our conclusions with respect to the weaknesses of the spend-and-tax adjustment, suggesting policy-makers to adopt a higher degree of caution when pursuing measures of fiscal consolidation relying exclusively on a unique instrument.

5 Conclusions

This paper performs an empirical analysis of the sustainability of the Italian public finances between 1960 and 2008. We provide robust evidence in favour of cointegration between taxes and government spending, with a cointegrating vector of $(1, -1)$. This result is generally interpreted as that the Italian government's IBC is sustainable. We find nevertheless that the year-to-year adjustments to correct budgetary disequilibria are made entirely via changes in taxes, rather than spending cuts or policy mixes, as the government spending share on GDP resulted weakly exogenous. This result is in line with the spend-and-tax model, where government spending is determined by the political process and taxes adjust consequently. We also document some rigidities in the tax instrument, particularly in terms of downward inflexibility of the average tax rate during periods of decreasing economic growth, pointing to a regressive use of the tax instrument.

Taken together, our results point to a relevant wekness of the Italian public finances, questioning the emphasis put on the sustainability analysis alone in previous studies, and confirming the importance of analysing the adjustment process towards a sustainable IBC.

Our work can be extended in several ways. Teräsvirta (1998) pointed out that non-linear models with quadratic and cubic error correction terms are first-order approximations to smooth transition autoregression models, where the transition mechanism between different regimes is driven by the disequilibrium error. In the context of our public finance model, it would be interesting to estimate a two-regime smooth transition model where adjustment takes place in every period but the speed of the adjustment as well as the impact of the lagged values of expenditure and taxes vary conditional on whether disequilibrium deviations from the expenditure/taxes relationship are large or small.

It would also be interesting to examine whether non-linear adjustment can be elevated into a stylized fact, by considering tax and government spending adjustment in other countries, as well as at a local government level. If it can, then non-linearities in taxes and spending might be incorporated into existing non-linear models of fiscal policy (see e.g. Giavazzi et al., 2000). We intend to address these issues in future research.

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Data Appendix

The data used for this paper are taken from the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs (AMECO).

The statistical definitions of the series are:

TAX: Total revenue; general government; ESA 1995 (URTG)

Total government revenue is the sum of: Sales of market output (ESA 95-code P.11) and output- for own final use (P.12) + Payments for other non-market output (P.131) + Other subsidies on production (D.39), receivable + Taxes on production and imports (D.2), receivable + Property income (D.4), receivable + Current taxes on income and wealth (D.5), receivable + Social contributions (D.61), receivable + Other current transfers (D.7), receivable + Capital transfers (D.9), receivable.

G:Total expenditure; general government; ESA 1995 (UUTG)

Total general government expenditure is the sum of: Intermediate consumption (P.2) + Gross capital formation (P.5) + Compensation of employees (D.1), payable + Other taxes on production (D.29), payable + Subsidies (D.3), payable + Property income (D.4), payable + Current taxes on income and wealth (D.5), payable + Social benefits other than social transfers in kind (D.62), payable + Social transfers in kind related to expenditure on products supplied to households via market producers (D.6311 + D.63121 + D.63131), payable + Other current transfers (D.7), payable + Adjustment for the change in the net equity of households on pension funds reserves (D.8)[13] + Capital transfers (D.9),

[13] The adjustment for the change in net equity of households in pension funds reserves (D.8) represents the adjustment needed to make appear in the saving of households the change in the actuarial reserves on which households have a definite claim. Accordingly, it is part of the expenditure of the insurance enterprises sector and other sectors administering non-autonomous pension funds (see ESA 1995, paragraph 4.141 and 4.144).

payable + Acquisitions of non-produced non-financial assets (K.2)

GDP: GDP (reference level for excessive deficit procedure)

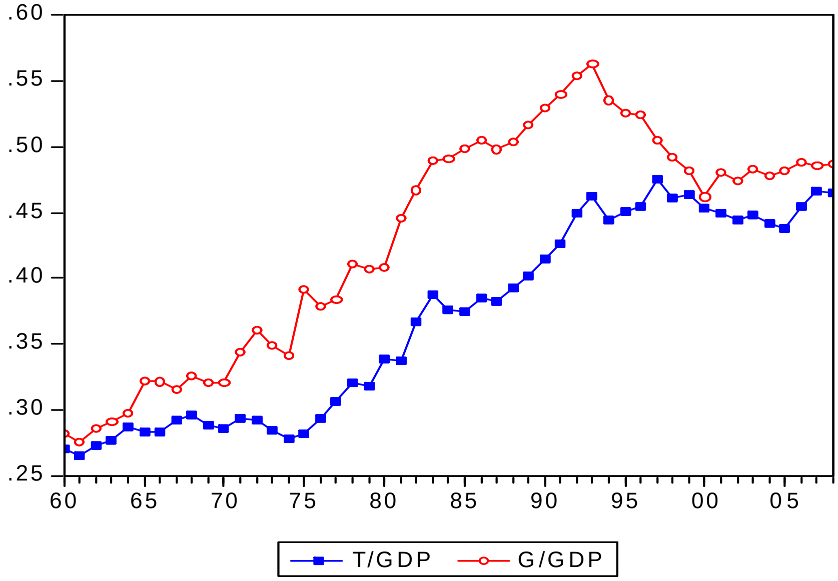
Gross domestic product at current market prices ; Reference level for excessive deficit procedure (UVGDH).

Table 1: OLS estimates of alternative error correction models for ΔTAX

	(i)	(ii)	(iii)
	Linear model	Asymmetric model	Non-linear model
Constant	0.003 (2.120)	0.002 (0.535)	0.005 (0.825)
ΔGOV_t	0.234 (2.572)	0.236 (1.960)	0.260 (2.051)
CV_{t-1}	-0.100 (-2.818)	-	0.010 (0.100)
CV^2_{t-1}	-	-	-0.131 (0.970)
CV^3_{t-1}	-	-	-39.239 (-3.062)
CV^+_{t-1}	-	-0.050 (-0.740)	-
CV^-_{t-1}	-	-0.132 (-1.770)	-
$\Delta^2 GDP_{t-1}$			0.231 (1.032)
Diagnostics			
Regression s.e.	0.010	0.008	0.001
$\overline{R}^2$	0.255	0.290	0.330
F*ar*	0.41 [0.66]	0.48 [0.61]	0.67 [0.51]
F*arch*	0.08 [0.76]	0.03 [0.86]	0.74 [0.39]
$\chi^2 nd$	4.56 [0.10]	1.11 [0.37]	5.47 [0.06]
F test of equal CV^+_{t-1} and CV^-_{t-1} effects	-	0.72 [0.38]	-
F test of zero effect from CV^3_{t-1}	-	-	8.98 [0.00]
F test of zero effects from CV^2_{t-1} and CV^3_{t-1}	-	-	4.72 [0.01]

Notes: t-ratios in parentheses. F*ar* is the Lagrange Multiplier F-test for 2nd order serial correlation. F*arch* is the 1st order ARCH F-test. $\chi^2 nd$ is a Chi-square test for normality. Numbers in square brackets are the *p*-values of the tests. $\overline{R}^2$ is the adjusted coefficient of determination. $CV = TAX - GOV$, in mean corrected form.

Figure 1: Plots of the levels and the first differences of the series



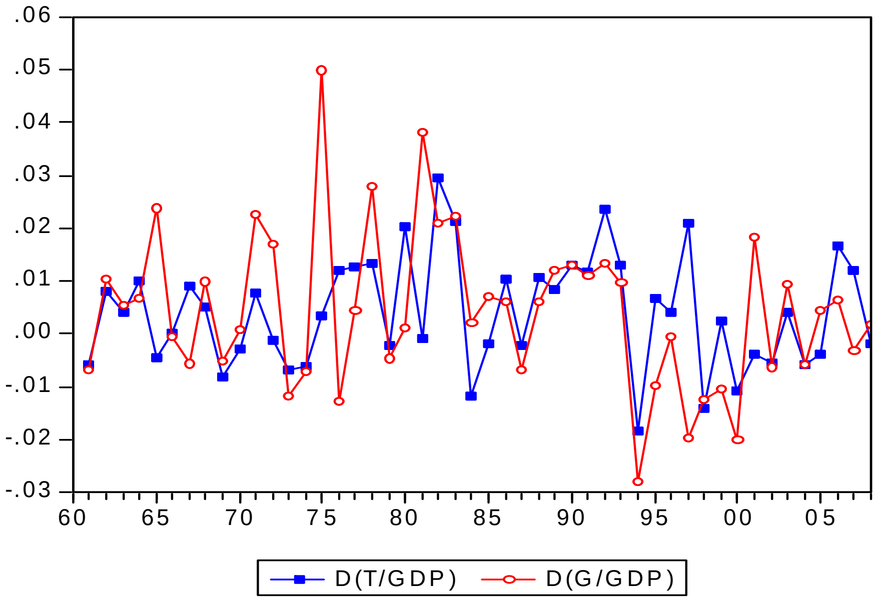


Figure 2: Long-run relationship: *CV* = *TAX* – *GOV*, in mean corrected form

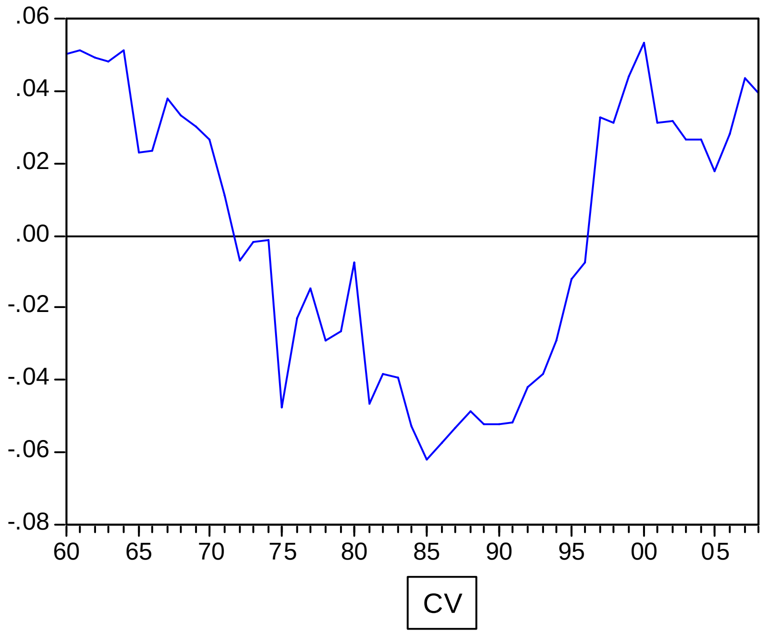


Figure 3: Trace and max test statistics divided by the corresponding 5% critical values

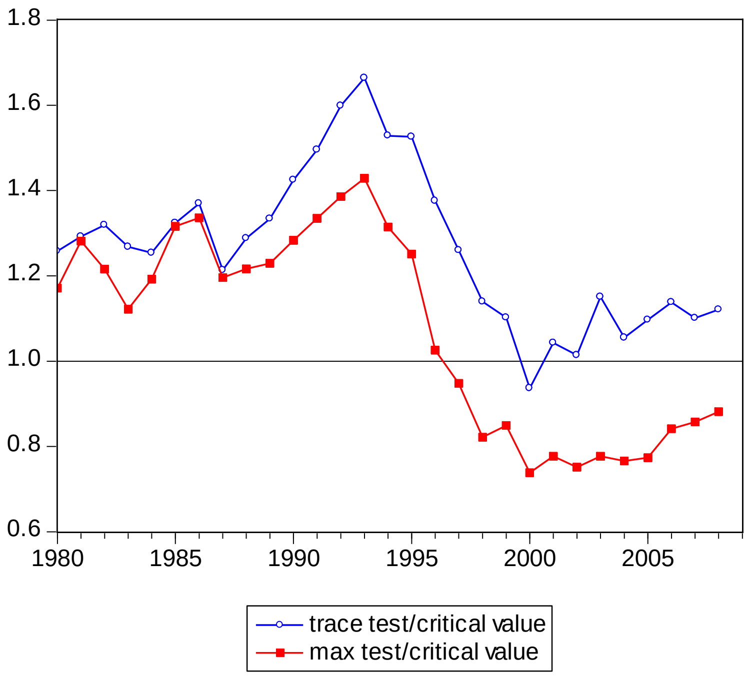


Figure 4: Recursive beta coefficient ± 2*standard errors

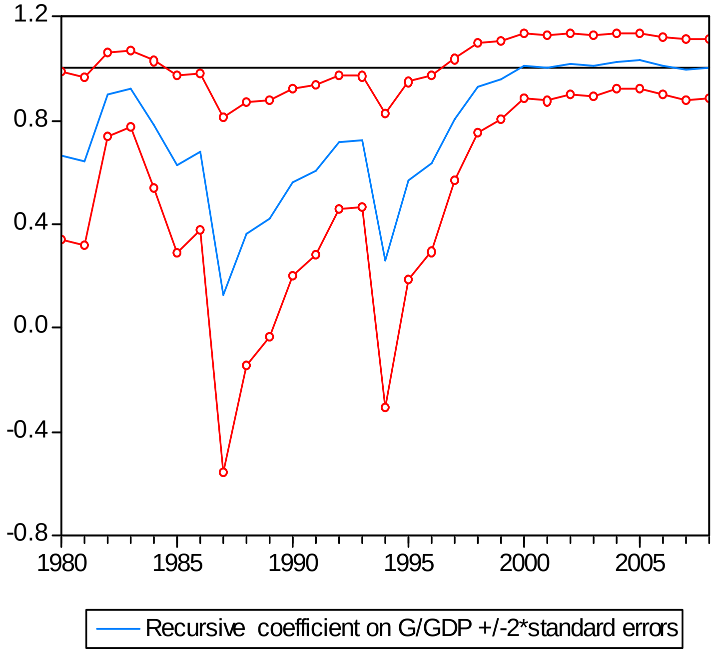


Figure 5: Persistence profile of the cointegrating vector to system-wide shocks

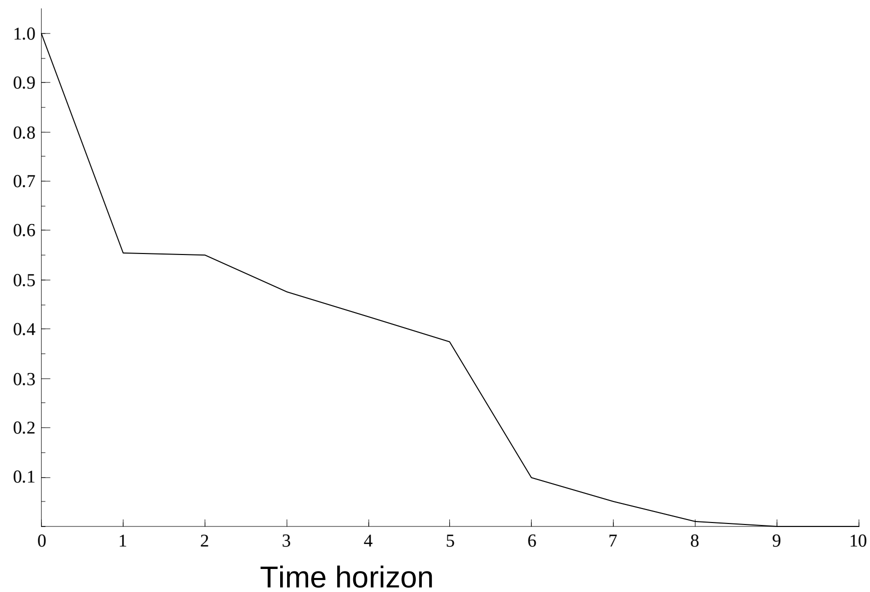
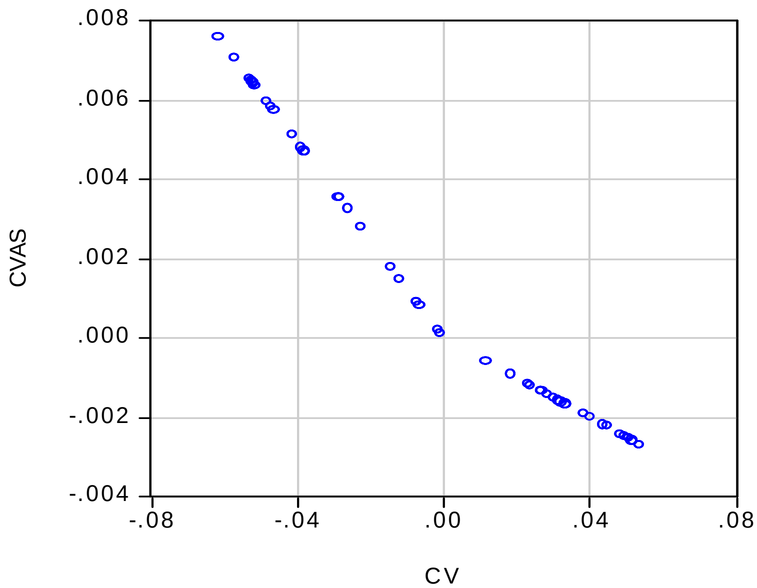
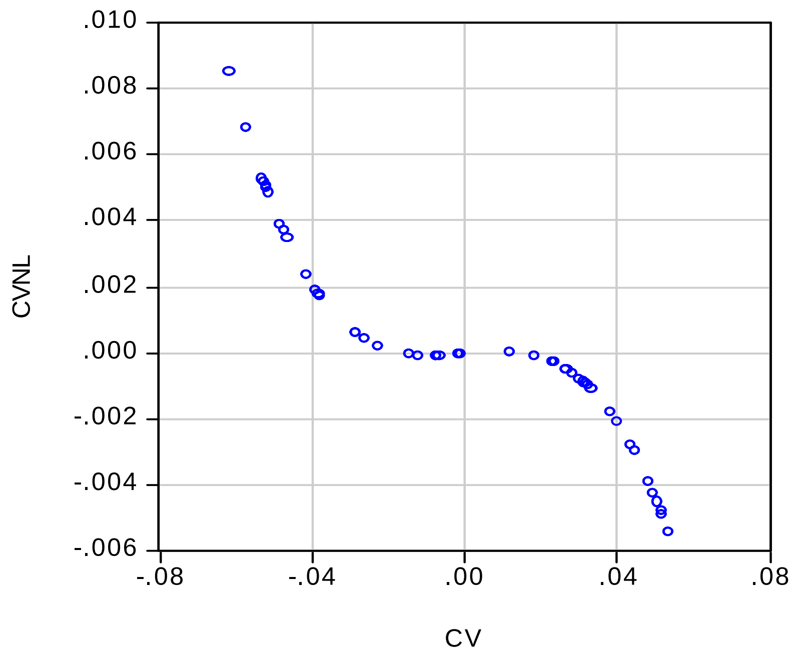


Figure 6: Asymmetric and non-linear adjustment

(a)

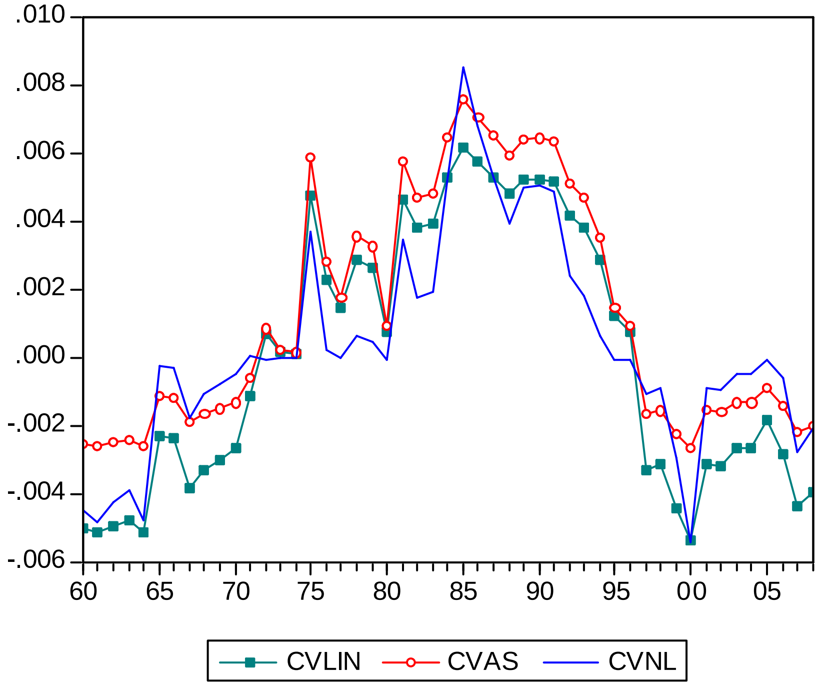


(b)



Notes: CVAS = $-0.050CV^{+} -0.132CV^{-}$, CVNL = $0.010CV - 0.131CV^{2} - 39.239CV^{3}$.

Figure 7: Error correction components of the linear, asymmetric and non-linear models for *ΔTAX*



Notes: CVAS = -0.050CV^{+} -0.132CV^{-}, CVNL = 0.010CV –0.131CV^{2} –39.239CV^{3}, CVLIN = -0.100CV

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