Is it the "How" or the "When" that Matters in Fiscal Adjustments?*

Alberto Alesina, Gualtiero Azzalini, Carlo Favero, Francesco Giavazzi and Armando Miano†

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Abstract

Using data from 16 OECD countres from 1981 to 2014, we find that the composition of fiscal adjustments is much more important than the state of the cycle in determining their effects on output. Fiscal adjustments based upon spending cuts are much less costly than those based upon tax increases, regardless of whether the adjustment starts in a recession or not.

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†Harvard and Igier Bocconi; NYU Stern; Igier Bocconi; Igier Bocconi; Harvard.

1 Introduction

The empirical literature on the macroeconomic effects of fiscal policy often finds that fiscal multipliers depend on the state of the economy: whether a shift in fiscal policy happens during an economic expansion or during a contraction makes a difference. Is this the relevant non-linearity when dealing with fiscal adjustments? This paper studies whether what matters most is the "when" (whether an adjustment is carried out during an expansion, or a recession) or the "how" (*i.e.* the composition of the adjustment, whether it is mostly based on tax increases, or on spending cuts). In order to properly answer this question one needs to study the two aspects – the "when" and the "how" – jointly, otherwise one risks attributing to one source of non-linearity effects that are really produced by the other. So far this has not been done in the literature which has typically studied the two aspects separately. This paper fills the gap by concentrating exclusively on fiscal consolidations. Our results have nothing to say about fiscal expansions.

We estimate a model which allows for both sources of non-linearity: "when" and "how". We find that the composition of fiscal adjustments is more important than the state of the cycle in determining their effect on output. Fiscal adjustments based upon spending cuts are much less costly in terms of short run output losses — such losses are in fact on average close to zero — than those based upon tax increases which are associated with large and prolonged recessions regardless of whether the adjustment starts in a recession or not. Our results appear not to be explained by different reactions of monetary policy and, therefore, they should survive at the zero lower bound (ZLB) when monetary policy is constrained, or within monetary unions where monetary policy cannot respond to the fiscal policy of a specific member country.

Auerbach and Gorodnichenko 2012, 2013 find that GDP multipliers of government purchases are larger in recessions. Barnichon and Matthes 2015 find that the multiplier associated with a negative shock to government spending is substantially above one, while it is way below one in the case of a positive spending shock. Ramey and Zubairy 2014 study how fiscal multipliers change depending on (i) the state of the economy, and (ii) whether interest rates are at the zero lower bound: using data for the US they find no evidence that multipliers are different across states of the economy, whether defined by the amount of output slack, or whether interest rates are near the ZLB. Wataru, Miyamoto and Sergeyev 2016, using data for Japan, investigate the effect on fiscal multipliers of the interaction between the slack in the economy and how close it is to the ZLB. However, the size of their sample does not allow them to address the two channels (slack and proximity to the ZLB) simultaneously; when they limit the analysis to the effect of being close to the ZLB they find only weak evidence of an asymmetry, a result which is within the range of the answers provided by the theoretical literature.[1] Alesina, Favero and Giavazzi 2015a limit their empirical analysis to fiscal consolidations: they construct exogenous (with respect to output) multi-year fiscal plans and classify them as tax-based or expenditure-based looking at the relative importance of tax increases and spending cuts within a multi-year plan. They find that the effects of a fiscal consolidation depend on the composition of the plan: spending-based adjustments have been associated, on average, with mild and short-lived recessions, in many cases with no recession at all; instead, tax-based adjustments have been followed by prolonged and deep recessions.[2] Erceg and Lindé 2013 investigate the effects of a spending-based *vs* labor tax-based fiscal consolidation in a two country DSGE model. They find that the effects depend on the degree of monetary accommodation. Under an independent monetary policy (no currency union) cuts in government spending are much less costly than tax hikes. Under a currency union the effect is partially reversed. Indeed, the model predicts that when monetary policy provides too little accommodation – given its focus on union wide aggregates — spending based fiscal consolidations are more costly in terms of output losses in the short run. In the long run, however, spending cuts are still less harmful than tax hikes, because of real exchange rates and price levels adjustments. The adverse impact of spending based consolidations (in the short run) is exacerbated when monetary policy is constrained at the ZLB.

Before explaining our empirical strategy it is useful to review the techniques used thus far to study how the slack in the economy may affect multipliers. Auerbach and Gorodnichenko 2012 estimate a regime-switching SVAR model with smooth transitions across states (recession *vs* expansion). Their

[1] In a simple real business cycle model, such as Baxter and King 1993, the output multiplier of a positive shift in government spending is below one. In New Keynesian models the magnitude of the output multiplier depends on the nature of the shock that takes the economy to the ZLB. Woodford 2010, Eggertsson 2011, and Christiano, Eichenbaum and Rebelo 2011 consider the case in which the economy reaches the ZLB as a result of a "fundamental" shock. In this case the multiplier can be substantially larger than one as temporary government spending is inflationary and stimulates private consumption and investment by decreasing the real interest rate. Mertens and Ravn 2014 consider instead a situation in which the ZLB is reached following a "non-fundamental" confidence shock: they find that the output multiplier during the ZLB period is quite small. The reason is that, in this situation, government spending shocks are deflationary, raising the real interest rate and reducing private consumption and investment.

[2] Alesina et al 2015b extend this analysis to post-crisis fiscal consolidations finding similar results.

evidence refers to the two polar cases in the sense that, in computing impulse responses, they assume that the regime prevailing when the shift in fiscal policy occurs never changes, *i.e.* that the shift in fiscal policy does not affect the state of the economy, for instance shifting it from an expansion to a recession. This is often not the case during fiscal consolidations. For instance, consider the case of Belgium: the large consolidation plan adopted in 1982 followed a year of recession but while it was implemented the economy started growing and returned to positive growth. Ten years later, the 1992 multi-year consolidation plan started after a period of expansion but in 1993 the Belgian economy experienced a recession from which it recovered in 1994.

The assumption that the shift in fiscal policy does not affect the state of the economy is relaxed in Ramey and Zubairy 2014: here the authors compute regime-dependent multipliers using the linear projections method proposed by Jordà 2005 which allows for the state of the economy to change following the shift in fiscal policy. When Ramey and Zubairy 2014 apply this methodology to data for the US, the size of multipliers appears not to depend on the cycle, thus reversing the conclusions of Auerbach and Gorodnichenko 2012, 2013. Results differ (and are more in line with Auerbach and Gorodnicenko 2012, 2013) when they apply the same technique to Canadian data (Ramey and Zubairy 2015). Caggiano et al 2015 also allow for a feedback from shifts in fiscal policy to the probability of the economy being in an expansion or a recession. They find that fiscal multipliers are higher in recessions than in booms. Their results, however, depend upon "extreme" events, that is deep recessions and strong expansionary periods.

A second important choice in the empirical strategy is how exogenous shifts in fiscal policy are identified and then organized. In this paper we follow our previous work (Alesina, Favero and Giavazzi 2015a) arguing that the relevant experiment to collect evidence on fiscal multipliers requires studying the effects of exogenous deviations from a fiscal status quo that come in the form of multi-year fiscal corrections: what we have labelled a "fiscal plan". In our view such plans are the correct way to describe how fiscal policy is implemented in real world situations because governments typically adopt, and parliaments vote, multi-year budget laws which have little resemblance to the isolated fiscal "shocks" often studied in the literature.

This paper is organized as follows. In Section 2 we describe how we construct our fiscal plans and discuss their exogeneity. In Section 3 we illustrate our empirical framework. Section 4 presents our results and Section 5 concludes.

2 Fiscal consolidation plans

In this section we first describe how we construct the multi-year fiscal plans we analyze. Then we discuss their exogeneity with respect to output growth.

2.1 Fiscal plans

We address the possible endogeneity of shifts in fiscal variables using the "narrative" approach first introduced by Romer and Romer 2010, later applied to a number of OECD countries by DeVries et al 2011 and extended by Alesina, Favero and Giavazzi 2015a. As in the latter paper, and differently from what is normally done in the literature, we do not study the effects of isolated fiscal "shocks". Rather, we study the effects of fiscal "plans", that is of announcements of shifts in fiscal variables to be implemented over an horizon of several years. To the extent that expectations matter, the multi-year nature of these budgets cannot be ignored.

Fiscal plans consist of the announcement of a sequence of actions, some to be implemented at the time the legislation is adopted, some to be implemented in following periods. Plans are also a mix of measures, some affecting government expenditures, other affecting revenues. Typically legislatures start debating the overall size of an adjustment and then discuss its composition: by how much to cut spending (and which programs) and by how much to raise taxes (and which ones). The design of plans thus generates inter-temporal and intra-temporal correlations among fiscal variables. The inter-temporal correlation is the one between the announced (future) and the unanticipated (current) components of a plan. The intra-temporal correlation is that between the changes in revenues and in spending that determines the composition of a plan, given its size. We assume that if a new plan is announced in period t the policies implemented in that period are unexpected. While a plan is debated in Parliament, economic agents could form expectations of what it will look like. In practice, however – beyond the fact that measuring these expectations is virtually impossible — the composition of a plan is almost always the result of political deals which often are only resolved shortly before the plan is announced. One could argue that fiscal announcements are "cheap talk" until they become laws.

Consider a fiscal plan coming into effect at the beginning of year t. A plan typically contains three components: *(i)* unexpected shifts in fiscal variables (announced and implemented at time t): we call them $e^u_{i,t}$, where i refers to the particular country implementing the fiscal correction; *(ii)* shifts implemented at time t but which had been announced in previous years: $e^a_{i,t-j,t}$, where j denotes the horizon of a fiscal plan and *(iii)* shifts announced at time t, to be implemented in future years $e^a_{i,t,t+j}$. Considering, for simplicity, the case in which the horizon of the plan is only one year ($j = 1$), and with reference to a specific country i, an overall fiscal correction $f_{i,t}$ can thus be described as follows

$$\begin{aligned} f_{i,t} &= e^u_{i,t} + e^a_{i,t-1,t} + e^a_{i,t,t+1} \\ e^u_{i,t} &= \tau^u_{i,t} + g^u_{i,t} \\ e^a_{i,t,t+1} &= \phi_1 e^u_{i,t} + v_{1,i,t} \end{aligned}$$

The second equation explains that a fiscal correction consists of changes in taxes and in expenditures: thus $e^u_{i,t} = \tau^u_{i,t} + g^u_{i,t}$ and the same holds for $e^a_{i,t-1,t}$ and $e^a_{i,t,t+1}$. The third equation captures the correlation between the immediately implemented and the announced parts of a plan. This is a crucial feature of fiscal plans: overlooking it would mean assuming that announcements are uncorrelated with unanticipated policy shifts. As we shall see this is an assumption violated in the data. Interestingly, different plans (for instance plans mostly based on tax hikes and plans mostly based on expenditure cuts) feature different correlations between announced measures and measures immediately implemented. The same happens if you consider individual countries: some countries tend to adopt plans in which future measures reinforce those currently being implemented; other tend to do the opposite, announcing that current measures will be, at least partially, undone in the future. In order to correctly simulate the effect of a fiscal plan it is necessary to estimate this inter-temporal correlation: simulating an unexpected policy shift overlooking the accompanying announcements would not reflect the data used to estimate fiscal multipliers

It often happens that fiscal plans are revised along the way: in that case, we classify a modification of an announced measure as an unexpected shift in fiscal policy.

The above description highlights that fiscal plans generate "fiscal foresight": economic agents learn in advance (through announcements) measures that will be implemented in the future. As observed by Leeper et al 2008, fiscal foresight makes the moving average (MA) representation of a VAR non-invertible and thus prevents the identification of exogenous shifts in fiscal variables from VAR innovations: this makes "narrative identification" inevitable. By "narrative identification" we mean, following Romer and Romer 2010, that a time-series of exogenous shifts in taxes and government spending, rather than being recovered from VAR residuals, is reconstructed directly, reading parliamentary reports and similar documents to identify the size, timing, and principal motivation for all major fiscal policy actions. Legislated tax and expenditure changes are then classified into endogenous (induced by short-run countercyclical concerns) and exogenous (responses to an inherited budget deficit, or to concerns about long-run, but not cyclical, economic growth, or politically motivated).

The fiscal consolidations we study are those implemented by 16 OECD countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Portugal, Spain, Sweden, United Kingdom, United States) between 1981 and 2014. We take as our starting point the narrative identification constructed for these countries by DeVries et al 2011: in their dataset episodes of fiscal adjustment are classified as exogenous if *(i)* they are geared towards reducing an inherited budget deficit or a long run trend of it, for example associated with pension outlays, induced by population ageing, *(ii)* are motivated by reasons which are independent from the state of the business cycle. Adjustments that instead are motivated by short-run countercyclical concerns are excluded on the argument that they are endogenous in the estimation of their effect on output.

For each country we go back to the original sources used by DeVries et al 2011 and, in order to construct fiscal plans, we re-classify the measures implemented distinguishing between those that were unexpected and those that were simply announced. We also decompose each adjustment in its two components: changes in taxes and in spending. While doing so we double check the DeVries et al identification and fix a few inconsistencies. We also extend their data reconstructing, following the same methodology, the fiscal consolidations implemented in 2009-2014.[3]

To illustrate our approach with a specific example, Table 1 shows — with reference to the fiscal correction implemented by Belgium between 1992 and 1994 — on the left-hand side the exogenous fiscal "shocks" identified by DeVries et al and then used in Guajardo et al 2014 and, on the right-hand side, the plan we have reconstructed. DeVries et al overlook fiscal announcements and construct the "fiscal shocks" whose effects they analyze (which we shall call $\widetilde{e_{i,t}}$) adding up shifts in fiscal variables that are unanticipated, $e^u_{i,t}$, with those that are implemented at time t but had been announced in previous periods, $e^a_{i,t-1,t}$. That is, keeping the simplifying assumption of a one-year horizon

$$\widetilde{e_{i,t}} = e^u_{i,t} + e^a_{i,t-1,t}$$

$\widetilde{e_{i,t}}$ and its components, $\widetilde{g_{i,t}}$, and $\widetilde{\tau_{i,t}}$, are shown in the first columns of Table 1. For instance, considering the row for 1992, $\widetilde{e_{i,t}} = 1.79$ and $e^u_{i,t} + e^a_{t,t-1,t} = 1.85$. The two corrections are not identical because shifts in fiscal variables are measured in billions of the domestic currency and then scaled using the GDP of

[3] The dataset used in this paper will be made available on a dedicated space in the IGIER webpage: www.igier.unibocconi.it/fiscalplans

the previous period. We use the latest available GDP series which sometimes may have been revised since the time DeVries et al accessed the data.[4] The same holds for the following years and for the two sub-components: for instance, remaining on row one, $\widetilde{\tau_{i,t}} = 0.99$ and $\tau^u_{i,t} + \tau^a_{t,t-1,t} = 1.03$. Components entering our fiscal plans appear on right-had-side columns of Table 1. Notice that, differently from the DeVries et al "shocks", our plans also include announcements of future shifts in fiscal variables.

In the last column of Table 1 (columns 6 to 11) we classify the plan considered in each row as tax-based *(TB)* or expenditure-based *(EB)*: this classification is done summing all fiscal measures, unanticipated, implemented but previously announced and future announcements. Plans for which the largest component of the fiscal correction (measured as a fraction of GDP the year before the budget law is introduced and summing unanticipated and announced measures) is an increase in taxes is labelled *TB*; similarly, spending-based plans *EB* are those where the largest component of the fiscal correction consists of expenditure cuts. Note that the labelling of a plan depends on the *full inter-temporal path* of the correction and not only on the measures adopted in a specific year. For example, 1992 in the case of Belgium is classified as an *EB* plan despite the fact that the amount of fiscal correction actually implemented in 1992 relies more heavily on taxation. The labelling of a plan can only change if during its implementation changes are introduced with respect to the measures planned when it was first announced. This, indeed, happened in Belgium in 1993 and then again in 1994.

Table 1: Fiscal plan implemented by Belgium during 1992-1994

Year	$\widetilde{\tau_{i,t}}$	$\widetilde{g_{i,t}}$	$\widetilde{e_{i,t}}$	$e^u_{i,t}+e^a_{t,t-1,t}$	$\tau^u_{i,t}$	$\tau^a_{i,t-1,t}$	$\tau^a_{i,t,t+1}$	$g^u_{i,t}$	$g^a_{i,t-1,t}$	$g^a_{i,t,t+1}$	Label
1992	0.99	0.80	1.79	1.85	1.03	0	0.05	0.82	0	0.42	*EB*
1993	0.43	0.49	0.92	0.99	0.40	0.05	0.55	0.12	0.42	0.28	*TB*
1994	0.55	0.60	1.15	1.21	0	0.55	0	0.38	0.28	0	*EB*

for each year t, plans are labelled following this convention

[4] As a convention, we use the GDP of the previous period because this was the latest estimate for GDP known by policymakers at the time these fiscal measures were announced. Results (available upon request) are essentially identical when scaling with current GDP.

$$if \ \left(\tau^u_{i,t}+\tau^a_{i,t-1,t}+\sum_{j=1}^{horiz}\tau^a_{i,t,t+j}\right) > \left(g^u_{i,t}+g^a_{i,t-1,t}+\sum_{j=1}^{horiz}g^a_{i,t,t+j}\right)$$
$$then \ TB_{i,t}=1 \ and \ \ EB_{i,t}=0, \ otherwise \ TB_{i,t}=0 \ \ and \ \ EB_{i,t}=1$$

To sum up. Using the narrative approach we identify consolidation episodes — that is shifts in fiscal variables extending over a number of years, and thus forming a fiscal plan — that are exogenous to output growth in the year in which the plan is first introduced. Obviously exogeneity of the narrative approach is critical. We address it in the next paragraph.

2.2 The exogeneity of fiscal plans

The fact that narratively identified fiscal adjustments are predictable, either by their own past or by past economic developments, has been considered by some authors (Hernandez de Cos and Moral-Benito 2016, Jorda and Taylor 2013) a threat to their exogeneity. Here we explain why this is not the case.

Consider first the fact that fiscal adjustments are predictable based upon past fiscal corrections. Consider the fiscal "shocks" analyzed by Devries et al ($\widetilde{e_{i,t}}=e^u_{i,t}+e^a_{i,t-1,t}$) which are found to be predictable by their own past. As we have illustrated in the previous section, within a plan, policy announcements are correlated with unanticipated policy shifts, that is $e^a_{i,t-1,t}=\phi_1 e^u_{i,t-1}+v_{1,i,t-1}$. Under the null that $e^u_{i,t}$ are not correlated over time

$$\begin{aligned}
Cov\left(\widetilde{e_{i,t}},\widetilde{e_{i,t-1}}\right) &= Cov\left(\left(e^u_{i,t}+e^a_{i,t-1,t}\right),\left(e^u_{i,t-1}+e^a_{i,t-2,t-1}\right)\right)\\
&= Cov\left(\left(e^u_{i,t}+\phi_1 e^u_{i,t-1}+v_{1,i,t-1}\right),\left(e^u_{i,t-1}+e^a_{i,t-2,t-1}\right)\right)\\
&= \phi_1 Var\left(e^u_{i,t-1}\right)
\end{aligned}$$

Finding $Cov\left(\widetilde{e_{i,t}},\widetilde{e_{i,t-1}}\right)\neq 0$ is therefore not surprising. In other words, predictability of $\widetilde{e_{i,t}}$ from their own past is a feature of multi-year fiscal plans and is properly dealt with analyzing plans rather than shocks such as $\widetilde{e_{i,t}}$.

Predictability by past economic variables raises a separate issue. Hernandez de Cos and Moral-Benito 2016 show that if fiscal adjustments are described by a dummy variable that takes the value of 1 when $\widetilde{e_{i,t}}\neq 0$, they are predictable based on information available at time $(t-1)$. This observation, however, does not take into account the fact that there are two sources of identification of narrative adjustments: the *timing* of a fiscal correction and its *size*. Transforming fiscal adjustments into a 0/1 dummy completely neglects the importance of size as a source of identification. To illustrate

Table 2: Time vs Size

	β_1	β_2
	1.0245***	0.6945***
	(0.0437)	(0.0413)
R^2	0.4236	0.2719
$\# \, of \, obs$	534	534

the practical relevance of this point we have run two simple regressions. Let I_t^a be an indicator variable that takes the value of 1 when an adjustment is implemented and 0 otherwise, and run on this indicator both unanticipated adjustments and announcements, that is run these two regressions: $e_t^u = \beta_1 I_t^a + \varepsilon_t$ and $\sum_j e_{t,t+j}^a = \beta_2 I_t^a + \eta_t$. If the only source of variation were the timing of the adjustment these regressions would produce an R^2 of 1. Table 2 reports the results: both R^2 are low, supporting the conjecture that the main source of identification is the size of adjustment, not its timing.

Summing up: evidence that the *timing* of narrative adjustments can be predicted does not imply that the fiscal correction itself is predictable because, as we have seen, its size cannot be predicted. It is useful to remember that fiscal policy is different from a medical treatment in which a group of patients are given the same dose of a medicine: if it wasn't, the above regression would produce an R^2 of 1.

Having said that, even considering the total (as opposed to the *zero/one* dummy) narrative adjustments some evidence of predictability on the basis of past output growth and past evolution of government revenues and expenditures remains. Therefore, we analyze fiscal plans within a panel VAR that includes three variables: output growth and the growth rates of revenues and expenditures as a fraction of GDP. As we show in Appendix 1, the estimated coefficients on the narrative adjustments in this VAR measure the effect on output growth of the component of such adjustments that is orthogonal to lagged predictors. The estimated multipliers are thus not affected by the observed predictability. Our specification of the VAR, although already adopted in the relevant literature (see, for example, Auerbach and Gorodnichenko (2012,2013)) is rather parsimonious in terms of the included variables.

This specification choice should not affect our results as (i) plans are identified outside the estimated VAR model and are thus independent from its specification and (ii) the dynamic effects of plans are not truncated, differently from what happens in the univariate moving-average representation adopted, for instance, by Romer and Romer (2010). Adding more structure could help the interpretation of the total effects – by separating direct from indirect effects – but should not matter for their measurement. In addition, in our model what matters in order to obtain consistent estimates of fiscal multipliers is the condition that innovations in output growth and in fiscal adjustments are not correlated. When this condition is satisfied, the fact that fiscal adjustments can be predicted based on past output growth is irrelevant for the consistency of the estimated multipliers (see again Appendix 1).

3 Non-linear fiscal multipliers

The simplest way to assess whether multipliers depend on the state of the economy is to separate fiscal consolidations initiated during an economic expansion from those that started during recessions. This procedure, however, misses the fact that the economy can start off in one state (for instance in a recession) and then, over time, transition to another (an expansion). For this reason we use a specification which allows the economy to move from one state to another following a shift in fiscal policy. We also allow multipliers to vary depending on the type of consolidation, tax-based *vs* expenditure-based. In Section 3.1 we introduce our indicator for the state of the economy; in Section 3.2 we present our estimation and simulation framework.

3.1 Tracking the state of economy

The simplest way of describing the state of the economy would be using output growth the year before the shift in fiscal policy, or a weighted average of output growth a few years before the shift. Auerbach and Gorodnichenko 2012, 2013 have suggested using, rather than a dummy, a logistic function, $F(s_t)$, which smoothes the distribution of Δy_{t-j} and transforms it into a variable ranging between 0 and 1. This allows for the transition between states of the economy to happen smoothly with $F(s_t)$ being the weight given to recessions and $1-F(s_t)$ the weight given to expansions. Using the weighted average of output growth over the previous two years, $F(s_{i,t})$ is (where the index i refers to the country)

$$
\begin{aligned}
F(s_{i,t}) &= \frac{\exp(-\gamma_i s_{i,t})}{1+\exp(-\gamma_i s_{i,t})}, \qquad \gamma_i > 0, \\
s_{i,t} &= \left(\mu_{i,t} - E\left(\mu_{i,t}\right)\right)/\sigma\left(\mu_{i,t}\right) \\
\mu_{i,t} &= \frac{\Delta y_{i,t-1} + \Delta y_{i,t-2}}{2}
\end{aligned}
$$

where $\mu_{i,t}$ is the moving average (and s_{it} its standardized version) of output growth during the previous two years. For comparison, as in Auerbach and Gorodnichenko 2012, 2013, we define an economy to be in recession if $F(s_{i,t}) > 0.8$.

The parameter γ is then calibrated to match actual recession probabilities. For this we use the percentage of years *in which growth is negative* over the entire sample. In the case of the US this number is 17%. That is, in order to have $Pr(F(s_{US,t}) > 0.8) = 0.17$, we need to set $\gamma_{US} = 1.56$. This frequency of recession years is close to that reported by the NBER Dating Committee which is 20%.[5] This choice allows us to use the same criterion for all countries in the sample, as most of them do not have dating Committees. Hence we calibrate γ_i so that country i spends x_i per cent of time in a recessionary regime — that is, $Pr(F(s_{i,t}) > 0.8) = x_i$, where x_i is the ratio of the number of years of negative GDP growth for country i to the total number of years in the sample, 1979-2014.[6] For example, in the case of Italy, $\gamma_i = 2.24$ so that the country features 22% of its time in recession: thus $Pr(F(s_{IT,t}) > 0.8) = 0.22$. The $\gamma_i' s$ obtained through this calibration procedure are reported in Table 3. In order to see how closely this method is able to match the data, Figure 1 compares the dynamics of $F(s)$ with actual recessions in the countries of our sample.[7]

3.2 A model with two sources of non-linearity

In this section we propose a general model that allows simultaneously for two type of non-linearities in the effect of fiscal policy: those related to the

[5] We obtain this share by considering as years of recession those where the number of months recorded as recessionary by the NBER is at least 3.

[6] To obtain values of $F(s)$ for the entire 1981-2014 sample we use data for output growth during two years prior to the starting date of the estimation.

[7] When we use $F(s_{i,t})$ in the specification below we are referring to the economic conditions prevailing at the beginning of the period in which the consolidation is implemented. Consistently with the way we constructed our indicator, in Figure 1 we plot $F(s_{i,t+1})$ as a measure of the state of the cycle in period t to get comparability with actual recessions.

Table 3: Calibration of γ_i

	γ	Avg time spent in recession		γ	Avg time spent in recession
AUS	1.14	14%	FRA	1.59	14%
AUT	1.53	14%	GBR	1.43	19%
BEL	1.13	14%	IRL	1.68	14%
CAN	1.09	17%	ITA	2.24	22%
DEU	1.31	17%	JPN	1.65	17%
DNK	1.72	19%	PRT	1.60	22%
ESP	1.70	25%	SWE	1.92	19%
FIN	4.92	22%	USA	1.56	17%

state of the cycle and those related to the nature of adjustments. The so far available empirical evidence has considered only one source of non-linearity at the time to find it statistically relevant. We propose a general model to assess the relative importance of the two non-linearities in the effects of fiscal policy considered so far in the literature: a Smooth Transition Panel VAR with two states, recession and expansion, and a non-linearity associated with the composition of a fiscal plan, that is we allow multipliers to differ depending on whether the fiscal consolidation plan is tax-based or expenditure-based. The variables included are the growth rate of per capita output ($\Delta y_{i,t}$), the percentage change of tax revenues as a fraction of GDP ($\Delta \tau_{i,t}$) and that of primary government spending, also as a fraction of GDP ($\Delta g_{i,t}$) (We describe these data and in particular the choice of our tax and expenditures variables in Section 4).

$$\begin{aligned}
\Delta y_{i,t} &= (1-F(s_{i,t}))A_1^E(L)\,\mathbf{z}_{i,t-1} + F(s_{i,t})A_1^R(L)\,\mathbf{z}_{i,t-1} + \\
&\quad \begin{bmatrix} 1-F(s_{i,t}) \\ F(s_{i,t}) \end{bmatrix}' \begin{bmatrix} \mathbf{a}'\mathbf{e}_{i,t} & \mathbf{b}'\mathbf{e}_{i,t} \\ \mathbf{c}'\mathbf{e}_{i,t} & \mathbf{d}'\mathbf{e}_{i,t} \end{bmatrix} \begin{bmatrix} TB_{i,t} \\ EB_{i,t} \end{bmatrix} \\
&\quad +\lambda_{1,i} + \chi_{1,t} + u_{1,i,t} \qquad (1) \\
\Delta g_{i,t} &= (1-F(s_{i,t}))A_2^E(L)\,\mathbf{z}_{i,t-1} + F(s_{i,t})A_2^R(L)\,\mathbf{z}_{i,t-1} + \\
&\quad +\beta_{21} g_{i,t}^u + \beta_{22} g_{i,t-1,t}^a + \lambda_{2,i} + \chi_{2,t} + u_{2,i,t} \\
\Delta \tau_{i,t} &= (1-F(s_{i,t}))A_3^E(L)\,\mathbf{z}_{i,t-1} + F(s_{i,t})A_3^R(L)\,\mathbf{z}_{i,t-1} + \\
&\quad +\beta_{31} \tau_{i,t}^u + \beta_{32} \tau_{i,t-1,t}^a + \lambda_{3,i} + \chi_{3,t} + u_{3,i,t}
\end{aligned}$$

where $\mathbf{z}_t = [\Delta g_t, \Delta \tau_t, \Delta y_t]$.

The narratively identified exogenous shifts in fiscal variables enter the estimation in two ways. In the output growth equation they enter as shifts in $\mathbf{e}_{i,t}$, the primary budget surplus; these are then interacted with the type of consolidation, *TB* or *EB*. The variable $\mathbf{e}_{i,t}$, has three components $\left[\begin{array}{ccc} e^u_{i,t} & e^a_{i,t-j,t} & e^a_{i,t,t+j} \end{array}\right]$ because shifts in fiscal variables can be unanticipated, announced or implementation of previously announced measures.

Differently from the output growth equation, in the following two equations we assume that the growth rates revenues and expenditures ($\Delta g_{i,t}$ and $\Delta\tau_{i,t}$) are affected only by the part of the narratively identified fiscal correction which is implemented in period t: $g^u_{i,t}$ and $g^a_{i,t-1,t}$ in the equation for expenditures and $\tau^u_{i,t}$ and $\tau^a_{i,t-1,t}$ in the equation for revenues. Future announced corrections do not directly affect the dynamics of revenues and expenditures. In these two equations the dynamics is state dependent, but not the effects of $g^u_{i,t}$, $g^a_{i,t-1,t}$, $\tau^u_{i,t}$ and $\tau^a_{i,t-1,t}$. We also assume that both revenues and expenditures respond only to their own adjustments. In both cases because the fiscal policy terms that appear on the right hand side are a component of the dependent variable. Finally the model also includes unobservable VAR innovations $\mathbf{u}_t$: these are uninteresting for our analysis, in the sense that we do not need to extract from them any structural shock.

Interacting the shifts in fiscal variables with the *TB* and *EB* dummies allows to decompose fiscal adjustments in two orthogonal components, whose effects can then be simulated separately. This would not be possible if $g_{i,t}$ and $\tau_{i,t}$ were directly included in the output growth equation because, as already observed, exogenous shifts in taxes and spending are correlated. If we were to include $g_{i,t}$ and $\tau_{i,t}$ directly, rather than through orthogonal plans, we could only simulate an "average" adjustment plan, that is a plan that reproduces the average correlation between changes in taxes and spending observed in the estimation sample. Thus we would no longer be able to study the heterogenous effect of fiscal adjustments based on their composition.

In the model we estimate, non-linearities with respect to the state of the economy and with respect the composition of a fiscal plan affect output growth both on impact and through the dynamic response of the economy to a consolidation plan. On impact, the possible non-linearities associated with a consolidation plan — both stemming from its composition and from the state of the economy — are described by the coefficient vectors $\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}$ in the first equation of model (1).[8] The statistical relevance of these non-linearities can be assessed testing the following restrictions

[8] We restrict the contemporaneous response of expenditure and taxation to their own corrections to be independent of the state of the economy. This is because the effect of a fiscal shock in the second and third equations is mainly an accounting one and should not, in principle, be heterogeneous in different states of the cycle. Removing this restriction does not alter our findings (results are available from the authors).

(i) $\mathbf{a} = \mathbf{c}$, $\mathbf{b} = \mathbf{d}$: the only source of non-linearity in the contemporaneous effect of a plan arises from its type (*EB vs TB*);

(ii) $\mathbf{a} = \mathbf{b}$, $\mathbf{c} = \mathbf{d}$: the only source of non-linearity in the contemporaneous effect of a plan arises from the state of the cycle;

(iii) $\mathbf{a} = \mathbf{b} = \mathbf{c} = \mathbf{d}$: the impact effect of a consolidation depend neither on the the state of cycle nor on the type of plan.

In the model, the dynamic response of the economy is also allowed to be different during expansions (E) and recessions (R) through the autoregressive coefficients, A. We can thus test the additional hypothesis

(iv) if $\mathbf{a} = \mathbf{b} = \mathbf{c} = \mathbf{d}$, $A_1^E(L) = A_1^R(L), A_2^E(L) = A_2^R(L)$ and $A_3^E(L) = A_3^R(L)$ we are left with a standard linear VAR model without non-linearities.

Since fiscal plans contain announcements of future shifts in taxes and spending, in order to simulate the effect of a plan we need to construct "artificial" announcements correlated with the unanticipated component entering a plan.[9] This is not necessary at the estimation stage since our data contain observations on fiscal announcements. Moreover, since fiscal plans include measures both on the tax side and on the spending side, we also need to estimate the contemporaneous correlation between these two components.

Model (1) must thus be accompanied by a set of auxiliary equations describing the response of announcements to contemporaneous corrections and the relative weights of tax and spending measures within a plan. We allow both correlations to be different according to the type of plan, *TB vs EB*. In other words, we allow for plans to have a different inter-temporal and

[9] Given the presence of non-linearities, impulse responses are constructed using the generalized method proposed by Koop et al 1996. This implies computing

$$I(\mathbf{z}_{i,t}, n, \delta, I_{t-1}) = E(\mathbf{z}_{i,t+n} \mid \mathbf{e}_{i,t} = \delta, I_{t-1}) - E(\mathbf{z}_{i,t+n} \mid \mathbf{e}_{i,t} = 0, I_{t-1})$$

using the following steps: *(i)* generate a baseline simulation for all variables by solving the full non-linear system dynamically forward. This requires setting to zero all shocks for a number of periods equal to the horizon up to which impulse responses are computed, *(ii)* generate an alternative simulation for all variables by implementing the structural adjustment plan of interest, and then solve dynamically forward the model up to the same horizon used in the baseline simulation, *(iii)* compute impulse responses to fiscal plans as the difference between the simulated values in the two steps above, *(iv)* compute confidence intervals by bootstrapping.

infra-temporal structure according to their type.[10] Thus we estimate, along with the VAR, the following auxiliary regressions:

$$\begin{aligned}
\tau^u_{i,t} &= \varphi^{TB}_0 e^u_{i,t} * TB_{i,t} + \varphi^{EB}_0 e^u_{i,t} * EB_{i,t} + \upsilon^{\tau}_{0,i,t} \\
g^u_{i,t} &= \vartheta^{TB}_0 e^u_{i,t} * TB_{i,t} + \vartheta^{EB}_0 e^u_{i,t} * EB_{i,t} + \upsilon^{g}_{0,i,t} \\
\tau^a_{i,t,t+j} &= \varphi^{TB}_j e^u_{i,t} * TB_{i,t} + \varphi^{EB}_j e^u_{i,t} * EB_{i,t} + \upsilon^{\tau}_{j,i,t} \quad j = 1,2 \\
g^a_{i,t,t+j} &= \vartheta^{TB}_j e^u_{i,t} * TB_{i,t} + \vartheta^{EB}_j e^u_{i,t} * EB_{i,t} + \upsilon^{g}_{j,i,t} \quad j = 1,2
\end{aligned}$$

where the first two equations describe the average tax and spending share of *EB* and *TB* plans. The third equation describes the relation between unanticipated shifts in the primary budget surplus and those announced for years $t+1$ and $t+2$, differentiating between *EB* and *TB* plans. (These auxiliary regression are needed to simulate the full model). Table 4 shows the estimated coefficients

Table 4: Estimated coefficients in the auxiliary equations

φ^{TB}_0	φ^{TB}_1	φ^{TB}_2	φ^{EB}_0	φ^{EB}_1	φ^{EB}_2
0.7823	0.1552	0.0170	0.3918	−0.0415	0.0072
(0.0175)	(0.0278)	(0.0099)	(0.0104)	(0.0165)	(0.0059)

ϑ^{TB}_0	ϑ^{TB}_1	ϑ^{TB}_2	ϑ^{EB}_0	ϑ^{EB}_1	ϑ^{EB}_2
0.2177	0.1290	0.0305	0.6082	0.1590	0.0364
(0.0175)	(0.0315)	(0.0152)	(0.0104)	(0.0187)	(0.0091)

the model we estimate deserves a few observations.

- While the state of the economy, *i.e.* the probability of being in an expansion or a recession, is affected by fiscal policy and can change as a plan evolves, the nature of the regime (TB, EB) is known the moment a plan is announced and does not change unless the plan is amended;
- The effect of fiscal measures when they are announced can be different from their effect as a plan is implemented. In particular:

[10] Alternatively we could have allowed the intertemporal structure of plans to be country- rather than plan-specific (see Alesina, Favero and Giavazzi 2015a). We opted for the latter to impose restrictions in the auxiliary regressions more similar to those in the main system — *i.e.* coefficients restricted across countries and unrestricted across types of plans.

- define $\mathbf{a} = \left[\begin{array}{ccc} a_{11} & a_{12} & a_{13} \end{array} \right]$, and similarly for the $\mathbf{b}, \mathbf{c}$ and $\mathbf{d}$ coefficient vectors. Then from the first equation of model (1) the effect of a fiscal measure is fully exhausted when the measure is announced — that is nothing more happens upon implementation — if $a_{11} = a_{13}$, $b_{11} = b_{13}$, $c_{11} = c_{13}$, $d_{11} = d_{13}$ and $a_{12} = b_{12} = c_{12} = d_{12} = 0$. When these restrictions are not rejected, plans can be collapsed into shocks of the type $f_{i,t} = e^u_{i,t} + e^a_{i,t,t+j}$. This is the assumption made in Romer and Romer 2010;
- symmetrically, the null that a measure is effective only when it is implemented can be tested imposing the following restrictions $a_{11} = a_{12}$, $b_{11} = b_{12}$, $c_{11} = c_{12}$, $d_{11} = d_{12}$ and $a_{13} = b_{13} = c_{13} = d_{13} = 0$. When these restrictions are not rejected plans can be collapsed into shocks using the alternative definition $f_{i,t} = e^u_{i,t} + e^a_{i,t-1,t}$. This is the assumption made in Guajardo et al 2014.

- The use of a VAR which includes the percentage change of revenues and spending (as a fraction of GDP), along with their narratively identified shocks, provides information on the impact of exogenous fiscal adjustments on government revenues and expenditures. This is an important check of the strength of the narratively identified instruments — a check which usually is not carried out in studies which use an MA representation to project output growth on a distributed lag of the narratively identified adjustments.

- The VAR model described above is not the way impulse response functions are usually constructed in the empirical literature that analyzes narrative shocks. This literature typically estimates a truncated MA representation or uses on linear projection methods. We show in Appendix 2 that a standard application of the linear projections method cannot properly deal with the non-linearities of our statistical model.

4 Results

4.1 Data and summary statistics

Macro data are from the OECD: Appendix 4 provides details on their sources and on how we compute the variables used in the analysis. Our government expenditure variable is total government spending net of interest payments on the debt: that is we do not distinguish between government consumption, government investment, transfers (Social security benefits etc) and other government outlays. In Alesina et al 2016 we have investigated whether multipliers for government transfers differ from those for other spending items finding very moderate differences.

Fiscal adjustment plans for the 16 countries in our sample are constructed as described in Section 2. They are reported in Appendix 3. Tables 5 through 8 illustrate the main features of our plans. Table 5 lists the number of plans that we have identified for each country over the sample of annual data 1981-2014. A new plan is recorded whenever either a new adjustment is announced or previously announced measures are modified. Each plan usually lasts for more than one year. We define each year of consolidation (*i.e.* a year in which we record any fiscal measure either announced or unexpected) as an *episode*. Hence, every plan covers one (if it includes only measures to be implemented immediately) or more episodes (if it also includes announcements of future measures). In other words, suppose a government in year t announces some measures to be implemented immediately and some other to be implemented in $t+1$. If, come year $t+1$, the government just implements what it had previously announced, we record one plan and two episodes. If instead in $t+1$ it introduces some new measures, we record two plans and two episodes. Note that given that our data are yearly, the estimation sample uses all the years in which there is an episode: we take into account the fact that episodes build into plans.by introducing separately, in the estimated equations, unexpected and announced measures.

In total we have 170 plans and 216 episodes, of which about two-thirds are *EB* and one-third are *TB*. Table 6 documents the composition of fiscal plans showing the share of their main component, which determines the nature of the plan. The majority of *EB (TB)* plans is indeed based on spending (tax) measures. As shown in the first column of Table 6, in half of *TB* plans taxes account for 75% or more of the total adjustment and the same holds for *EB* ones. The cases in which plans are labelled as *EB* or *TB* in the presence of a marginally dominant component (*e.g.* the spending share of *EB* plans and the tax share of *TB* ones less than 55%) are rare as shown in the last column of Table 6.

Table 7 investigates whether there is a relation between the timing of a fiscal adjustment, or its composition, and the state of the economy. Overall, adjustment plans are more likely to be introduced during a recession. There was a consolidation in 62 out of 99 years of recession ($F(s_{i,t}) > 0.8$), while we record a consolidation in only 13 over 94 years of expansion ($F(s_{i,t}) < 0.2$) (see the last column of Table 7). To some extent this is a consequence of the fact that fiscal adjustments motivated by cooling down the economy are excluded by definition, as they are endogenous. Nevertheless, it is somewhat surprising that a majority of the shifts in fiscal policy designed to reduce deficits are implemented during recessions. The relative frequency of *TB* and *EB* plans in a recession is not very different from that of the full sample. In other words, it is not the case that *EB* adjustments occur more frequently than *TB* ones in a particular state of the economy (recession or expansion). For instance, of all the consolidations implemented when $F(s_{i,t})$ is higher than 0.8, two-thirds were *EB* and one-third *TB*. As previously described in Table 5, these proportions hold also in our full sample.

Finally, Table 8 documents the length and the size of plans. Most plans have a one year horizon and, on average, *EB* plans usually last longer than *TB* ones. The last three columns, instead, show the magnitude of, respectively, the total shift in fiscal variables, the shift corresponding to the spending side and that corresponding to the tax side in the case of *EB, TB* and *all* new plans. *EB* plans are larger than *TB* ones and the average size of a plan is 1.83% of GDP. Finally the last two columns of Table 8 confirm that plans are well classified with our scheme: the spending part of *EB* plans is indeed larger than that of *TB* ones and vice versa for taxes.

Table 5: Fiscal Adjustment Plans

	TB	EB		TB	EB
AUS	3	4	FRA	3	7
AUT	1	3	GBR	4	6
BEL	4	11	IRL	6	8
CAN	3	16	ITA	6	12
DEU	3	6	JPN	3	5
DNK	3	5	PRT	4	7
ESP	8	7	SWE	0	5
FIN	2	7	USA	4	4
Total TB:	57		Total EB:	113	

Table 6: The Composition of Fiscal Adjustments

	Share of Main Component			
Type of Plan	≥ 0.75	< 0.75	< 0.65	< 0.55
TB (57 plans)	30	27	19	9
EB (113 plans)	55	58	33	7
Total Plans: 170		Total Episodes: 216		

Table 7: Fiscal Adjustments and the State of the Economy

	$F(s_{i,t})$			
Type of Plan	< 0.2	< 0.5	≥ 0.5	> 0.8
TB (57 plans)	3	17	40	22
EB (113 plans)	10	41	72	40
Years in Sample - (515)	94	283	232	99

Table 8: Plans' Size and Length

	Horizon of plans in years							Size of plans (%GDP)		
Type of Plan	0	1	2	3	4	5	Average	Total	Spending	Taxes
TB	16	20	6	7	7	1	1.51	1.60	0.49	1.10
EB	26	41	7	14	9	16	1.88	1.94	1.46	0.48
All Plans	42	61	13	21	16	17	1.76	1.83	1.14	0.69

4.2 Results

We first show impulse responses from the general unrestricted model that allows for all non-linearities (model 1). The impulse responses of the variables included in the VAR and of the indicator $F(s)$, the probability of being in a recessionary regime, are presented in Figure 2. Dark blue and dark red lines show the responses of the variables in the case, respectively, of an *EB* plan and a *TB* plan *introduced at a time when the economy is in an expansionary state* (defined as $F(s) \simeq 0.2$); light blue and light red lines *starting from a recessionary state* (defined as $F(s) \simeq 0.8$) *SHOULDN'T THIS BE >=??? SAME BELOW.* The response of the state indicator $F(s)$ is computed as the difference between its simulated values following a fiscal adjustment which starts in a recession (expansion) and its simulation in the absence of a fiscal adjustment, starting from the same initial regime.

The upper left hand panel of Figure 2 clearly shows that the relevant non-linearity is that between *TB* (red) and *EB* (blue) plans. In the case of an *EB* consolidation, the point estimates of the responses of output growth are almost identical across the two states of the economy, while in the case of a *TB* consolidation the point estimates are slightly different although the difference is not statistically significant.

The difference between *EB* and *TB* consolidations starting in any given state of the economy is a strong feature of the data with multipliers comparable to those estimated in Alesina, Favero and Giavazzi 2015a abstracting from the state of the economy. Panels 2 and 3 of Figure 2 show the responses of government revenues and government consumption (defined as explained at the top of this section and both measured as a fraction of GDP) to a *TB* and an *EB* plan starting from the two initial states: expansion and recession. Importantly, revenues do indeed increase by a larger amount during a *TB* consolidation, and spending decrease the most during an *EB* consolidation. This confirms that our classification of plans is trustworthy. Interestingly, we observe a positive (negative) response of revenues (spending) also to an *EB (TB)* consolidation, confirming that spending and tax measures are not taken in isolation, thus supporting our choice of analyzing plans rather individual shifts in taxes and spending. Panel 4 of Figure 2 shows the responses of $F(s)$: in all four cases a consolidation increases the probability of experiencing a recession (the impulse response is always positive). There is however a significant difference between types of plans. During *TB* consolidations $F(s)$ increases much more than during *EB* ones and this holds both in expansions and recessions. Note that in the cycle-down regime the difference in $F(s)$ is not statistically significant between *TB* and *EB* adjustments. However the total effect on output growth – which is what matters and is the result of the effect going through the response of $F(s)$ as well as the effect going through all other coefficients in the model – is always statistically different between the two types of adjustment.

Table 9 shows tests of the four hypotheses introduced in Section 3.2:

(i) $\mathbf{a} = \mathbf{c}$, $\mathbf{b} = \mathbf{d}$

(ii) $\mathbf{a} = \mathbf{b}$, $\mathbf{c} = \mathbf{d}$

(iii) $\mathbf{a} = \mathbf{b} = \mathbf{c} = \mathbf{d}$

(iv) $\mathbf{a} = \mathbf{b} = \mathbf{c} = \mathbf{d},\ A_1^E(L) = A_1^R(L),\ A_2^E(L) = A_2^R(L),\ A_3^E(L) = A_3^R(L)$

Table 9: Hypotheses' Tests

H_0	Likelihood. ratio	Number of Restrictions	Probability
(i)	6.9848	6	0.3223
(ii)	16.4584	6	0.0115
(iii)	20.6639	12	0.0555
(iv)	46.0683	21	0.0013

The only hypothesis that cannot be rejected is *(i) i.e.* the hypothesis that the only source of non-linearity in the contemporaneous effect of a fiscal adjustment is the type of plan (*EB vs TB*). Following the result of this test we have estimated a model restricting the effect of fiscal shocks to be equal across states of the cycle but different across types of plans. In this model we also allow the autoregressive coefficients $\left((1 - F(s_{i,t}))A_1^E(L) \text{ and } F(s_{i,t})A_1^R(L)\right)$ to be state-dependent. Figure 3 reports impulse responses from this model. Results are quite similar to those in Figure 2: the response of output is negative following the introduction of both *EB* and *TB* plans but *TB* consolidations are much more harmful than *EB* ones.

In Figure 4 we remove the non-linearity across types of plans while keeping that across states of the economy. We thus perform an exercise that is similar to what has so far been done in the literature — with the important caveat that our estimates endogenize the state of the economy after a shift in fiscal policy. Looking at the first panel of the figure the response of output after the announcement of a fiscal consolidation plan does not appear to be affected by the state of the economy: the two impulse responses are almost identical, thus confirming that the state of the economy — remember that here "state of the economy" refers to the state at the time the consolidation is first introduced — does not seem to be relevant. In other words, overlooking the composition of the fiscal adjustment (*TB or EB*), fiscal multipliers do not appear to differ significantly when the economy starts from an expansion or a recession. This results confirms the finding for the US reported in Ramey and Zubairy 2014. Of course this does not mean that the welfare effects are also similar: losing one per cent of GDP when the economy is already in a recession can be more harmful compared to losing the same amount of output when the economy is expanding.

The response of the indicator $F(s)$ in the fourth panel shows that implementing a consolidation always increases the probability of being in a recession — slightly more so when the economy starts from an expansion rather than a recession.

Finally, in Figure 5 we keep only the non-linearity across type of plans. In other words we replicate (using a panel VAR rather than estimating an MA representation) the exercise performed in Alesina, Favero and Giavazzi 2015a. The strong similarity between the impulse responses reported here and those reported in our previous paper shows that the effect of predictability of the adjustments, which is properly dealt with in a VAR but not in an MA, is minor.

4.3 Robustness: evidence when monetary policy is constrained

Ideally one would want to study how multipliers are affected not only by the cycle and the composition of a fiscal plan but also whether they occur at or close to the zero lower bound. Unfortunately, we do not have enough observations to consider all three factors (state of the economy, composition and ZLB) together. What we can ask, however, is whether the asymmetries we identified can be explained by a different (more or less constrained) response of monetary policy. If the asymmetries in fiscal multipliers were related to a different response of monetary policy our evidence could considerably change when monetary policy is constrained.

In order to assess the potential relevance of the monetary policy response (or lack thereof at the ZLB) in determining the asymmetries we found above, we perform two exercises. First, we split our data in two sub-samples: euro area countries (Austria, Belgium, France, Finland, Germany, Ireland, Italy, Portugal and Spain) from 1999 onwards and non euro-area countries (Australia, Denmark, UK, Japan, Sweden, U.S. and Canada) together with euro area countries before 1999. The motivation for this split is that the common currency prevents monetary policy from responding to fiscal developments in individual member countries. However, while it is true that monetary policy cannot respond at the country level, the ECB could still respond if fiscal consolidation happened in a large enough number of euro area countries at the same time. To capture this possible common response of monetary policy in the euro area, the specification also includes year fixed effects estimated on euro countries from 1999 onwards. Model (1) is thus extended to

$$\begin{aligned}
\Delta y_{i,t} \quad = \quad & (1-F(s_{i,t}))A_1^E(L)\, z_{i,t-1} + F(s_{i,t})A_1^R(L)\, z_{i,t-1} + \\
& + Euro_{i,t} \cdot \begin{bmatrix} 1-F(s_{i,t}) \\ F(s_{i,t}) \end{bmatrix}' \begin{bmatrix} \mathbf{a}'\mathbf{e}_{i,t} & \mathbf{b}'\mathbf{e}_{i,t} \\ \mathbf{c}'\mathbf{e}_{i,t} & \mathbf{d}'\mathbf{e}_{i,t} \end{bmatrix} \begin{bmatrix} TB_{i,t} \\ EB_{i,t} \end{bmatrix} + \\
& + (1-Euro_{i,t}) \cdot \begin{bmatrix} 1-F(s_{i,t}) \\ F(s_{i,t}) \end{bmatrix}' \begin{bmatrix} \mathbf{a}'\mathbf{e}_{i,t} & \mathbf{b}'\mathbf{e}_{i,t} \\ \mathbf{c}'\mathbf{e}_{i,t} & \mathbf{d}'\mathbf{e}_{i,t} \end{bmatrix} \begin{bmatrix} TB_{i,t} \\ EB_{i,t} \end{bmatrix} + \\
& + \lambda_i + \chi_t \cdot Euro_{i,t} + \partial_t \cdot (1-Euro_{i,t}) + u_{i,t}
\end{aligned}$$

$$with\ Euro_{i,t} \quad = \quad 1\ if \begin{cases} country = AUT, BEL, DEU, ESP, FIN, FRA, IRL, ITA, PRT \\ year \geq 1999 \end{cases}$$

Figure 6 plots the impulse response functions from this model. The results appear to be similar regardless of the response of monetary policy. The only difference is that TB consolidations started during a recession appear to be more harmful when monetary policy is constrained. Overall, however, this finding confirms that our results are not driven by a different response of monetary policy to *TB* or *EB* adjustments, or to consolidations implemented in recession or expansion. The heterogeneity between *EB* and *TB* adjustments is in fact particularly clear when monetary policy cannot respond. As in the baseline simulations, there is little evidence of heterogeneity across states of the cycle.

As a further robustness check, we study whether the response of the economy to consolidations implemented while monetary policy is at the zero lower bound plays a significant role in influencing our results. Unfortunately, we cannot split our data between countries in years at the ZLB and countries in years out of the ZLB because the number of observations in the former group is too small. As an alternative we check the stability of our baseline results by removing the observations at the ZLB from our sample, *i.e.* we remove euro area countries in 2013 and 2014, the US from 2008 and Japan from 1996 onward.[11] The results of this exercise are presented in Figure 7. The impulse response functions are very similar to the baseline case and this confirms that observations at the ZLB do not influence our findings significantly.

5 Conclusions

Fiscal consolidations can differ along three dimensions: their composition (taxes *vs* expenditures), the state of the business cycles (whether a consolidation starts during a recession or an expansion) and whether or not they occur at a ZLB or, more generally, whether monetary policy can respond to the consolidation. In this paper we investigated the first two aspects. We concluded that what matters for the short run output cost of fiscal consolidations is mainly the composition of the adjustment. Tax-based adjustments are costly in terms of output losses. Expenditure-based ones have on average very low costs: this average may be the result of some cases of expansionary *EB* adjustments and other which are mildly recessionary. The asymmetry between the two types of fiscal adjustment is independent of whether the fiscal adjustment starts during a recession or an expansion. The role of the

[11] More precisely, we perform this check starting form the baseline model and interacting the fiscal shocks in the equation for output with a dummy equal to one for observations at the ZLB and another dummy which equals one for observations outside the ZLB. Then, we perfom our simulation using the coefficients estimated on the latter. We do not present the IRFs for consolidations at the ZLB as they are unreliable, being estimated on a very limited number of observations.

ZLB is more difficult to assess given the low number of observations in our sample of OECD countries. However our (admittedly not conclusive) evidence does not point towards a large difference between episodes at or away from the ZLB, or more generally when monetary policy cannot react to a fiscal adjustment as happens inside a monetary union. However this is an issue that deserves further research.

Appendix 1: Predictability and exogeneity

In a dynamic time-series model, estimation and simulation require, respectively, weak and strong exogeneity: these requirements are different from lack of predictability. To illustrate the point consider the following simplified model, which only includes the unanticipated component of fiscal plans

$$\begin{aligned}
\Delta y_t &= \beta_0 + \beta_1 e_t^u + \\
&\quad + \beta_3 \Delta y_{t-1} + \beta_4 \Delta \tau_{t-1} + \beta_3 \Delta g_{t-1} + u_{1t} \\
e_t^u &= \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta \tau_{t-1} + \gamma_3 \Delta g_{t-1} + u_{2t} \\
\begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} &\sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{pmatrix} \right]
\end{aligned}$$

The condition required for e_t^u to be weakly exogenous for the estimation of β_1 is $\sigma_{12} = 0$. This condition is independent of $\gamma_1, \gamma_2, \gamma_3$. In other words, when weak exogeneity is satisfied, the existence of predictability does not affect the consistency of the estimate of β_1. Moreover β_1 measures, by construction, the impact on Δy_t of u_{2t}, *i.e.* of the part of e_t^u that cannot be predicted by Δy_{t-1}, $\Delta \tau_{t-1}$ and Δg_{t-1}. In fact, by the partial regression theorem, when $\hat{u}_{2t} = e_t^u - \hat{\gamma}_1 \Delta y_{t-1} + \hat{\gamma}_2 \Delta \tau_{t-1} + \hat{\gamma}_3 \Delta g_{t-1}$ then estimating δ_1 running $\Delta y_t = \delta_0 + \delta_1 \hat{u}_{2t} + v_t$, gives $\hat{\beta}_1 = \hat{\delta}_1$.

Appendix 2: MA's vs VAR's

The VAR model described in the text (*model* (1)) is not the way impulse response functions are constructed in the recent empirical literature. In the literature the effect of narratively identified shifts in fiscal variables relies either on estimates of a truncated MA representation or on linear projection methods. The reason for these choices is that in the presence of multiple non-linearities the MA representation of a VAR is much heavier than in the linear case — which means it could only be estimated imposing restrictions that limit the relevance of such non-linearities. Consider for instance the following model in which fiscal adjustment plans have heterogenous effects according to the state of the cycle, but the VAR dynamics does not depend on the state of the economy, that is, using the terminology in the text, $A_i^E = A_i^R$. Assume also that TB and EB plans have identical effects.[12]

$$\mathbf{z}_{i,t} = A_1 \mathbf{z}_{i,t-1} + (1 - F(s_{i,t})) B_1 e_{i,t} + F(s_{i,t}) B_2 e_{i,t} + \mathbf{u}_{i,t} \tag{2}$$

where $\mathbf{z}_{i,t}$ is the vector containing output growth and the growth rates of taxes and spending, $e_{i,t}$ are, as in the main text, the narratively identified fiscal adjustments and $\mathbf{u}_{i,t}$ unobservable VAR innovations. From this VAR we would derive the following MA truncated representations

$$\mathbf{z}_{i,t} = \sum_{j=0}^{k} A_1^j \left((1 - F(s_{i,t-j})) B_1 e_{i,t-j} + F(s_{i,t-j}) B_2 e_{i,t-j} \right) + \sum_{j=0}^{k} A_1^j \mathbf{u}_{i,t-j} + A_1^{k+1} \mathbf{z}_{i,t-k-1}$$

Now apply to this framework the linear projection method. This would amount to deriving impulse responses for the relevant component of $\mathbf{z}_{i,t}$ — say $\Delta y_{i,t}$ — running the following set of regressions[13]

$$\Delta y_{i,t+h} = \alpha_{i,h} + (1 - F(s_{i,t})) \beta_{h,1} e_{i,t} + F(s_{i,t}) \beta_{h,2} e_{i,t} + + \Gamma_h \mathbf{z}_{i,t} + \epsilon_{i,t} \tag{3}$$

Now compare this with the more general case in which the VAR dynamics is also affected by the state of the cycle — that is remove the restriction $A_i^E = A_i^R, (i = 1, 2, 3)$

$$\mathbf{z}_{i,t} = (1 - F(s_{i,t})) A_1 (L, E) \mathbf{z}_{i,t-1} + F(s_{i,t}) A_1 (L, R) \mathbf{z}_{i,t-1} + (1 - F(s_{i,t})) B_1 e_{i,t} + F(s_{i,t}) B_2 e_{i,t} + \mathbf{u}_{i,t}$$

In this case the truncated MA representation would be much more complicated than (3), as the response of $\mathbf{z}_{i,t+h}$ to $e_{i,t}$ would depend on all states of the economy between t and $t+h$. Estimating the correct linear projection would no longer be feasible.

To further illustrate the point observe that the correct linear projection to estimate the effect of $e_{i,t}$ on $\Delta y_{i,t+1}$

$$\begin{aligned} \Delta y_{i,t+1} \quad = \quad & \alpha_{i,1} + (1 - F(s_{i,t+1})) F(s_{i,t}) \beta_{1,1} e_{i,t} + (1 - F(s_{i,t+1}))(1 - F(s_{i,t})) \beta_{1,2} e_{i,t} + \\ & + (F(s_{i,t+1})) F(s_{i,t}) \beta_{1,3} e_{i,t} + (F(s_{i,t+1}))(1 - F(s_{i,t})) \beta_{1,4} e_{i,t} \\ & + \Gamma_h \mathbf{z}_{i,t} + \epsilon_{i,t} \end{aligned} \tag{4}$$

[12] Allowing for the presence of TB and EB plans would strengthen our point but at the cost of making the algebra more complicated.

[13] This is the specification adopted by Auerbach and Gorodnichenko 2013 to estimate a regime-dependent impulse response.

is in general different from

$$\Delta y_{i,t+1} = \alpha_{i,h} + (1 - F(s_{i,t}))\beta_{1,1}e_{i,t} + F(s_{i,t})\beta_{1,2}e_{i,t} + \Gamma_h \mathbf{z}_{i,t} + \epsilon_{i,t} \quad (5)$$

Note, in closing, that the cases in which the two representations coincide are very specific. Indeed, when (4) is the data generating process and (5) is estimated, the implied assumption is that the states $F(s_{i,t+1}) = 1$ and $F(s_{i,t+1}) = 0$ are observationally equivalent.

Summing up: if the data are generated by (4) the VAR representation is much more parsimonious than the linear projection which becomes practically not feasible unless very strong restrictions are imposed on the empirical model.

Appendix 3: Fiscal plans

Table A1: Classification of fiscal adjustments

		Tax					Spend					TB	EB
		T^u_t	$T^a_{t-1,t}$	$T^a_{t,t+1}$	$T^a_{t,t+2}$	$T^a_{t,t+3}$	g^u_t	$g^a_{t-1,t}$	$g^a_{t,t+1}$	$g^a_{t,t+2}$	$g^a_{t,t+3}$		
AUS	1985	0	0	0	0	0	0.2671	0	0.2671	0	0	0	1
AUS	1986	0.1658	0	-0.318	-0.484	0	0.3724	0.2671	0.2911	-0.081	0	0	1
AUS	1987	0	-0.318	-0.484	0	0	0.3994	0.2911	0.3181	0	0	0	1
AUS	1988	0	-0.484	0	0	0	0	0.3181	0	0	0	0	1
AUS	1993	0	0	0.2662	0.2662	0	0	0	0	0	0	1	0
AUS	1994	0	0.2662	0.2662	0	0	0	0	0	0	0	1	0
AUS	1995	0.4912	0.2662	0.4912	0	0	0	0	0	0	0	1	0
AUS	1996	0.0823	0.4912	0.2009	0.124	0.0054	0.3101	0	0.5544	0.2103	-0.034	0	1
AUS	1997	-0.005	0.2009	0.2311	0.1129	0.0708	-0.018	0.5544	0.1838	-0.058	-0.051	1	0
AUS	1998	0	0.2311	0.1129	0.0708	0.0752	0	0.1838	-0.058	-0.051	-0.035	1	0
AUS	1999	0	0.1129	0.0708	0.0752	0	0	-0.058	-0.051	-0.035	0	1	0
AUT	1980	0.1219	0	0	0	0	0.721	0	0	0	0	0	1
AUT	1981	0.5295	0	0	0	0	1.1251	0	0	0	0	0	1
AUT	1984	1.4915	0	0	0	0	0.6392	0	0	0	0	1	0
AUT	1996	0.9087	0	0.7311	0	0	1.5778	0	0.9128	0	0	0	1
AUT	1997	0	0.7311	0	0	0	0	0.9128	0	0	0	0	1
AUT	2001	0.912	0	-0.017	0	0	0.2246	0	1.1128	0	0	0	1
AUT	2002	0	-0.017	0	0	0	0	1.1128	0	0	0	0	1
AUT	2011	0.4033	0	0.1994	0.0613	0.0919	0.3022	0	0.1705	0.0643	0.0698	1	0
AUT	2012	0.3557	0.1994	0.3447	0.0255	0.0162	0.1688	0.1705	0.3309	0.6036	0.508	0	1
AUT	2013	0	0.3447	0.0255	0.0162	0.081	0	0.3309	0.6036	0.508	0.3492	0	1
AUT	2014	0.0549	0.0255	0.1117	0.2295	0.0136	0.0409	0.6036	0.3899	0.2686	0.009	0	1
BEL	1982	0	0	0	0	0	1.7677	0	0	0	0	0	1
BEL	1983	0.6155	0	0	0	0	0.9683	0	0	0	0	0	1
BEL	1984	0.2994	0	0.8179	0	0	0.4402	0	1.0346	0	0	0	1
BEL	1985	0	0.8179	0	0	0	0	1.0346	0	0	0	0	1
BEL	1986	0	0	0.1089	0	0	0	0	1.9837	0	0	0	1
BEL	1987	0	0.1089	0	0	0	0.2787	1.9837	0	0	0	0	1
BEL	1990	0.3849	0	0	0	0	0.0924	0	0	0	0	1	0
BEL	1992	1.0255	0	0.0485	0	0	0.8245	0	0.4192	0	0	0	1
BEL	1993	0.3959	0.0485	0.5543	0	0	0.1188	0.4192	0.2771	0	0	1	0
BEL	1994	0	0.5543	0	0	0	0.3844	0.2771	0	0	0	0	1
BEL	1996	0.7449	0	-0.233	0	0	0.4655	0	-0.233	0	0	1	0
BEL	1997	0.3796	-0.233	0	0	0	0.4601	-0.233	0	0	0	0	1
BEL	2010	0.2145	0	0.2917	0	0	0.8298	0	0.0841	0	0	0	1
BEL	2011	0.2108	0.2917	0	0	0	0.254	0.0841	0	0	0	1	0
BEL	2012	0.8512	0	0.1106	0.1616	0	1.5808	0	0.527	0.6133	0	0	1
BEL	2013	0.5258	0.1106	0.1616	0	0	0.5503	0.527	0.6133	0	0	0	1
BEL	2014	0	0.1616	0	0	0	0	0.6133	0	0	0	0	1
CAN	1983	0	0	0.1917	0.3863	0.2641	0	0	0	0	0	1	0
CAN	1984	0	0.1917	0.3863	0.2641	0.0514	0	0	0	0	0	1	0
CAN	1985	0.1767	0.3863	0.8197	0.217	0	0.5156	0	0.2823	0.2197	0.2438	0	1
CAN	1986	0.2883	0.8197	0.4697	0.1032	0.017	0.1211	0.2823	0.2903	0.2771	0.2515	1	0
CAN	1987	0	0.4697	0.323	-0.266	0.0242	0	0.2903	0.2282	0.2324	0.2392	0	1
CAN	1988	0.0297	0.323	-0.246	0.0275	0.0994	0	0.2282	0.2324	0.2392	-0.003	0	1
CAN	1989	0.445	-0.246	0.5678	0.2301	0.0172	0.165	0.2324	0.3561	0.018	-5E-04	1	0
CAN	1990	-0.243	0.5678	0.2604	0.2493	0.065	0.2076	0.3561	0.2291	0.0963	0.0165	0	1
CAN	1991	0	0.2604	0.2493	0.065	0	0.1104	0.2291	0.2464	0.148	0.0312	0	1
CAN	1992	-0.058	0.2493	0.048	0.0427	0.014	0	0.2464	0.148	0.0312	0	0	1
CAN	1993	0	0.048	0.0427	0.014	0	0.237	0.148	0.1988	0.1442	0.0382	0	1
CAN	1994	0.0582	0.0427	0.1163	0.0393	0.0039	0.2216	0.1988	0.5501	0.3379	0.133	0	1
CAN	1995	0.0896	0.1163	0.1011	0.0303	0.0052	0.3687	0.5501	0.6517	0.3253	0.0662	0	1
CAN	1996	0.0032	0.1011	0.0313	0.0052	0	-0.082	0.6517	0.3944	0.0984	0	0	1
CAN	1997	-0.036	0.0313	-0.013	-0.018	-0.005	-0.014	0.3944	0.0807	-0.01	-0.002	0	1
CAN	2010	0.018	0	0.0091	0.0039	0.0041	0.0216	0	0.0615	0.1088	0.0754	0	1
CAN	2011	0.0108	0.0091	0.0296	0.0279	0.0069	0.0088	0.0615	0.1603	0.1502	0.1566	0	1
CAN	2012	0	0.0296	0.0279	0.0069	-0.002	0.0624	0.1603	0.2383	0.2671	0.0704	0	1
CAN	2013	0.013	0.0279	0.0346	0.0214	0.0097	0.0091	0.2383	0.2883	0.0778	0.0006	0	1
CAN	2014	0.0019	0.0346	0.0356	0.0162	0.0075	0.1279	0.2883	0.1193	-0.033	-0.061	0	1

Table A1: Classification of fiscal adjustments

		Tax					Spend					TB	EB
		τ^u_t	$\tau^a_{t-1,t}$	$\tau^a_{t,t+1}$	$\tau^a_{t,t+2}$	$\tau^a_{t,t+3}$	g^u_t	$g^a_{t-1,t}$	$g^a_{t,t+1}$	$g^a_{t,t+2}$	$g^a_{t,t+3}$		
DEU	1982	0.6343	0	0	-0.354	0	0.7008	0	0	0	0	0	1
DEU	1983	0.3467	0	-0.354	0	0	0.6455	0	0	0	0	0	1
DEU	1984	0	-0.354	0	0	0	0.6729	0	0	0	0	0	1
DEU	1991	1.1776	0	0.4114	0.1189	0.0585	0.0421	0	0.1755	0.2047	0.1852	1	0
DEU	1992	0	0.4114	0.1189	0.0585	0	0	0.1755	0.2047	0.1852	0	1	0
DEU	1993	0	0.1189	0.0585	0.8445	0	0	0.2047	0.1852	0.1178	0	1	0
DEU	1994	0.0819	0.0585	0.9146	0	0	0.6579	0.1852	0.2611	0	0	0	1
DEU	1995	0	0.9146	0	0	0	0	0.2611	0	0	0	0	1
DEU	1997	0.5313	0	0	0	0	0.9935	0	-0.08	0	0	0	1
DEU	1998	0.1015	0	0	0	0	0	-0.08	0	0	0	1	0
DEU	1999	0	0	0.1313	0	0	0	0	0.5917	0	0	0	1
DEU	2000	0	0.1313	0	0	-0.381	0	0.5917	0	0	0	0	1
DEU	2003	1.4821	-0.381	-0.68	0	0	0	0	0	0	0	1	0
DEU	2004	0	-0.68	0	0	0	1.0532	0	0	0.3039	0	0	1
DEU	2005	0	0	0	0	0	0	0	0.3039	0	0	0	1
DEU	2006	0	0	0.4042	0	0	0	0.3039	0.5053	0	0	0	1
DEU	2007	0	0.4042	0	0	0	0	0.5053	0	0	0	0	1
DEU	2011	0.3299	0	-0.019	0	0	0.229	-0.122	0.1263	-0.122	0	1	0
DEU	2012	-0.074	-0.019	-0.193	0	0	0.5632	0.1263	-0.033	0	0	0	1
DEU	2013	0	-0.193	0	0	0	0	-0.033	0	0	0	0	1
DNK	1982	0	0	0.1144	0	0	0	0	0	0	0	1	0
DNK	1983	1.0015	0.1144	0	0	0	1.9029	0	1.2018	0	0	0	1
DNK	1984	-0.218	0	0.9084	0	0	0.763	1.2018	0.9084	0	0	0	1
DNK	1985	0	0.9084	0	0	0	0	0.9084	0	0	0	0	1
DNK	1994	0	0	0.0432	0	0	0	0	0	0	0	1	0
DNK	1995	0	0.0432	0	0	0	0.1208	0	0	0	0	0	1
DNK	2009	0	0	0	0.0975	0	0	0	0	0	0	1	0
DNK	2010	0	0	0.3889	0.0971	0.4872	0	0	0.5827	0.5827	0.5827	0	1
DNK	2011	0	0.3889	0.0971	0.4872	0	0	0.5827	0.5827	0.5827	0	0	1
DNK	2012	0.1955	0.0971	0.585	0	0	0	0.5827	0.5827	0	0	0	1
DNK	2013	0	0.585	0	0	0	0	0.5827	0	0	0	0	1
ESP	1983	1.7616	0	0	0	0	0	0	0	0	0	1	0
ESP	1984	0.409	0	0	0	0	0.8179	0	0	0	0	0	1
ESP	1989	1.0791	0	-0.309	0	0	0.0915	0	0	0	0	1	0
ESP	1990	0	-0.309	0	0	0	0	0	0	0	0	1	0
ESP	1992	0.8245	-0.603	0.4581	0	0	0.3665	0	0.2884	0	0	1	0
ESP	1993	0.2741	0.4581	0	0	0	0	0.2884	0	0	0	1	0
ESP	1994	0	0	0	0	0	1.5526	0	0	0	0	0	1
ESP	1995	0	0	0	0	0	0.776	0	0	0	0	0	1
ESP	1996	0.1928	0	0	0	0	1.0602	0	0	0	0	0	1
ESP	1997	0.0907	0	0	0	0	1.3608	0	0	0	0	0	1
ESP	2009	0.2924	0	0	0	0	0	0	0	0	0	1	0
ESP	2010	0.4851	0	0	0	0	1.1695	0	0.5616	0	0	0	1
ESP	2011	0	0	0	0	0	0.9807	0.5616	0	0	0	0	1
ESP	2012	1.6662	0	0.8371	0	0	1.5005	0	0.4469	0.2684	0.2105	1	0
ESP	2013	2.0485	0.8371	0.5853	0.2926	0	-0.332	0.4469	0.2022	0.1337	0	1	0
ESP	2014	0.9068	0.5853	0.4389	-0.078	0	-0.028	0.2022	0.773	0	0	1	0
FIN	1992	0	0	0	0	0	0.8672	0	1.934	0	0	0	1
FIN	1993	0	0	0	0	0	1.6848	1.934	0	0	0	0	1
FIN	1994	1.6868	0	-0.706	0	0	1.7653	0	0	0	0	0	1
FIN	1995	0	-0.706	0	0	0	2.4088	0	1.6028	0	0	0	1
FIN	1996	0	0	-0.273	0	0	0	1.6028	0	0	0	0	1
FIN	1997	-0.478	-0.273	0	0	0	0.9888	0	0	0	0	0	1
FIN	2010	0	0	0.6463	0.1215	0	0	0	0	0	0	1	0
FIN	2011	0	0.6463	0.1215	0	0	0	0	0	0	0	1	0
FIN	2012	-0.054	0.1215	1.0331	0.0807	0.0172	0.2291	0	0.1945	0.2377	0.2581	1	0
FIN	2013	0	1.0331	0.0807	0.0172	0.2438	0	0.1945	0.2377	0.2581	0	1	0
FIN	2014	0	0.0807	0.2786	0.2438	0	0	0.2377	0.6962	0.0193	0.0755	0	1

Table A1: Classification of fiscal adjustments

		Tax					Spend					TB	EB
		τ^u_t	$\tau^a_{t-1,t}$	$\tau^a_{t,t+1}$	$\tau^a_{t,t+2}$	$\tau^a_{t,t+3}$	g^u_t	$g^a_{t-1,t}$	$g^a_{t,t+1}$	$g^a_{t,t+2}$	$g^a_{t,t+3}$		
FRA	1979	0.9588	0	0	0	0	0	0	0	0	0	1	0
FRA	1987	-0.265	-0.26	0	-0.194	0	0.7502	0	0	-0.005	0	0	1
FRA	1988	0	0	-0.194	0	0	0	0	-0.005	0	0	0	1
FRA	1989	0	-0.194	0	0	0	0	-0.005	0	0	0	0	1
FRA	1991	0.0864	0	-0.058	0	0	0.2188	0	0	0	0	0	1
FRA	1992	0	-0.058	0	0	0	0	0	0	0	0	0	1
FRA	1995	0.4007	0	0.5067	0	0	-0.118	0	0	0	0	1	0
FRA	1996	0.4162	0.5067	0.1033	0	0	0.4012	0	0.2103	0	0	1	0
FRA	1997	0.2905	0.1033	0	-0.097	-0.194	0	0.2103	0	0	0	0	1
FRA	1998	0	0	-0.097	-0.194	0	0	0	0	0	0	0	1
FRA	1999	0	-0.097	-0.194	0	0	0	0	0	0	0	0	1
FRA	2000	0	-0.194	0	0	0	0	0	0	0	0	0	1
FRA	2010	0	0	0	0	0	0	0	0.3558	0	0	0	1
FRA	2011	0.661	0	0.6119	0	0	0.5358	0.3558	0.5758	0.1052	0.0551	0	1
FRA	2012	0.5911	0.6119	0.4409	0.01	0	0.1215	0.5758	0.1325	0.0536	0.1502	1	0
FRA	2013	1.3422	0.4409	-0.182	0	0	0.5752	0.1325	0.4371	0.1502	0.3135	0	1
FRA	2014	0.1224	-0.182	-0.165	-0.349	-0.118	0.8582	0.4371	1.0823	1.0237	0.577	0	1
GBR	1979	-0.493	0	-0.164	0	0	0.739	0	0.2463	0	0	0	1
GBR	1980	0	-0.164	0	0	0	0	0.2463	0	0	0	0	1
GBR	1981	1.1107	0	0.3702	0	0	0.1234	0	0.0411	0	0	1	0
GBR	1982	0	0.3702	0	0	0	0	0.0411	0	0	0	1	0
GBR	1993	0	0	0.5205	0.1735	0	0	0	0	0	0	1	0
GBR	1994	0.177	0.5205	0.2325	0	0	0.1261	0	0.042	0	0	1	0
GBR	1995	0	0.2325	0	0	0	0	0.042	0	0	0	1	0
GBR	1996	0	0	0	0	0	0.3161	0	0.1054	0	0	0	1
GBR	1997	0.4633	0	0.3437	0.2398	0.0589	0.2278	0.1054	0.058	-0.006	0	1	0
GBR	1998	0	0.3437	0.2398	0.0589	0	0	0.058	-0.006	0	0	1	0
GBR	1999	0	0.2398	0.0589	0	0	0	-0.006	0	0	0	1	0
GBR	2010	0.1457	0	0.7011	0.3703	0.246	0.2629	0	0.2981	0.4054	0.4685	0	1
GBR	2011	0.0462	0.7011	0.3879	0.2898	0.1448	-0.004	0.2981	0.5252	0.7168	0.5982	0	1
GBR	2012	-0.079	0.3879	0.3135	0.2414	0.008	-0.011	0.5252	0.7216	0.6579	0.1829	0	1
GBR	2013	-0.049	0.3135	0.3108	0.1231	-0.043	0.0727	0.7216	0.6715	0.1608	0.0262	0	1
GBR	2014	-0.029	0.3108	0.1166	-0.101	-0.037	-0.011	0.6715	0.1754	0.1172	0.0454	0	1
IRL	1982	2.9483	0	0	0	0	0.3033	0	0	0	0	1	0
IRL	1983	2.6459	0	0	0	0	0.0669	0	0	0	0	1	0
IRL	1984	0.3127	0	0	0	0	0	0	0	0	0	1	0
IRL	1985	0.1316	0	0	0	0	0	0	0	0	0	1	0
IRL	1986	0.5607	0	0	0	0	0	0	0	0	0	1	0
IRL	1987	0.4188	0	0	0	0	1.1986	0	0	0	0	0	1
IRL	1988	0	0	0	0	0	2.0879	0	0	0	0	0	1
IRL	2008	0	0	0	0	0	0	0	0.2846	0	0	0	1
IRL	2009	2.8437	0	0.8922	0	0	1.2085	0.2846	0.8045	0	0	1	0
IRL	2010	0.0119	0.8922	0.0315	0	0	2.4086	0.8045	0.1105	0	0	0	1
IRL	2011	0.7932	0.0315	0.6245	0	0	2.5554	0.1105	0.5748	0	0	0	1
IRL	2012	0.6224	0.6245	0.1311	0	0	1.327	0.5748	0.3657	0	0	0	1
IRL	2013	0.6503	0.1311	0.3589	0	0	0.8829	0.3657	0.2606	0	0	0	1
IRL	2014	0.1917	0.3589	-0.034	0	0	0.7086	0.2606	0.0011	0	0	0	1
ITA	1991	1.7626	0	-1.062	0	0	0.9203	0	0	0	0	0	1
ITA	1992	2.5155	-1.062	-1.899	0	0	1.6204	0	0	0	0	0	1
ITA	1993	3.25	-1.899	-0.678	0	0	2.917	0	0	0	0	0	1
ITA	1994	0.2575	-0.678	0	0	0	1.5389	0	0	0	0	0	1
ITA	1995	2.2616	0	-1.515	0	0	1.6623	0	0.0565	0	0	0	1
ITA	1996	1.4769	-1.515	-0.395	0	0	1.063	0.0565	0	0	0	0	1
ITA	1997	1.2673	-0.395	-0.569	0	0	0.901	0	0	0	0	0	1
ITA	1998	0.6162	-0.569	0	0	0	0.567	0	0	0	0	0	1
ITA	2004	0.9018	0	-0.288	0	0	0.3449	0	0	0	0	1	0
ITA	2005	0.351	-0.288	0	0	0	0.8085	0	0	0	0	0	1
ITA	2006	0.5232	0	0	0	0	0.8841	0	0	0	0	0	1
ITA	2007	1.1981	0	0	0	0	-0.36	0	0	0	0	1	0
ITA	2009	0	0	0.1133	-0.023	-0.027	0	0	0.0075	0.0012	-6E-04	1	0

Table A1: Classification of fiscal adjustments

		Tax					Spend					TB	EB
		τ^{u}_{t}	$\tau^{a}_{t-1,t}$	$\tau^{a}_{t,t+1}$	$\tau^{a}_{t,t+2}$	$\tau^{a}_{t,t+3}$	g^{u}_{t}	$g^{a}_{t-1,t}$	$g^{a}_{t,t+1}$	$g^{a}_{t,t+2}$	$g^{a}_{t,t+3}$		
ITA	2011	0.2226	0.1754	1.2884	0.7647	0.2124	0.2335	0.6763	0.6835	0.8533	0.1503	1	0
ITA	2012	0.9684	1.2884	0.7526	0.0931	0	0.3741	0.6835	1.2754	0.4812	0.0405	1	0
ITA	2013	0.3141	0.7526	0.231	0.0487	0.0032	0.0372	1.2754	0.4562	0.0092	-0.031	0	1
ITA	2014	-0.039	0.231	0.0806	0.268	0.0274	-0.11	0.4562	0.2956	-0.05	0.0107	1	0
JPN	1979	0.1207	0	0.1399	0.0383	0	0	0	0	0	0	1	0
JPN	1980	0.0901	0.1399	0.1027	0	0	0	0	0	0	0	1	0
JPN	1981	0.3337	0.1027	0.2384	0	0	0	0	0	0	0	1	0
JPN	1982	0.0771	0.2384	0.055	0	0	0.6842	0	0.0629	0	0	0	1
JPN	1983	0	0.055	0	0	0	0.2758	0.0629	0	0	0	0	1
JPN	1997	0.9816	0	0.3272	0	0	0.4395	0	0.1465	0	0	1	0
JPN	1998	0	0.3272	0	0	0	0	0.1465	0	0	0	1	0
JPN	2003	0	0	0	0	0	0.4884	0	0	0	0	0	1
JPN	2004	0.1804	0	0.0601	0	0	0.454	0	0	0	0	0	1
JPN	2005	0	0.0601	0	0	0	0.2207	0	0	0	0	0	1
JPN	2006	0.4763	0	0.1588	0	0	0.2735	0	0	0	0	1	0
JPN	2007	0	0.1588	0	0	0	0	0	0	0	0	1	0
PRT	1983	1.0304	0	0	0	0	0.7295	0	0	0	0	1	0
PRT	2000	0	0	0	0	0	0.4628	0	0	0	0	0	1
PRT	2002	1.0348	0	0	0	0	0.2587	0	0	0	0	1	0
PRT	2005	0.5316	0	0.4528	0	0	0.082	0	0.4765	0.9201	0	0	1
PRT	2006	0.5704	0.4528	0.4916	0	0	0.786	0.4765	1.3128	0	0	0	1
PRT	2007	0	0.4916	0	0	0	0.388	1.3128	0	0	0	0	1
PRT	2010	0.6052	0	1.3832	0	0	0.5091	0	1.3832	0	0	1	0
PRT	2011	0.4804	1.3832	0.8646	0.4804	0	0.538	1.3832	2.9782	1.345	0	0	1
PRT	2012	0.3886	0.8646	2.6174	0	0	0.7771	2.9782	2.1221	0	0	0	1
PRT	2013	0.3922	2.6174	-0.392	0	0	0.0981	2.1221	0	0	0	1	0
PRT	2014	0.5437	-0.392	0.0679	0	0	1.5213	0	-0.027	0	0	0	1
SWE	1984	0.2269	0	0	0	0	0.7312	0	0	0	0	0	1
SWE	1993	0.4046	0	0.1962	0	0	1.0176	0	0.7601	0	0	0	1
SWE	1994	0	0.1962	0.1961	0.1121	0.0841	0	0.7601	0.2942	0.1681	0.1261	0	1
SWE	1995	1.0645	0.1961	0.7208	0.5407	0.3607	1.5988	0.2942	1.0812	0.8111	0.5409	0	1
SWE	1996	0	0.7208	0.5407	0.3607	0	0	1.0812	0.9492	0.6789	0.1381	0	1
SWE	1997	0	0.5407	0.3607	0	0	0	0.9492	0.6789	0.1381	0	0	1
SWE	1998	0	0.3607	0	0	0	0	0.6789	0.1381	0	0	0	1
USA	1978	0.139	0	0	0.0815	0.8246	0	0	0	0	0	1	0
USA	1979	0	0	0.0815	0.8246	0	0	0	0	0	0	1	0
USA	1980	0	0.0815	0.8246	0	0	0	0	0	0	0	1	0
USA	1981	-0.311	0.8246	0	0	0	0	0	0	0	0	1	0
USA	1983	0	0	0	0.1913	0.1106	0	0	0	0	0	1	0
USA	1984	0	0	0.1913	0.1106	0	0	0	0	0	0	1	0
USA	1985	0	0.1913	0.1106	0	0.4395	0	0	0	0	0	1	0
USA	1986	0	0.1106	0	0.4395	0	0	0	0	0	0	1	0
USA	1987	0	0	0.2826	0	0	0	0	0	0	0	1	0
USA	1988	0.2382	0.2826	0	0	0	0.2731	0	0	0	0	1	0
USA	1990	0.2263	0	0.3005	0.1944	-0.004	0.0742	0	0.304	0.3252	0.3183	0	1
USA	1991	0	0.3005	0.1944	-0.004	0.0751	0	0.304	0.3252	0.3183	0.4808	0	1
USA	1992	0	0.1944	-0.004	0.0751	0.0265	0	0.3252	0.3183	0.4808	0.2384	0	1
USA	1993	0.0929	-0.004	0.4009	0.1764	0.0856	0.021	0.3183	0.5725	0.4036	0.3028	0	1
USA	1994	0	0.4009	0.1764	0.0856	0.0612	0	0.5725	0.4036	0.3028	0.341	0	1
USA	1995	0	0.1764	0.0856	0.0612	-0.034	0	0.4036	0.3028	0.341	0.237	0	1
USA	1996	0	0.0856	0.0612	-0.034	0	0	0.3028	0.341	0.237	0	0	1
USA	1997	0	0.0612	-0.034	0	0	0	0.341	0.237	0	0	0	1
USA	1998	0	-0.034	0	0	0	0	0.237	0	0	0	0	1
USA	2011	0	0	0	0	0	0.0368	0	0.142	0.1203	0.0785	0	1
USA	2012	0	0	0	0	0	0	0.142	0.1203	0.0785	0.0501	0	1
USA	2013	0.1732	0	0.1237	0	0	0.2642	0.1203	0.0785	0.0501	0.0434	0	1

6 Appendix 4: Data sources

Table 10: Macroeconomic Data Sources

Variable	Label	Definition
Output (real)	*gdpv*	Gross domestic product, volume, market prices
Output (nominal)	*gdp*	Gross domestic product, value, market prices
Govt. Consumption (real)	*cgv*	Govt. final consumption expenditure, volume
Govt. Inventment (real)	*igv*	Govt. gross fixed capital formation, volume
Revenues (nominal)	*yrg*	Current receipts, general govt., value
Social Security (nominal)	*sspg*	Social security benefits paid by general govt., value
Other Outlays (nominal)	*oco*	Other current outlays, general govt., value
Population	*popt*	Population, all ages, all persons

gdpv, **gdp**: OECD Economic Outlook n.97; for Ireland, IMF WEO April 2015;

cgv: OECD Economic Outlook n.97; for Ireland we used data from AMECO (final consumption expenditure of general government at current prices deflated in 2012 prices with the correspondent deflator series in the AMECO dataset - price deflator total final consumption expenditure of general government);

igv: OECD Economic Outlook n.97; for Austria missing data in the period 1978-1994; for Ireland, Italy, Portugal, Spain, we used data from AMECO (gross fixed capital formation at current prices: general government, deflated with correspondent deflator series in AMECO dataset - price deflator gross fixed capital formation: total economy); note that for Portugal and Ireland series are respectively in 2011 and 2012 prices;

yrg: OECD Economic Outlook n.98; for Australia in the period 1978-1988 and Ireland before 1990, Economic Outlook n.88;

sspg: OECD Economic Outlook n.98; for Australia in the period 1978-1988 and Ireland before 1990, Economic Outlook n.88;

oco: OECD Economic Outlook n.98; for Australia in the period 1978-1988 and Ireland before 1990, Economic Outlook n.88;

popt: OECD Historical Population Data and Projections (1950-2050).

The variables we use in the analysis are constructed as follows:

- GDP deflator
$$pgdp_{i,t} = \frac{gdp_{i,t}}{gdpv_{i,t}}$$

- Real per capita GDP growth
$$\Delta y_{i,t} = 100 * \left[\log \left(\frac{gdpv_{i,t}}{gdpv_{i,t-1}} \right) - \log \left(\frac{popt_{i,t}}{popt_{i,t-1}} \right) \right]$$

- Percentage Change of Government Spending (as fraction of GDP)
$$\Delta g_{i,t} = 100 * \left[\frac{(igv_{i,t} + cgv_{i,t}) + \frac{oco_{i,t} + sspg_{i,t}}{pgdp_{i,t}}}{gdpv_{i,t}} - \frac{(igv_{i,t-1} + cgv_{i,t-1}) + \frac{oco_{i,t-1} + sspg_{i,t-1}}{pgdp_{i,t-1}}}{gdpv_{i,t-1}} \right]$$

- Percentage Change of Government Revenues (as fraction of GDP)
$$\Delta \tau_{i,t} = 100 * \left[\frac{\frac{yrg_{i,t}}{pgdp_{i,t}}}{gdpv_{i,t}} - \frac{\frac{yrg_{i,t-1}}{pgdp_{i,t-1}}}{gdpv_{i,t-1}} \right]$$

References

Alesina, A., C. Favero and F. Giavazzi (2015a), “The output effects of fiscal stabilization plans”, *Journal of International Economics*, 96, 1, S19-S42.

Alesina A, O. Barbiero, C. Favero. F. Giavazzi and M. Paradisi (2015b), "Austerity in 2009-13", *Economic Policy.*

Alesina A, O. Barbiero, C. Favero. F. Giavazzi and M. Paradisi (2016),"The output effects of fiscal adjustment plans: disaggregating taxes and spending", mimeo, IGIER.

Auerbach A. and Y. Gorodnichenko (2012), “Measuring the Output Responses to Fiscal Policy”, *American Economic Journal: Economic Policy*, 4(2), 1–27.

Auerbach A. and Y. Gorodnichenko (2013), “Fiscal Multipliers in Recession and Expansion”, in A. Alesina and F. Giavazzi (eds) *Fiscal Policy After the Financial Crisis*, 63–98, University of Chicago Press.

Barnichon R. and C. Matthes (2015), "Understanding the size of Government Spending Multipliers: it is all in the sign", mimeo CREI, Universitat Pompeu Fabra.

Caggiano G., E. Castelnuovo, V. Colombo and G. Nodari (2015), "Estimating Fiscal Multipliers: News from a Non-Linear World", *The Economic Journal*, 125, 746-776.

DeVries P., J. Guajardo, D. Leigh and A. Pescatori (2011), “A New Action-based Dataset of Fiscal Consolidation”, IMF Working Paper No 11/128, International Monetary Fund.

Erceg, C. J. and Lindé, J (2013) “Fiscal consolidations in a currency union: spending cuts vs. tax hikes”, *Journal fo Economic Dynamics and Control*, 37:2, p 422-445.

Guajardo, Jaime, D. Leigh, and A. Pescatori (2014), “Expansionary Austerity? International Evidence”, *Journal of the European Economic Association*, 12(4): 949-968.

Hernandez de Cos P. and E. Moral-Benito (2016), "On the Predictability of Narrative Fiscal Adjustments", *Economics Letters*, 143, 69-72

Jordà, O. (2005), “Estimation and Inference of Impulse Responses by Local Projections”, *American Economic Review*, 95(1): 161-182.

Jordà, Ò. and A. M. Taylor (2013), "The Time for Austerity: Estimating the Average Treatment Effect of Fiscal Policy," NBER Working Papers 19414, National Bureau of Economic Research, Inc.

Koop G., M.H. Pesaran and S.Potter (1996), "Impulse Response Analysis in Non-Linear Multivariate Models" *Journal of Econometrics*, 74, 119-147.

Leeper E. M., T. B. Walker and S. C. Yang (2008), “Fiscal Foresight: Analytics and Econometrics”, NBER Working Papers No. 14028, National Bureau of Economic Research, Inc.

Miyamoto, Wataru, Thuy Lan Nguyen and Dmitriy Sergeyev (2016), "Government Spending Multipliers under the Zero Lower Bound: Evidence from Japan", mimeo, IGIER, Bocconi University, Milan.

Ramey, V. (2016), "Macroeconomic Shocks and Their Propagation", NBER Working Paper 21978.

Ramey, V., Owyang and S. Zubairy (2013), "Are Government Spending Multipliers Greater During Periods of Slack? Evidence from 20th Century Historical Data, *American Economic Review,* 103(3):129-34.

Ramey, Valerie A. and Sarah Zubairy (2014), "Government Spending Multipliers in Good Times and in Bad: Evidence from U.S. Historical Data", NBER Working Paper No. 20719.

Ramey, Valerie A. and Sarah Zubairy (2015), "Are Government Spending Multipliers State Dependent? Evidence from Canadian Historical Data", mimeo.

Romer C. and D. H. Romer (2010), “The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks”, *American Economic Review*, 100(3), 763–801.

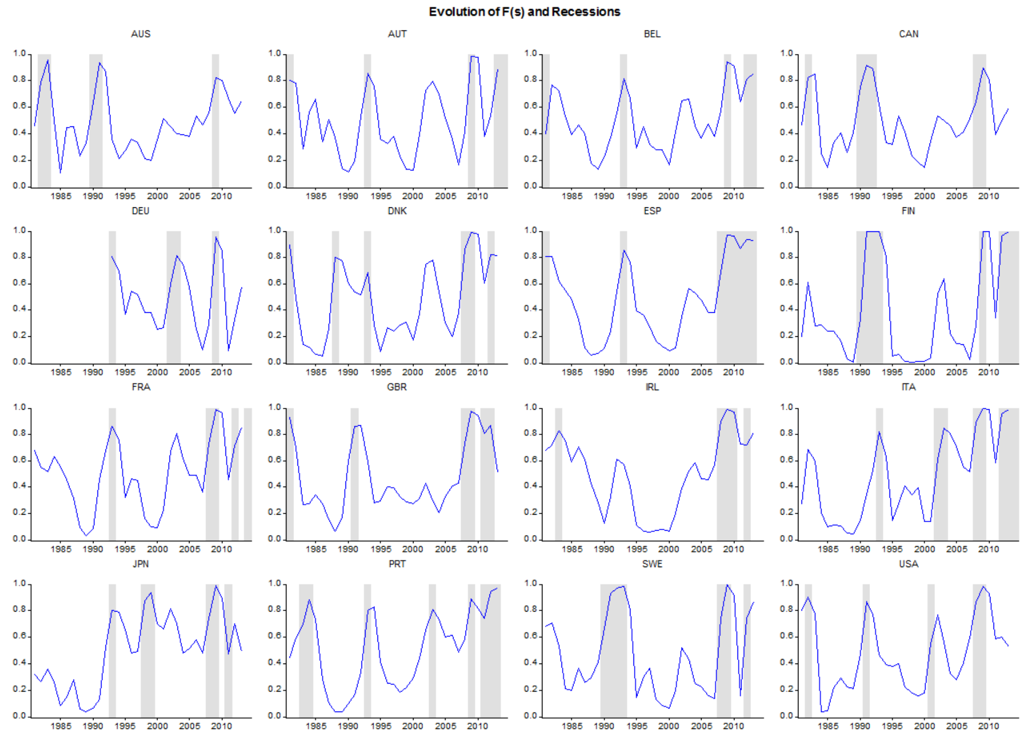

Figure 1: Evolution of $F(s)$ for the countries in our sample and years of recession (shaded areas), 1981-2013.

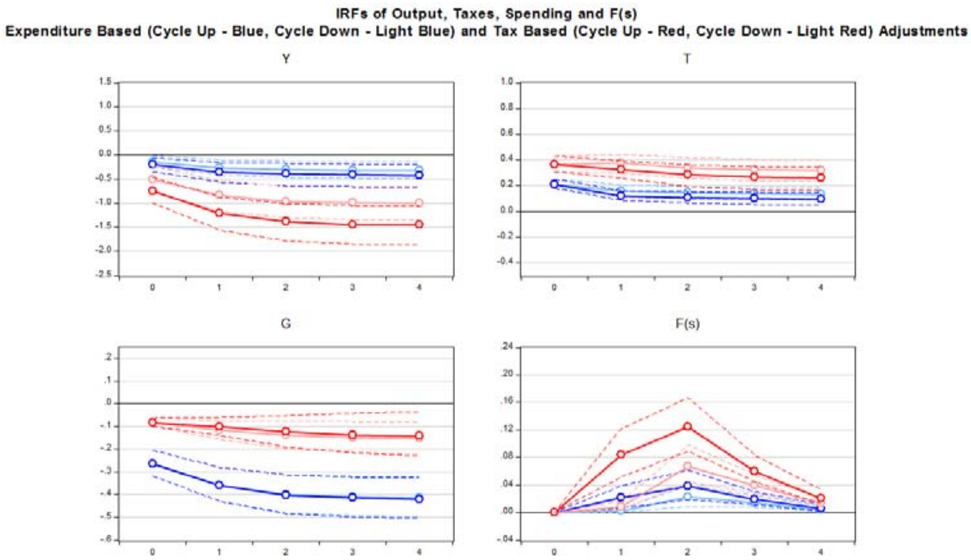

Figure 2: Allowing for heterogeneity between EB and TB plans and across states of the cycle.

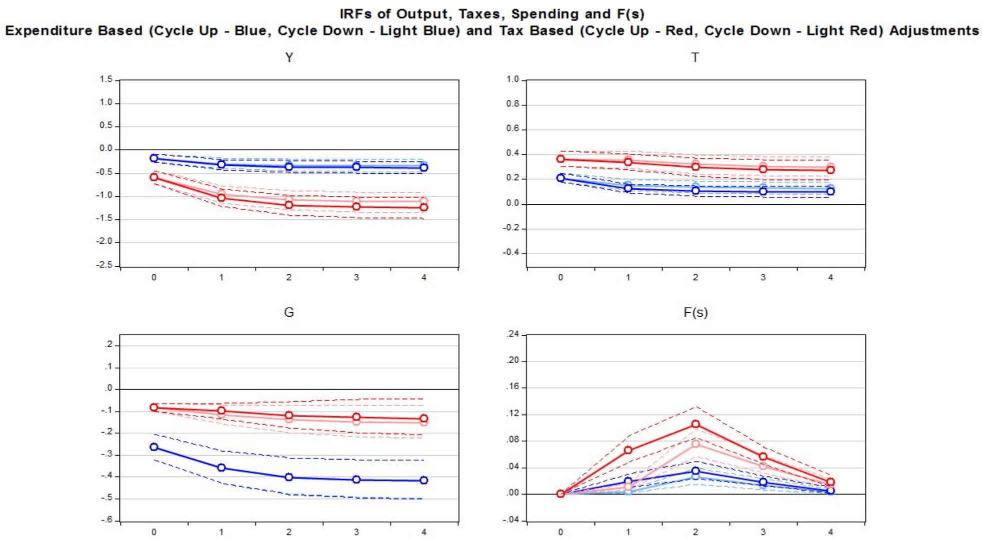

Figure 3: Allowing for heterogeneity between EB and TB (only shocks) and across states of the cycle (only autoregressive part).

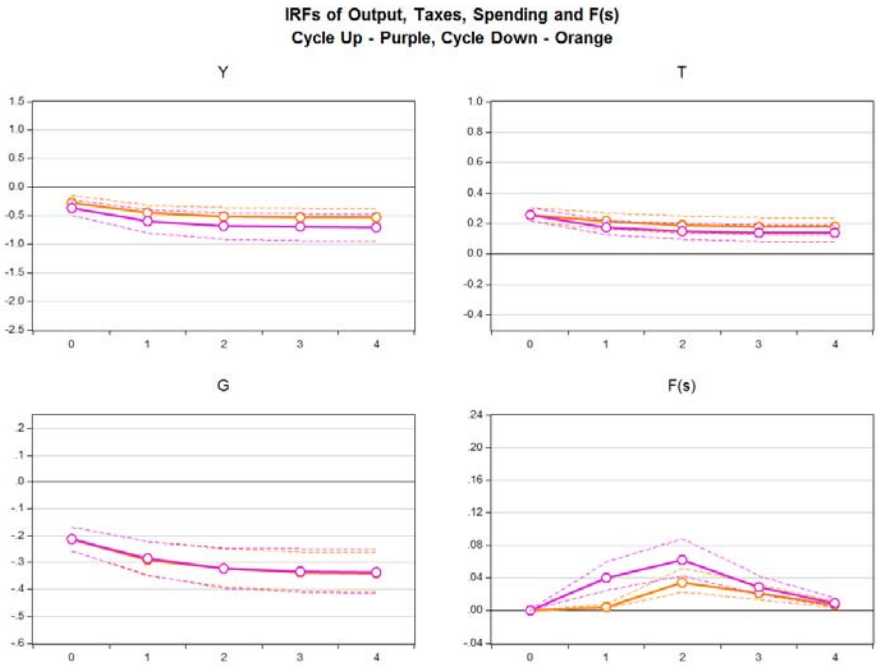

Figure 4: Allowing for heterogeneity only across states of the cycle.

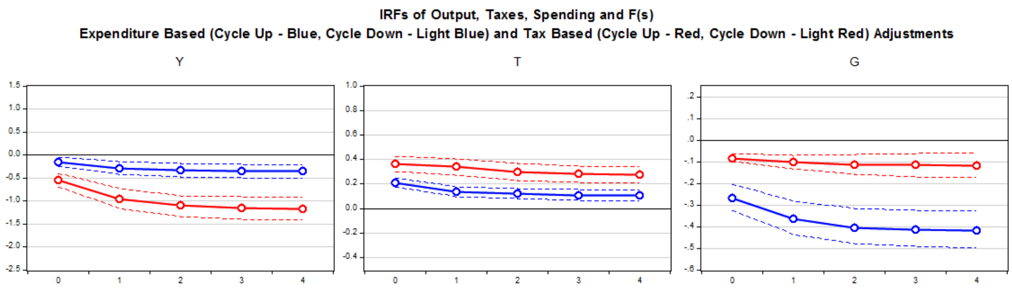

Figure 5: Allowing for heterogeneity only between EB and TB plans.

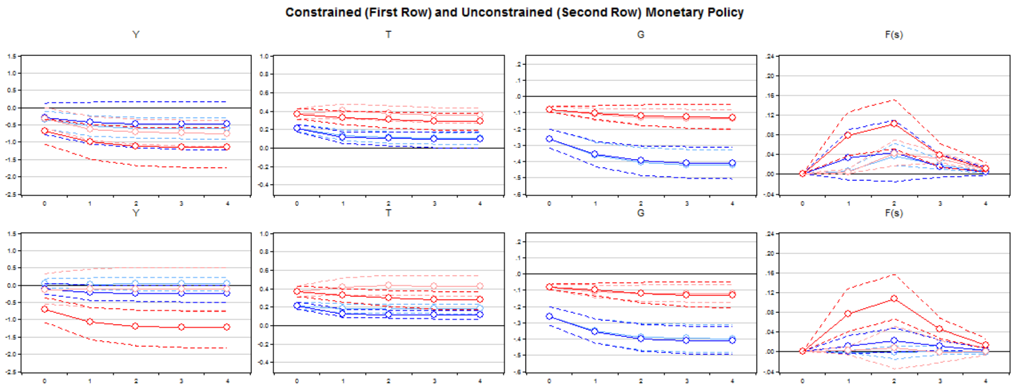

Figure 6: Monetary Policy Check: Euro Area vs Non-Euro Area.

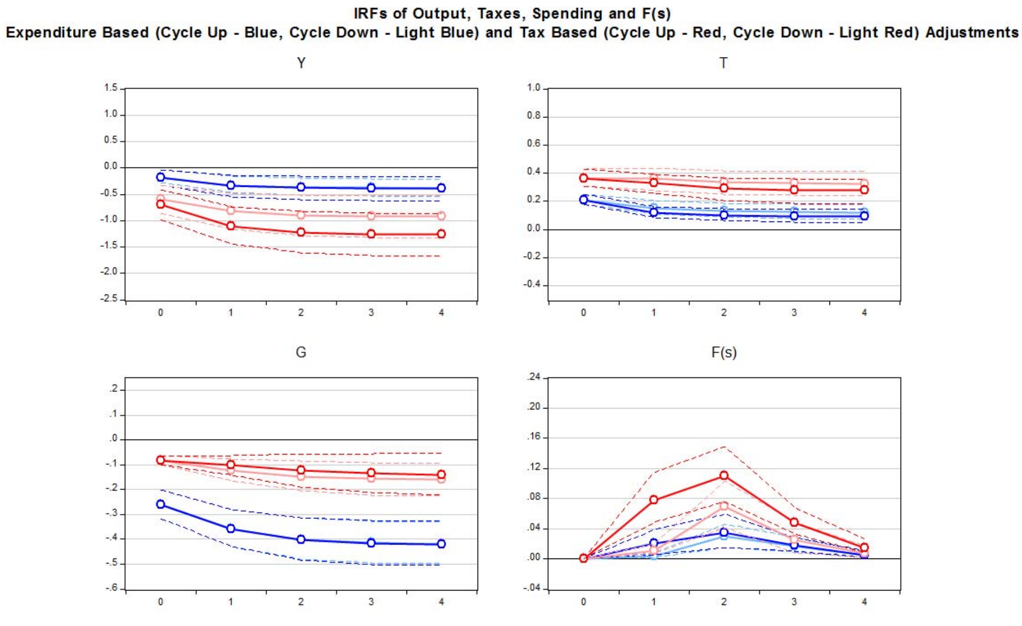

Figure 7: Monetary Policy Check: Excluding Episodes at the ZLB.