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Abstract

Recent empirical evidence suggests that fiscal consolidations mainly based on tax hikes have a more recessionary impact on economic growth relative to those based on expenditure cuts. In the first chapter of my thesis, "Can Uncertainty Explain the Heterogeneous Output Effects of Fiscal Adjustments?", I evaluate the output effects of fiscal adjustment plans identified through the narrative approach. Plans are different from shocks that are usually considered in the literature, since fiscal plans track more closely the dynamics of fiscal policy. I incorporate fiscal plans into a vector autoregression model to investigate the channels of transmission of fiscal consolidations. In addition to a direct effect of fiscal adjustment plans on output I explore two indirect effects. In particular, I investigate whether monetary policy or uncertainty could explain the heterogeneous output effects of fiscal adjustment plans. The evidence indicates that uncertainty increases following tax-based fiscal plans and decreases following expenditure-based fiscal plans. Monetary policy cannot fully explain this difference. By closing the monetary policy and uncertainty channels, first, one at a time and then both together, I measure how much of difference in output effects of fiscal adjustment plans is due to each particular channel. Finally, I investigate whether my empirical results are consistent with the simulation of a general equilibrium model.

The Empirical evidence on fiscal multipliers is very heterogenous. The second chapter of my thesis, "What Do We Know About Fiscal Multipliers?" (coauthored with Carlo Favero), first surveys available estimates of fiscal multipliers in order to understand their heterogeneity. Later a general framework is provided that allows to make the identification and specification choices made by the different authors explict and leads hopefully to a better understanding of the heterogeneity of results.

Fiscal policy is conducted through rare decisions and it is implemented through multi-year plans. This involves an intertemporal dimension and an intratemporal one. The third chapter of my thesis, "The Measurement of the Output Effect of Fiscal Adjustments" (coauthored with Carlo Favero), argues that the analysis of the dynamic impact of fiscal policy shocks neglects the fact that fiscal policy is conducted throughout multi-year plans. And by ignoring the intertemporal dimension, one disregards the fact that agents are aware of future, but not yet realized fiscal adjustments. While by ignoring the intratemporal dimension one fails to capture the composition of the plan. This chapter addresses the important question of plans' simulation from the econometric prospective.

Chapter 1

Can Uncertainty Explain the Heterogeneous Output Effects of Fiscal Adjustments?

1.1 Introduction

In this paper I analyze possible explanations of the heterogeneous output effects of fiscal adjustment plans. To do this I go through several steps. The first step is the measurement of fiscal consolidations. In practice, fiscal consolidations are usually implemented through the set of multi-year actions. This set of actions generates interactions between the spending and revenue components as well as between the unexpected component (announced upon implementation at time t) and the expected component of a plan (implemented at time t but announced in previous years or/and announced at time t to be implemented in the future). Therefore, I start by constructing a database of fiscal plans for the U.S. using quarterly data.

Next, I incorporate fiscal plans into a vector autoregression model because it allows me to track dynamics and interdependencies between the variables of interest, to capture expectational effects and, most importantly, to explain the heterogeneity of the output effects of fiscal adjustments.

I consider three ways in which a fiscal consolidation that is mainly implemented through tax hikes can affect output differently from one that is mainly implemented through expenditure cuts. The first way is by reducing or increasing the amount of distortions in the economy; the second way is by inducing a response of monetary policy that in turn effects output; thirdly, by changing the level of uncertainty in the economy, which in turn affects output. The first captures a direct effect of fiscal adjustment plans on output, while the second and third capture indirect effects. The direct effect can be measured simply by projecting the output growth on the current and past values of the exogenous fiscal adjustments. It is worth noticing that while the direct effect works through two channels, a wealth and a substitution effect, I do not distinguish between them. To measure the indirect effects one needs to consider the other endogenous variables such as the monetary policy variables and the uncertainty variables.

It appears that uncertainty plays an important role in explaining the difference between the output effects of fiscal adjustment plans while monetary policy cannot fully explain this difference. By closing the monetary policy and uncertainty channels one at a time, I measure how much the difference in output effects of fiscal adjustment plans are due to each particular channel. I then investigate whether my empirical results are consistent with the simulation of a general equilibrium model.

The intuition for the direct effect goes as follows: taking into account the fact that tax - based policies are distortionary, an increase in distortionary taxes produces negative effect on output growth. Expenditure - based policy, per se, does not create an effect. This can be due to the fact that more than sixty percent of U.S. expenditure cuts are reduction in transfers and the other forty percent are reduction in government consumption and investment (see Alesina et al., 2015). There could be two effects going in the opposite direction. For example, cutting large transfer payments to working-age people may encourage working, that in turn will increase output growth. While cutting government investment in research and development will discourage innovation, and in turn decrease output growth. However, through the government intertemporal budget constraint a reduction in government spending eventually produces a corresponding reduction in taxation, producing positive effect on output growth.

The question then becomes, through which mechanism should monetary policy and uncertainty explain the difference between the output effects of fiscal consolidations?

The intuition for monetary policy is rather straightforward. The difference between the output effects of tax-based fiscal adjustments and expenditure-based fiscal adjustments could be due to a more contractionary monetary policy in the case of tax-based plans and less contractionary or expansionary monetary policy in the case of expenditure-based plans.

The intuition I have for uncertainty goes as follows: after applying tax - based fiscal adjustment plans, higher uncertainty leads to an increase of the risk premium, which causes an increase in the cost of financing. Higher cost of financing of firms leads to a reduction in investment and, consequently, to a decrease in output growth. Following the previous logic expenditure - based policy, per se, does not create an effect and through the government budget constraint one can think about expenditure cuts today as future decrease in taxes.

In this study I am interested in two types of uncertainty. One type is "Bloom's" uncertainty that makes an economy unresponsive, creating a so-called "caution effect;" one that captures a traditional "wait-and-see" effect. Importantly, Bloom (2009) shows that due to investment irreversibility, in periods of higher uncertainty firms take the "wait-and-see" position, which decreases investment and, in turn, output growth. Moreover, Baker, Bloom and Davis (2013), by constructing the economic policy uncertainty measure, show that the drop and recovery in production are due to economic policy uncertainty.

The second type of uncertainty reflects financial market distortions. According to Gilchrist, Sim and Zakrajsek (2012), increases in uncertainty lead to a significant widening of credit spreads and a decline in output through a drop in the investment component of aggregate demand. Moreover, Gomes and Schmid (2012), within a general equilibrium framework with heterogeneous firms and an endogenous default, show that since credit risk premia plays an important role in the cost of capital, there appears to be a link between credit, equity markets and macroeconomic aggregates and be an amplification mechanism for macroeconomic fluctuations. Further, I call the first type a traditional uncertainty and the second type financial market uncertainty.

To analyze the output effect of fiscal policy several requirements need to be satisfied. First of all, correct estimation of the parameters requires identified fiscal policy shocks to be exogenous. There are several different ways of policy shock identification commonly used in the literature (see Ramey, 2015). A traditional approach is to identify fiscal shocks using a structural vector autoregression with the help of either economic theory or exogenous estimates to restrict the parameters (see Blanchard and Perotti 2002). The second is a narrative approach, which involves constructing shocks from historical documents by identifying the motivation and timing and the quantities, as in Romer and Romer (2010) and Devries et al. (2011). The third method of fiscal adjustment identification is a proxy structural vector autoregression, offered by Mertens and Ravn (2013). This approach handles the measurement error problem by using the narrative shocks as instrumental variables to identify the structural shocks.

The fact that fiscal adjustments are implemented through multi-year plans generates the "fiscal foresight" problem (Leeper et al 2008, Leeper 2010), with the agent knowing the future announced measures in advance. Leeper et al. (2013) show that the moving average representation of the VAR becomes non-invertible because fiscal foresight causes the number of shocks to be mapped out of the VAR innovations too high to achieve identification. Narrative identification of fiscal adjustment plans explicitly allow for the fiscal foresight, since one of the components of the plan is an announced component. Therefore, simulation of the fiscal adjustment plans narratively identified in VAR allow to avoidance of the "fiscal foresight" problem.

This paper uses fiscal adjustments identified through a narrative approach as exogenous variables in the vector autoregression framework. A narrative approach allows us to identify exogenous fiscal adjustments independent of the current state of the economy, serving to stabilize deficit. I construct an original dataset (described below), which is another contribution of this paper. I use fiscal plans rather than separate shocks, similar to

Alesina, Favero and Giavazzi (2013) and Favero and Karamysheva (2014). It makes sense to use fiscal plans rather than separate shocks in the empirical world, since fiscal policy is a complicated set of actions that are taken at some point and then applied over the course of several years. Fiscal plans allow us to consider several dimensions. First, it allows us to take into account both anticipated and unanticipated components of fiscal plans, so as to disentangle expected and unexpected components. Second, it allows us to take into account so-called intratemporal dimension, tax-based versus expenditure-based, which is very important since the empirical literature shows that the effect of expenditure-based policy on real output is less recessional than that of the tax-based policy.

To produce a database of exogenous fiscal plans for the U.S. at quarterly frequency I combine the narrative databases of Romer and Romer (2010) and Devries et al. (2011). Reconsidering these two databases I construct a quarterly time series of exogenous fiscal stabilization plans for the U.S. economy. In practice, I extend the deficit-driven quarterly dataset of tax adjustment produced by Romer and Romer (2010) to include a quarterly measure of the deficit-driven expenditure adjustments proposed by Devries et al. (2011). By taking for granted the exogeneity of the episodes identified by these authors I simply reclassify them to trace precisely fiscal plans. Quarterly data allows us to avoid any inconveniences with timing distinguishing between unanticipated and anticipated components of the plans. Moreover, monetary policy and uncertainty react within three months or better, so having annual data may cause imprecision in estimation. However, the downside of quarterly fiscal plans' data is having a lot of zeros in the data and having variables with low variation on the right hand side of the system. The extension is important because it includes recent crisis as well as fiscal cliff and zero lower bound. The current paper uses quarterly observations for the 1978 - 2012 sample period.

The question that I address in this paper is exactly the one for which according to Ramey (2015), *"dynamics are all-important, general equilibrium effects are crucial, and expectations have powerful effects."* To explain heterogeneous output effects of fiscal adjustment plans, one needs to take into account expectations, since the effect of anticipated and unanticipated components of the plan can be rather different. Moreover, interdependencies between the variables of interest are crucial for defining the transmission channel. Since truncated moving average, which is a commonly used methodology to derive the dynamic effect of the exogenous fiscal policy on the variable of interest, simply projects these variables on current and past values of the shocks without capturing dynamics between the variables, it is not valid for investigating the transmission mechanism. Instead, the vector autoregression model satisfies all the interdependencies between the variables. Moreover, a vector autoregression model with exogenous fiscal plans allows me to close the channels, first one at a time and then all together to measure how much of a difference in output effects of fiscal adjustment plans is due to a particular channel.

To disentangle between the monetary policy channel and the uncertainty channel I consider vector autoregression with exogenous fiscal plans and these two channels (VARX + channels). To capture economic activity and business cycle variation, I include growth of output. To take into account monetary policy I use three months T-bill rate and inflation. To take into account uncertainty I consider different proxies of uncertainty. To disentangle between the two types of uncertainty I incorporate both types into the model at the same time. As a main proxy for traditional uncertainty I use the economic policy uncertainty index constructed by Baker, Bloom and Davis, (2013); and as a main proxy for financial market uncertainty I take into account BAA - AAA corporate bond spread.

This paper is related to a growing literature examining the transmission mechanism linking policy and the real economy. Bekaert, Hoerova and Lo Duca, (2012) provide the first dynamic model of links between risk, uncertainty and monetary policy, using a simple vector-autoregressive framework. I differ from these articles in many aspects. Most importantly, I focus on fiscal policy, precisely on fiscal consolidation, while Bekaert, Hoerova and Lo Duca, (2012) examine the effects of monetary policy on economic performance. Moreover, I link fiscal policy and economic activity as in Bachmann and Sims (2011). While these researches focus only on the government expenditure side of fiscal policy, abstracting from the revenue side, my work explicitly considers both expenditure and tax components of fiscal policy. Bachmann and Sims (2011), using a non-linear framework, stress consumer and business confidence as main transmission channels. In contrast, the current study focuses on uncertainty as a main transmission channel.

The main empirical findings of the paper are the following: between the two competing channels (monetary policy and uncertainty), uncertainty is the one that may explain the heterogeneity. Moreover, going deeper and distinguishing between the two types of uncertainty, the one that matters more is the financial market uncertainty (proxied by the BAA - AAA corporate bond spread). BAA - AAA corporate bond spread opens up significantly in the tax-based case, while remaining close to zero in the expenditure-based case. To see how much of the effect is going through the particular channel, I use the methodology of the counterfactual experiment. By closing channels I confirm the main result.

Finally, I investigate whether my empirical results are consistent with the simulation of a general equilibrium model. I show that the risk premium increases more when fiscal consolidation is implemented through tax increase relative to the case when fiscal consolidation is implemented through expenditure cuts. I use as a benchmark Croce et al. (2012) general equilibrium model, which links fiscal policy, equity risk premia and real economy. The important difference between my model and the model of Croce et al. (2012) is that they focus on taxes and take expenditure as an exogenous variable, while I also endogenize expenditure component. In addition, the nature of the fiscal shocks is different: for Croce et al. (2012) it is expenditure shock, while for me the shock comes through a change in the debt-to-GDP ratio target similar to Erceg and Linde (2013).

The rest of paper is organized as follows: Section 2 - fiscal plans database construction and description of channels and economic variables, Section 3 - simulation of fiscal plans in VARX model, Section 4 - estimation and results, Section 5 - a general equilibrium model and a conclusion follow.

1.2 Data

1.2.1 Construction of fiscal adjustment plans

Measuring the output effect of fiscal consolidations requires a sample of exogenous shifts in fiscal stance. Fiscal foresight does not allow us to treat exogenous shifts in fiscal policy as unobservable and to identify them by imposing restrictions on reduced form dynamic specifications of macroeconomic and fiscal variables. The narrative method allows us instead to construct a time-series of the relevant shocks without the need to estimate a model. R&R refer to presidential speeches and Congressional reports, to identify the size, timing, and principal motivation for all major post-war tax policy actions. Next they classify legislated changes into endogenous (those induced by short-run countercyclical concerns and those taken because of change in government spending) and exogenous (those that are responses to the state of government debt or to concerns about long-run economic growth).

Similarly, Devries et al. (2013) produce a data set that documents exogenous shifts in fiscal policy (both tax and expenditure) by applying the narrative approach to a set of seventeen OECD countries. Among all fiscal actions, these authors have selected those that were designed to reduce a budget deficit and/or to put the public debt on a sustainable path.

In this paper I reconsider these two databases to construct a quarterly time-series of exogenous fiscal stabilization episodes for the U.S. economy. In practice, I extend the deficit-driven quarterly dataset of tax adjustment produced by R&R to include a quarterly measure of the deficit-driven expenditure adjustments proposed by Devries et al. (2013). By taking for granted the exogeneity of the episodes identified by these authors I simply reclassify them to precisely trace fiscal plans.

When fiscal policy is conducted through multi-year plans, narrative exogenous fiscal adjustments in each year are made of three components: the unexpected adjustments (announced upon implementation at time t); the past announced adjustments (implemented at time t but announced in the previous years) and the future announced corrections.

Plans are sequences of fiscal corrections announced at time t to be implemented between time t and time $t+k$; where k is the anticipation horizon. The unanticipated fiscal shocks at time t as the surprise change in the primary surplus at time t:

$$e_t^u = \tau_t^u + g_t^u$$

where τ_t^u is the surprise increase in taxes announced at time t and implemented in the same year, and g_t^u is the surprise reduction in government expenditure also announced at time t and implemented in the same year. $\tau_{t,j}^a$and $g_{t,j}^a$ are instead the tax and expenditure changes announced by the fiscal authorities at date t with an anticipation horizon of j years (*i.e.* to be implemented in year $t + j$). In the D&al dataset fiscal plans almost never extend beyond a 3-year horizon; thus $j = 3$ is the maximum anticipation horizon [1]. Therefore, I define the observed anticipated shocks in period t as follows:

$$\begin{aligned}
\tau_{t,0}^a &= \tau_{t-1,1}^a \\
\tau_{t,j}^a &= \tau_{t-1,j+1}^a + \left(\tau_{t,j}^a - \tau_{t-1,j+1}^a\right) \; j \geqslant 1 \\
g_{t,0}^a &= g_{t-1,1}^a \\
g_{t,j}^a &= g_{t-1,j+1}^a + \left(g_{t,j}^a - g_{t-1,j+1}^a\right) \; j \geqslant 1 \\
e_{t,j}^a &= \tau_{t,j}^a + g_{t,j}^a
\end{aligned}$$

Implementing fiscal policy through plans means that fiscal corrections can be written as follows:

$$f_t = e_t^u + e_{t,t}^a + \sum_{j=1}^{horz} e_{t,t+j}^a$$

An extensive description of how I constructed the database building on the work by R&R is in the appendix.

To illustrate the procedure, consider the case of 1990 *OBRA (Omnibus Budget Reconciliation Act) - 1990, which is considered by R&R and Devries et al. as exclusively motivated by* a deficit reduction motive and therefore exogenous for the estimation of the output effect of fiscal corrections.

Insert Table 1 (example OBRA - 90, part 1)

Table 1 illustrates how Devries et al and R&R, using different sources, reclassify the plan. OBRA - 1990 plans fiscal adjustment both on revenue and expenditure side over the period 1991-1995. R&R concentrate only on the revenue adjustment and ”lump” in the first quarter of 1991 all the relevant adjustment (that therefore add up adjustment to be implemented in 1991 and 1992). The post-1992 adjustments are not included because of their small size. *”... almost all the revenue provisions were effective January 1, 1991.*

[1] In the sample there are a few occurences of policy shifts anticipated four and five years ahead. Their number is too small to allow us to include them in our estimation.

Thus, the first full fiscal year the changes were scheduled to be in effect were in fiscal 1992. We therefore use the estimated revenue effect from the budget for that year as our revenue estimate. That is, we estimate that there was a tax increase of $35.2 billion in 1991Q1..." Devries et al. take a different source (CBO (1990), The 1990 Budget Agreement: An Interim Assessment (Table 2, p. 6)) and, after the reclassification from fiscal to calendar year, use the implementation rather than the announcement as a criterion to attribute shocks to each period[2].

Table 2 is a reclassification of the OBRA 90, along with the snapshots from the series of the shocks constructed by R&R and Devries et al.

Insert Table 2 (example OBRA - 90, part 2)

Following the approach illustrated for the OBRA plan, I have reconstructed a quarterly database of exogenous adjustments in the U.S. by reclassifying and disaggregating at the quarterly frequency the Devries et al. series for expenditure adjustments and revenue adjustments. Plans are labeled as tax - based or expenditure - based by adopting the following rule:

$$\begin{aligned} if \quad \left(\tau_t^u + \tau_{t,t}^a + \sum_{j=1}^{horz} \tau_{t,t+j}^a\right) \quad &> \quad \left(g_t^u + g_{t,t}^a + \sum_{j=1}^{horz} g_{t,t+j}^a\right) \\ then\ TB_t \quad &= \quad 1\ and\ \ EB_t = 0, \\ else\ TB_t \quad &= \quad 0\ \ and\ \ EB_t = 1, \forall\ t \end{aligned} \tag{1.1}$$

The Data appendix provides a detailed description of the series and their construction. In total, I have 53 observations with non-zero adjustment for a total of 20 plans divided into EB and TB (21 quarters of adjustment are labeled TB and 32 are labeled EB). Mean, standard deviation and number of observations are in Table 3. The mean of total non-zero historical adjustments is 0.286. The means of TB plans are 0.166 and 0.123 both for unanticipated and anticipated components of the plan respectively, and it is lower than that of EB plans than stands at 0.304 and 0.323.

Insert Table 3 (descriptive statistics)

A number of comments about narrative plans are in order.

First, as illustrated in Table 4, there is significant evidence of both intertemporal and intratemporal correlations among the different dimensions of plans:

[2]Following Devries et al. 2011, I concentrate on those deficit-driven exogenous adjustments, which are not offset by the long-run adjustments in the R&R terminology. Moreover, R&R propose several measures of the tax adjustments, generated respectively by including or not the retroactive components of the measures. There are no cases of retroactive components in deficit-driven adjustments, and the retroactive components of a long run do not affect my measure of revenue adjustments.

Insert Table 4 (correlation)

The unanticipated tax τ_t^u and spending g_t^u adjustments are strongly correlated with $\rho = 0.56$. By simply regressing τ_t^u on g_t^u, the coefficient is strongly significant and equal to 0.42 with $std.err = 0.05$ and $R\hat{}2 = 0.31$. With anticipated shocks we observe the same pattern: $\rho = 0.60$; the coefficient is 0.63 with $std.err = 0.07$ and $R\hat{}2 = 0.4$. Correlation between the unanticipated component of the plans at date t and those announced previously and executed at date t is very low.

A simple orthogonality check supports the idea of using plans instead of shocks. Considering separately anticipated and unanticipated parts of a plan, I estimate two systems: in the first one I include both components, while in the second one only a surprise component[3]. As one would expect, taking into account the correlation between the plans' components, estimated coefficients vary depending on the specification I use. So, once again, this evidence supports an idea of using the plans.

Second, as there is potential measurement error in narrative episodes (see, for example, Mertens, Ravn 2013), it is interesting to see how these constructed variables are related to observed fiscal variables constructed using NIPA tables.

Insert Figure1.1,1.2

Figure 1.1 shows the time series of expenditure and tax variables from NIPA tables. Figure 1.2 plots changes in both expenditure and tax variables (left and right column respectively), together with expenditure and tax adjustments (first row) and EB and TB fiscal plans (last row). Narrative variables include both components anticipated and unanticipated. Shocks in the upper panel are constructed in such a way that all adjustments are recorded as positive (therefore a positive adjustment in expenditure is a spending cut).

The sample period is from 1978 till 2012, covering the recent crisis. It is quarterly data for the United States.

1.2.2 Exogeneity and predictability of fiscal plans

One important and necessary condition for the correct estimation and simulation of the effect of fiscal plans on output growth is the exogeneity of the plans. There is no consensus in the literature on the fact that narrative approach per se is responsible for holding the exogeneity condition (see Ramey, 2015). So, several additional checks will help to make sure that the fiscal plans are exogenous to growth of output, that is they are not predictable by past values of output growth. Moreover, it is important to check that fiscal plans are not predictable by debt as well as by channel variables. Furthermore, it

[3]Estimated coefficients are not reported here; however they can be available upon request.

is important to show that the choice of being a tax-based or expenditure-based plan is independent of the business cycle.

The first set of checks can be conducted simply by the OLS regressions including constant. As a dependent variable first, I use the unanticipated component of the plan:

$$e_t^u = \tau_t^u + g_t^u$$

next, I take the executed anticipated component of the fiscal plan, so:

$$e_{t,0}^a = \tau_{t,.0}^a + g_{t,.0}^a$$

while the independent variables are both the first and the second lags of an output growth, debt-to-GDP ratio growth, financial market uncertainty, which is financial market distortion proxied by corporate BAA-AAA bond spread, high–information content credit spread index (Gilchrist and Zakrajsek, 2012) and excess bond premium (Gilchrist and Zakrajsek, 2012), economic policy uncertainty (Bloom, Baker and Davis proxy), and short term interest rate. Importantly, in the regressions with output growth as well as debt-to-GDP ratio growth, spread, Gilchrist and Zakrajsek, (2012) proxies, and interest rate none of the coefficients are significant, so their lagged values do not affect the fiscal plan's components, while in the regressions with economic policy uncertainty the coefficients are significant. However, this result is driven only by one observation, precisely by 1988q1. That is why after inclusion the dummy 1988q1 into the regression both of the coefficients become insignificant. So, fiscal plans are not predictable by the variables of my interest.

To address the question of independency of fiscal plans from the business cycle one can do a binary choice logit (probit) regression. I take the dummies TB and EB as choice variables and regress it on a cycle measure separately. Cycle measure is constructed as a deviation of the GDP from the Hodrick-Prescot (hp) trend. After conducting the regression I find no evidence of the relations between choice of doing expenditure-based (EB) fiscal plan or not and the cycle. The coefficient in front of the cycle variable is - 0.2, while the standard error is 0.25 and the p-value is 0.4, McFadden R-squared is 0.004. On the contrary, there is evidence of applying tax-based (TB) fiscal policy in times of booms. Even though the positive coefficient in front of cycle variable is 1.23 (standard error 0.35, p-value is 0.0006, McFadden R-squared is 0.112) tells us that increase of independent variable (so times of boom) leads to a higher probability of choosing TB policy, which contradicts the results and makes them even more difficult to obtain.

Additionally with a binary choice logit (probit) regression I have checked the independency of the choice between TB and EB from the potential channels. The results confirm the independency of a fiscal plan choice, since none of the coefficient is significant[4].

[4]Estimated regressions are not reported in the current paper and can be available upon request.

1.2.3 The proxies for Uncertainty and Monetary Policy

The first candidate is an uncertainty. There is a large stream of literature that focuses on the relationship between uncertainty and real economy. There are several important concepts to notice. Uncertainty is a variable that is hard to measure. According to Bloom (2012), today's volatility could be a proxy for uncertainty about tomorrow. For example, uncertainty of the S&P 500 tomorrow is today's volatility of the S&P 500. Moreover, macroeconomic uncertainty could be measured as stock return volatility, forecaster disagreement, economic policy uncertainty index, as offered by Bloom, Baker and Davis, (2012) and by news-mentioned uncertainty.

I use mainly two proxies for uncertainty. The first uncertainty proxy to capture the "traditional wait-and-see" effect is the news-based index. Baker, Bloom and Davis, (2013) extend the news-based index of policy uncertainty to 1900, using a panel of six newspapers: The New York Times, The Boston Globe, The Wall Street Journal, The LA Times, The Chicago Tribune, and The Washington Post[5]. My main proxy for the second type of uncertainty, which captures financial market distortions, is a BAA - AAA corporate bond spread. It is a rough one since according to the Gilchrist and Zakrajsek, (2012) the spread index could be decomposed into predicted default risk and unpredictable excess bond premium. So as additional proxies I take the Gilchrist and Zakrajsek, (2012) spread index as well as their excess bond premium[6]. Data for corporate bond spread are from the FRED website and the source is Board of Governors of the Federal Reserve System, while data for high–information content credit spread index and excess bond premium are from Gilchrist and Zakrajsek, (2012)[7]. The detailed description of proxies and the data sources is in Appendix 2.

Additionally, for the robustness I substitute uncertainty with the following proxy: "mvol," which is the combination of VXO (implied volatility) and realized volatility[8]. This measure of uncertainty was offered for the first time by Bloom (2009). He took monthly U.S. stock market volatility from the Chicago Board of Options Exchange VXO index of percentage implied volatility from 1986 onward. Pre-1986 the VXO index is unavailable, so, following the Bloom "actual monthly returns volatilities are calculated as the monthly standard deviation of the daily S&P500 index normalized to the same mean and variance as the VXO index when they overlap from 1986 onward. Actual and VXO are correlated at 0.874 over this period." After this proxy for uncertainty is scaled to make it comparable by the following formula:

[5]Thanks to professor STEVEN J. DAVIS for sending me this data.

[6]Results can be available upon request.

[7]Data for a high–information content credit spread index and excess bond premium are from Gilchrist, Zakrajsek, (2012) : http://people.bu.edu/sgilchri/Data/data.htm

[8]Results can be available upon request.

$$mvol = log(mvol\hat{}2/12)$$

As a proxy for monetary policy I take the change in 3 months tbill rate from FRED. Inflation is a log ratio of personal consumption expenditures (PCE) from NIPA 2.3.4. Where expenditure variable is $EXP_t = (tot\_expend - int\_paym)/ngdp$ and tax variable is $TAX_t = (tot\_receip - int\_receip)/ngdp$, taken from the NIPA 3.1 and 1.1.5. As an additional check, I take different definitions of the EXP_t and TAX_t variables as in Blanchard and Perotti (2002) and Mertens and Ravn (2012). However, results are virtually the same and are available upon request. Output is growth rate of the quantity index for real GDP (NIPA 1.1.3), Consumption is growth rate of the Real Personal Consumption Expenditures (NIPA 2.3.3), Investment is growth rate of the Real Private Fixed Investment (NIPA 5.3.3) and DEBT (debt-to-GDP ratio) is constructed as in Favero and Giavazzi, (2012), so using Federal debt held by the public.

1.3 Simulation of fiscal adjustment plans in a VARX setting

After their identification, fiscal adjustment plans are considered to be the correct experiment and can be used in empirical models to measure policy effect. Empirical reduced form models are needed to be simulated by keeping all parameters constant, and only the simulation of fiscal adjustment plans allows this. For the valid experiments with reduced form model two requirements must be satisfied: simulate exogenous policy actions and consider experiments that do not change the correlation in the data used to estimate the parameters in the empirical model.

Importantly, simulation of the fiscal adjustment plans narratively identified in VAR allows avoidance of the "fiscal foresight" problem. Fiscal policy is based on rare decisions and is implemented through multi-year plans. These features of fiscal policy generate "fiscal foresight" (Leeper et al. 2008, Leeper 2010), agent know in advance future announced, measures. Ramey (2011a, b) argues that distinguishing between announced and unanticipated shifts in fiscal variables, and allowing them to have different effects on output, is crucial for evaluating fiscal multipliers. Leeper et al.(2013) show that the moving average representation of the VAR becomes non-invertible because fiscal foresight makes the number of shocks to be mapped out of the VAR innovations too high to achieve identification. In other words, misalignment between the information set used by the econometrician in a VAR and that available to economic agents causes a failure of a unique recovery from VAR innovations of an exogenous combination of unanticipated and announced fiscal corrections that characterizes a plan. Narrative identification of fiscal adjustment plans explicitly allow for the fiscal foresight.

Simulation of fiscal adjustment plans in the VAR model allows me not only to avoid the fiscal foresight problem and correctly simulate exogenous policy actions, but also, most importantly, it allows me to track interdependencies between the variables of interest. The main question of this paper is the question of the transmission mechanism, which stands behind the heterogeneous output effects of fiscal adjustment plans and is related to the set of macroeconomic questions, for which dynamics and expectations are all-important. The truncated moving average which is commonly used in the literature for deriving the dynamic effect of the exogenous fiscal policy on the variables of interest by simply projecting these variables on current and past values of the shocks does not allow the capture of dynamics between the variables of interest. Therefore it is not valid for investigating the transmission mechanism.

Ideally, one would like to consider a general model, which covers different sectors of the economy to see the full set of interdependencies. Since fiscal policy is based on rare decisions this will cause a model to be over-parameterized, not having a sufficient number of degrees of freedom to be estimated. Since current study focuses on uncertainty and monetary policy transmission channels and considers only U.S. economy, the set of endogenous variables can be limited to the following set of domestic macro variables: real GDP growth, inflation, three months t-bill rate and proxy for uncertainty.

U.S. debt dynamics have never deviated from stability and therefore on the one hand, one should not worry about an inclusion of identity driving the debt dynamics into the model. However, Leeper (2010) stresses the importance of avoiding analyses of "unsustainable fiscal policies." To ensure that the policy does not lay on an unsustainable path, to pin down explicitly the debt stabilization motive in the fiscal reaction function and the impact of debt in the macro dynamics, I do an additional check for the robustness by the endogenization of the debt-deficit dynamics[9]. This precisely allows us to see that impulse response functions are not computed by diverging paths for fiscal fundamentals.

Furthermore, VARX with fiscal adjustment plans allows us to do a counterfactual model check. This is useful for defining the effect not only from a qualitative perspective but also a quantitative one.

After correct identification, estimation and simulation of the fiscal adjustment plans, the impulse responses can be computed as the difference between two forecasts. Once impulse responses are available, multipliers can be calculated as the ratio of the integral of the output response and the integral of taxes or expenditure responses (see Mountford and Uhlig (2009), Uhlig (2010)).

To give a sense of how simulation of the fiscal adjustment plans is done in the VARX framework, consider a simplified example with just two endogenous variables: variable of interest y_t and transmission channel z_t. Consider a reduced form VARX(1) model

[9]Results can be available upon request.

with exogenous fiscal adjustment plans. There are no lags on unanticipated components, anticipated executed components and anticipated future components. The anticipation horizon is equal to one. There is not a constant and trend for simplicity. Then, the model is as follows:

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = A * \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + B * \begin{pmatrix} \tau_t^u \\ \tau_{t,t}^a \\ \tau_{t,t+1}^a \end{pmatrix} + \tag{1.2}$$

$$+C * \begin{pmatrix} g_t^u \\ g_{t,t}^a \\ g_{t,t+1}^a \end{pmatrix} + \begin{pmatrix} \epsilon_t^y \\ \epsilon_t^z \end{pmatrix} \tag{1.3}$$

$$\begin{aligned} \tau_{t,t+1}^a &= d_1^\tau \tau_t^u + \epsilon_{t+1}^\tau \\ g_{t,t+1}^a &= d_1^g g_t^u + \epsilon_{t+i}^g \end{aligned} \tag{1.4}$$

$$\begin{aligned} \tau_{t,t}^a &= \tau_{t-1,t}^a \\ g_{t,t}^a &= g_{t-1,t}^a \end{aligned} \tag{1.5}$$

where $\begin{pmatrix} y_t \\ z_t \end{pmatrix}$ - is vector of endogenous variables, while $\begin{pmatrix} \tau_t^u \\ \tau_{t,t}^a \\ \tau_{t,t+1}^a \end{pmatrix}$ - is vector of exogenous tax hikes (τ_t^u - is unanticipated tax adjustment, $\tau_{t,t}^a$ - anticipated tax adjustment executed in quarter t, $\tau_{t,t+1}^a$ - anticipated tax adjustment which is announced in quarter t and will be executed in quarter $t+1$) and $\begin{pmatrix} g_t^u \\ g_{t,t}^a \\ g_{t,t+1}^a \end{pmatrix}$ - is vector of exogenous expenditure cuts (g_t^u - is unanticipated expenditure adjustment, $g_{t,t}^a$ - anticipated expenditure adjustment executed in quarter t, $g_{t,t+1}^a$ - anticipated expenditure adjustment which is announced in quarter t and will be executed in quarter $t+1$). Matrices $A = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$, $B = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \end{pmatrix}$, $C = \begin{pmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \end{pmatrix}$ are coefficients needed to be estimated. Equations (1.4) capture correlation between the anticipated future component and the unanticipated one. This example is very much simplified since it is also assumes zero correlation between the tax and expenditure components, which is not true in reality. In the real world, correlation between revenue and expenditure sides of fiscal plans are not zero and the interpretation of the effect of simulated shocks are not immediate: an initial correction to expenditure might generate a plan that is much more tax-based than expenditure-based. Favero, Karamysheva (2014) provide a detailed econometric analysis of the fiscal adjustment plan's importance.

I am interested in the effect of exogenous variables on endogenous. After a correct estimation of the coefficients of the matrices A, B, C as well as d_1^τ, d_1^g the simulation of the plans is possible. Taking in to account the assumption of this simplified example about zero correlation between tax and expenditure components of the plans, one can define separately the effects of a pure tax - based plan or an expenditure - based plan. Importantly, there are two effects of the fiscal adjustment plans on endogenous variables. One is direct and goes through the estimated coefficient of the matrices B, C as well as d_1^τ, d_1^g. The other effect is an indirect one, which propagates through the interdependencies of endogenous variables.

Consider the simulation of the tax - based plan in this example: at time t you give a shock to τ_t^u, then using equations (1.4) obtain $\tau_{t,t+1}^a$. As a next step, using equations (1.5) get $\tau_{t+1,t+1}^a$. Since there is no lags of unanticipated and anticipated components of the fiscal adjustment plans, and moreover, the anticipation horizon is equal to one, further propagation goes through the coefficient of matrix A, in other words, it goes through the endogenous variables.

1.4 Estimation and Results

This section presents the estimation technique and the results in the form of impulse response functions. The model I use for estimation is a vector autoregression model with exogenous variables (VARX). The logic of this section proceeds as follows:

First, I do a baseline model, where I compare two channels: monetary policy and uncertainty. Then a counterfactual model check confirms results not only qualitatively but also quantitatively.

1.4.1 VARX - Baseline model with fiscal plans

I do a time series analysis of fiscal plans in the U.S. The baseline model considered in this study is VAR with exogenous fiscal plans (VARX). As was mentioned above it would be great to have a general model, covering different sectors of the economy to see the full set of interdependencies. However, taking into account the feasibility one needs to make a choice. The set of endogenous variables I consider in the baseline model can be limited to the following set of domestic macro variables: real GDP growth, inflation growth, change in three months t-bill rate and proxy for uncertainty: change in BAA-AAA corporate bond spread and change in Economic Policy Uncertainty index. I also estimate a bigger system, appending real consumption growth, real investment growth, results are virtually the same. The behavior of investment growth and output growth very similar. And there is no heterogeneity in response of consumption growth.

$$\begin{aligned}\Delta x_t &= \widetilde{\alpha_0} + \widetilde{\alpha_1} t + \widetilde{B_0(L)}\Delta x_{t-1} + \widetilde{B_1(L)}(\tau_t^u + g_t^u) * EB_t + \\ &+\widetilde{B_2(L)}(\tau_t^u + g_t^u) * TB_t + \widetilde{C_1(L)}(\tau_{t,t}^a + g_{t,t}^a) * EB_t + \quad (1.6)\\ &+\widetilde{C_2(L)}(\tau_{t,t}^a + g_{t,t}^a) * TB_t + \sum_{i=1}^{horz} \widetilde{D_i} * (\tau_{t,i+t}^a + g_{t,i+t}^a) * EB_t + \quad (1.7)\\ &+\sum_{i=1}^{horz} \widetilde{E_i} * (\tau_{t,i+t}^a + g_{t,i+t}^a) * TB_t + \epsilon_t\end{aligned}$$

$$\begin{aligned}(\tau_{t,t+i}^a + g_{t,t+i}^a) * TB_t &= \widetilde{\delta_i^{TB}}(\tau_t^u + g_t^u) * TB_t + \epsilon_{t+i}^1,\ for\ i = \overline{1, horz} \quad (1.8)\\ (\tau_{t,t+i}^a + g_{t,t+i}^a) * EB_t &= \widetilde{\delta_i^{EB}}(\tau_t^u + g_t^u) * EB_t + \epsilon_{t+i}^2,\ for\ i = \overline{1, horz}\end{aligned}$$

where x_t - is a vector of endogenous variables and in the baseline model

$$\begin{aligned}x_t &= [GDP_t, MP, UNC]\\ MP &= [INFL_t, Tbill] \quad (1.9)\\ UNC &= [SPREAD, EPU] \quad (1.10)\end{aligned}$$

τ_t^u - is unanticipated tax adjustment, g_t^u - is unanticipated expenditure adjustment, $\tau_{t,t}^a$ - anticipated tax adjustment executed in quarter t, $g_{t,t}^a$ - anticipated expenditure adjustment executed in quarter t, $\tau_{t,i+t}^a$ - anticipated tax adjustment which is announced in year t and will be executed in year $t+i$, $g_{t,i+t}^a$ - anticipated expenditure adjustment which is announced in quarter t and will be executed in quarter $t+i$.

I set anticipated horizon to six quarters, since it is a median implementation lag, while the length of lag polynomials is three, so in total I consider four quarters because of two reasons: the number of parameters to be estimated and the possibility of error in timing.

This parsimonious specification allows us to identify separately the output effect of tax-based corrections from that of expenditure-based. This is important since the interpretation of the effect of simulating separate shock is not trivial. For example, fiscal adjustment plan, which initially has an expenditure correction in the end may appears to be more tax - based than expenditure - based.

Before estimating the system several preliminary tests must be performed. VAR satisfies the stability condition and no root lies outside of the unit circle. By Hannan-Quinn information criterion and Schwarz information criterion the number of lags is set to one.

Results are in the form of impulse response functions. Bootstrap confidence intervals are obtained by 1000 replications with one standard deviation (68%). I restrict the length of the block to four in order to take into account serial correlation in residuals. Initial shock to TB (EB) plans is set in such a way that the total size of the plan is equal to one percent of GDP, that is in TB case - 0.36, while in EB case - 0.79.

The full sample covers 1978q1–2012q4 period. It includes the period of the Paul Volcker's era or the inflation targeting. The inflation has a peak in 1980q1 and the interest rate (three months tbill rate) has a peak in 1981q3. This time is considered to be a well known structural break. To avoid the results being affected by this break, I cut the sample to the following one: 1983q1 - 2012q4. Moreover, zero low bound, which is also covered by the sample may have an effect on the results either, So, I do a second cut and test the following sample: 1983q1 - 2006q4. The baseline result does not change depending on the sample. All results are available upon request. Here I report the results for the sample period 1983q1 2012q4. Figure **1.3** shows the impulse response functions of the baseline model.

Insert figure 1.3

Output declines in response to tax - based plan and are close to zero in response to expenditure based plan. This evidence goes in the opposite direction of the Keynesian view, under which one would expect a positive reaction of output in response to an increase in spending.

There is no heterogeneity in responses of the monetary variables depending on fiscal plans. However looking at the point estimates, in the case of tax-based fiscal plan there is an increase of both inflation and interest rate in the short run, while in the long run there is a decrease of this variables. As for expenditure - based plans interest rate goes up, while inflation is close to zero.

Both proxies of uncertainty produce a strong heterogeneity in results depending on the fiscal adjustment plans used. There is an increase in BAA -AAA corporate bond spread as well as Economic policy uncertainty index in the medium and long - run after the tax - based plan is introduced, while mild decrease of BAA -AAA corporate bond spread as well as Economic policy uncertainty follows the expenditure - based plan.

1.4.2 VARX - closing one channel at a time

To address the question of how much of the effect is actually going through the variables of interest, I use a counterfactual experiment. To better understand the logic that stands behind the experiment, I first bring an example of the basic methodology of the counterfactual model and then conduct an empirical experiment with the data. The idea of a counterfactual experiment is as follows: one assumes that the full model (without any restrictions) is a true one, counterfactual is an artificial model, *something that has not happened but could, would, or might under differing conditions.*

Bachmann and Sims (2012), for a baseline approach of the counterfactual experiment, fix the economic environment and investigate the hypothetical shock combinations. In other words, first, one needs to place identifying restrictions on the impact matrix, fixing the contemporaneous relations between the variables, after recovering the matrix substitute the structural model with the reduced form by inverting the impact matrix and, finally, putting restrictions in place to create specific statistical shock combinations. However, Bachmann and Sims (2012) show that an alternative approach, which considers two different economies (restricted versus unrestricted) and structurally prevents one variable from responding to another, produces an equivalent result to the baseline model. Considering the method of using the reduced form specification, in the current paper I choose an alternative approach.

Consider simple reduced form VAR(1) model with exogenous variables:

$$\begin{pmatrix} x_t^c \\ y_t^c \\ z_t^c \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} * \begin{pmatrix} x_{t-1}^c \\ y_{t-1}^c \\ z_{t-1}^c \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix} * \begin{pmatrix} \lambda_t^c \\ \mu_t^c \\ \nu_t^c \end{pmatrix} + \begin{pmatrix} \epsilon_t^{x^c} \\ \epsilon_t^{y^c} \\ \epsilon_t^{z^c} \end{pmatrix} \tag{1.11}$$

where $\begin{pmatrix} x_t^c \\ y_t^c \\ z_t^c \end{pmatrix}$ - is vector of endogenous variables, while $\begin{pmatrix} \lambda_t^c \\ \mu_t^c \\ \nu_t^c \end{pmatrix}$ - is vector of exogenous variables. We are interested in the effect of exogenous variables on endogenous. Assume that one needs to isolate the effect of exogenous variables on x^c and y^c, which goes through z^c. There are several ways of doing so. First, I could simply take away z^c at all horizons from the x^c and y^c equations. But this method is quite restrictive in the sense that if another power exists there, different from the vector of exogenous variables that affect x^c and y^c equations, then by doing so I eliminate this effect as well. For example vector of exogenous variables is fiscal policy, but there is also monetary policy, which is not considered in the model and so hides in residuals. Eliminating z^c at all horizons from the x^c and y^c equations misspecifies the system and loses the indirect effect of the monetary policy, that goes through z^c and affects x^c and y^c.

Another way of isolating the effect (the one I use) contains two steps. The first is to make z^c - unresponsive to any exogenous variables, so in the matrix B, put to zero coefficients $b_{31} = 0$, $b_{32} = 0$ and $b_{33} = 0$. One may decide to stop after the first step, since this type of counterfactual model is less subjected to Lucas critique, because only the contemporaneous response of the z^c variable to the exogenous variables is shut down. The economic structure is barely affected by this type of one period change, since it takes time for agents to learn.

$$\begin{pmatrix} x_t^c \\ y_t^c \\ z_t^c \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} * \begin{pmatrix} x_{t-1}^c \\ y_{t-1}^c \\ z_{t-1}^c \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ 0 & 0 & 0 \end{pmatrix} * \begin{pmatrix} \lambda_t^c \\ \mu_t^c \\ \nu_t^c \end{pmatrix} + \begin{pmatrix} \epsilon_t^{x^c} \\ \epsilon_t^{y^c} \\ \epsilon_t^{z^c} \end{pmatrix} \tag{1.12}$$

Another option is to continue and move to a more restrictive case. By the first step I only eliminate the effect at the horizon one, while still the effect could go at different horizons through x^c and y^c. So I need also to put zero coefficient on matrix $A : a_{31} = 0$ and $a_{32} = 0$. Now the system looks as:

$$\begin{pmatrix} x_t^c \\ y_t^c \\ z_t^c \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ 0 & 0 & a_{33} \end{pmatrix} * \begin{pmatrix} x_{t-1}^c \\ y_{t-1}^c \\ z_{t-1}^c \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ 0 & 0 & 0 \end{pmatrix} * \begin{pmatrix} \lambda_t^c \\ \mu_t^c \\ \nu_t^c \end{pmatrix} + \begin{pmatrix} \epsilon_t^{x^c} \\ \epsilon_t^{y^c} \\ \epsilon_t^{z^c} \end{pmatrix} \tag{1.13}$$

So on the one hand I isolate the effect of the exogenous variables on x^c and y^c which goes through z^c, on the other I still maintain the possibility that there is another power that affect x^c and y^c through z^c, since I keep z^c variable in the x^c and y^c equations.

Applying this methodology to the data I compare the effects, using two specifications. The first one keeps channel of uncertainty and risk open, while the second one shuts the channel down. By doing so it is possible to understand how important one channel is from another. I do this exercise for all proxies. The results for both specifications then are plotted in the same graph.

Step one and step two produce virtually the same set of results. So what matters, is an isolation of the channel's variable from exogenous variables. I report in the paper the results from the first step only[10].

Figures **1.4, 1.5** demonstrate the effect of fiscal adjustment plans in case the channels of uncertainty are shut down. Once corporate bond spread channels is closed, the heterogeneity of results disappears. Closing economic policy uncertainty does not influence response of output to fiscal adjustment plans. Therefore between the two, consistently with Gilchrist, Sim and Zakrajsek (2012) uncertainty reflecting financial market distortions plays more important role for the heterogeneity of the results.

Insert figure 1.4,1.5

Closing monetary policy channel does not change the response of output, which figure **1.6** demonstrates. This suggests that monetary policy can not be fully responsible for the heterogenous output effects of fiscal adjustment plans.

Insert figure 1.6

[10]Results from the second step can be available upon request.

Next, I close all the channels at the same time and the result is similar to the one, when I close the spread channel only[11]. The conclusion one may draw is that an indirect effect of fiscal adjustment plans on output growth that goes through uncertainty reflecting financial market distortions is an important one. However there is also a direct effect playing an important role.

1.5 Uncertainty through the lenses of a DSGE model

In this section, I investigate whether a DSGE model can produce results that are consistent with those obtained, empirically, in the first part of the paper. Taking a DSGE model of Croce et al. (2012) as a benchmark, mostly keeping their parameter specification and calibration, I modify the government part of the model, introducing a fiscal rule and allowing the government to use both taxes and expenditures as fiscal instruments to deal with the government debt. Using data simulated from the general equilibrium model, I show that fiscal consolidation that is based on tax hikes leads to a higher equity risk premium relative to the one based on expenditure cuts.

It is important to see what will be an effect of a particular government fiscal policy on the decisions made by the household and the firm. It is worth noticing that in the current DSGE model, equity risk premium is a premium of equity over the bonds both issued by the firm and by the government, since there is an assumption that in the equilibrium there is no default, so bonds issued by the firm have the same interest rate as the ones issued by the government and are considered to be risk-free. Tax increase play two side effects on the financial decisions of the firm. On the one hand, with a tax increase a firm will prefer to finance itself with more debt, since there are benefits coming from the tax shield; on the other hand, increase in taxes will distort future corporate profit, which in turn will decrease the collateral value of the firm, making the debt more costly. At a certain point the cost of the debt will overcome the benefits and firms will start to deleverage, decreasing the amount of debt. To maintain the value of the firm, it needs to increase equity. This is not always a good sign, so at some point the firm may prefer to decrease in value and not undertake a new investment project.

$$\begin{aligned} if\ Debt &\downarrow \quad , then\ Lev = \frac{Debt}{Equity} \downarrow \\ Value &= Debt + Equity \end{aligned} \tag{1.14}$$

A drop in average investment will decrease the possibility of hedging against the exogenous shocks, which in turn will decrease the opportunity for a consumption smoothing, causing the equity risk premium to increase.

[11] Result can be available upon request.

From the demand perspective, higher taxes induce higher risk in the long run and a higher stochastic discount factor. Under the assumption of the early resolution of uncertainty, the household will move the demand towards safer assets "fly to quality phenomenon," choosing the safer assets to hedge themselves against negative shock. Increase of bond demand will decrease the interest rate for bonds and increase the equity risk premium.

Cutting expenditures may be considered as an expected decrease in taxes in the future, or at least no increase in taxes, under the assumption that one type of government expenditure alters the real economy through expected future taxes. From the firm's perspective, on the one hand less tax shield is expected in the future, which will shift the supply of bonds toward equity. While from the agent's perspective an expenditure cut, which is expected to cause a future decrease in taxes, leading to a decrease in long-run productivity risk, will make the agent more confident, causing him to shift demand from bonds (less risky assets) towards equity, decreasing the cost of equity and reducing the equity risk premium.

1.5.1 Government

Croce et al. (2012) offer a production-based economic model to study the asset pricing effects of fiscal policy. Importantly, the risk generated by exogenous expenditure shocks can be either mitigated or exacerbated depending on the policy chosen by the government. Croce et al. (2012) find out that the use of fiscal policy to stabilize short-run consumption growth may generate welfare cost, while fiscal policy applied to stabilize long-run dynamics generates a welfare benefit. Observed effects are created by incorporating two important features into the model. First, it is necessary to have a special form of utility, in particular the Epstein-Zin utility function, which allows the agent to have a preference for timing of uncertainty resolution. The second feature is financial friction, such as financial distress costs and debt adjustment cost, since it causes a levered return to be exposed to aggregate risk and capital accumulation to be sensitive to the long-run risk.

Croce et al. (2012) consider exogenous expenditure shocks, they left the government to operate only with the tax fiscal instrument; however, the government is also allowed to have deficit and debt.

Nowadays, taking into account the debate around fiscal consolidation it is crucial to understand which kind of fiscal policy is better to apply and what are the reasons and consequences of such a different effect on real economy of tax based and expenditure based fiscal policy. So it is crucial to allow the government to have both fiscal instruments: taxes and expenditures.

Following Erceg and Linde (2013), I permit the government to adjust spending or taxes in response to the shock, which moves the debt-output ratio and/or the deficit away from the target path. The debt - output target follows AR(2) process:

$$b^*_{Gt+1} - b^*_{Gt} = \rho_{d_1}(b^*_{Gt} - b^*_{Gt-1}) - \rho_{d_2} b^*_{Gt} + \epsilon_{b^*,t} \tag{1.15}$$

which captures gradual adjustment and avoids large negative effect on output. $\epsilon_{b^*,t}$ - is a white noise $N(0, \sigma_{\epsilon_{b^*,t}})$. Importantly, the process should be stationary to allow for the debt target to converge to the steady state level. If the process is an AR(2):

$$x_t^{AR(2)} = \alpha^{AR(2)} + \varphi_1^{AR(2)} x_{t-1}^{AR(2)} + \varphi_2^{AR(2)} x_{t-2}^{AR(2)} + \nu_t^{AR(2)}$$

then conditions for stationarity are the following:

$$\begin{aligned} \varphi_1^{AR(2)} + \varphi_2^{AR(2)} &< 1 \\ \varphi_2^{AR(2)} - \varphi_1^{AR(2)} &< 1 \\ |\varphi_2^{AR(2)}| &< 1 \end{aligned}$$

For the above-mentioned AR(2) process this will mean:

$$\begin{aligned} \rho_{d_2} &> 0 \\ 0 &\leq \rho_{d_2} < 1 \end{aligned}$$

Obviously there is no sense in using this equation in the theoretical model, if in reality the target never exists or if it exists but only for the short sample period or for only the different country. This is not the case and the targets not only exist in history but also they are changing through time. For example, in Europe The Maastricht Treaty, signed in February 1992 and entered into force on 1 November 1993, contains the 5 convergence criteria EU member states are required to fulfill to adopt the new currency, the euro. Specifically, the ratio of the annual general government deficit relative to GDP at market prices must not exceed 3% at the end of the preceding fiscal year. While the ratio of gross government debt (measured at its nominal value outstanding at the end of the year and consolidated between and within the sectors of general government) relative to GDP at market prices, must not exceed 60% at the end of the preceding fiscal year.

As for United States, there are plenty of examples where the target is not only introduced, but also revised. For instance, the Balanced Budget and Emergency Deficit Control Act of 1985 put as a deficit target for 1988 - 108 bl of \$, for 1989 - 72 bl of \$, for 1990 - 36 bl of \$; while the Balanced Budget and Emergency Deficit Control Reaffirmation Act of 1987 made a revision of this target, for example, for 1988 - 144 bl of \$, for 1989 - 136 bl of \$, for 1990 - 100 bl of \$ (according to CBO Statutory Budget Controls in Effect Between 1985 and 2002, July 1, 2011). OBRA - 1990 target was offered to reduce the deficit by cumulative U.S.\$500 billion (equivalent to 8.5 percent of 1991 GDP) within a period of 1991–95, while OBRA - 1993 target was offered to reduce the deficit by 1.75 % of GDP, relative to the no-policy-change baseline, by 1998.

Following Erceg, Linde (2013) I define taxes and expenditures by the following equations:

$$
\begin{aligned}
g_t &= \nu_{g0} g_{t-1} + (1-\nu_{g0})[\nu_{g1}(b_{Gt} - b^*_{Gt}) + \nu_{g2}(\Delta b_{Gt+1} - \Delta b^*_{Gt+1})] \\
\tau_t &= \nu_{\tau 0} \tau_{t-1} + (1-\nu_{\tau 0})[\nu_{\tau 1}(b_{Gt} - b^*_{Gt}) + \nu_{\tau 2}(\Delta b_{Gt+1} - \Delta b^*_{Gt+1})]
\end{aligned}
\tag{1.16}
$$

where g_t, τ_t is expressed in the percent deviation from steady state level, b_{Gt} is the ratio of nominal debt to steady state (or"trend") of nominal GDP, and b^*_{Gt} is the debt/GDP ratio target .

$$
\begin{aligned}
b_{Gt} &= \frac{B^G_t}{Y_t} \\
b^*_{Gt} &= \frac{B^{G*}_t}{Y_t}
\end{aligned}
\tag{1.17}
$$

the above stated equations simply show that future spending (taxes) will consist of two parts: first coming from the past spending (taxes) and second coming if the debt or deficit deviates from the target.

To confirm the empirical findings from the previous section, ideally one would like to have the same fiscal measures as in the empirical model. On the other hand, the work with theoretical model gives more flexibility. In fact, in working with the empirical reduced form model two conditions must be satisfied, namely, exogenous policy actions and experiments that do not change the correlation in the data used to estimate the parameters in the empirical model. Only the simulation of exogenous plans meets these two conditions, while the theoretical model creates multi - scenario experiments. In other words, the theoretical model allows under first scenario to have fiscal plans, while under the second scenario, one might have only changes in taxes (expenditures), setting some of the coefficients to zero or under third scenario one might have a mixed strategy, with changes both in taxes and expenditures. To work with fiscal plans, one needs to consider both intertemporal and intratemporal dimensions, and so include into the model both unanticipated and anticipated components as well as taxes and expenditures. Intertemporal dimension is possible to make by including the expectation in the model. To start simply I use only the intratemporal dimension and do several experiments in this direction: taxes only, expenditures only and a mixed strategy. The model can be extended further by also including intertemporal dimension of the plan.

The budget constraint of the government is a standard one:

$$
B^G_t = (1 + r_{f,t-1}) B^G_{t-1} + (g_t - \tau_t)(Y_t - W_t H_t - B_{t-1} r_{f,t-1}) \tag{1.18}
$$

Growth rate of productivity is an important element of the model needed to be determined. Croce et al. (2012) impose a condition, relying on the previous empirical findings by Lee and Gordon (2005); Djankov et al. (2010), as well as on the endogenous growth model by Croce et al. (2011), supporting the idea that an increase in taxes reduces long-run growth.

Barro (1990) in the endogenous growth model, extended with the tax financing government services, affecting production or utility, finds that an increase in utility expenditures leads to a fall of growth rate, meanwhile an increase in production expenditure leads initially to an increase in growth rate, followed by the fall. At the same time Alesina et al. (2002) using the q theory (Andrew B. Abel and Blanchard (1986) - this theory provides a standard framework that highlights the central role of profits as a determinant of investment) and the panel of eighteen OECD countries show that an increase in public spending will increase labor cost and profit, which in turn will decrease investment, and an increase in taxes leads to a decrease in profit and investment; however, much less than in the case of expenditures. So the conclusion they draw is that an increase in growth after fiscal stabilization is explained mainly by expenditure cuts (especially in government wage and transfers), while the decrease in growth is due to tax increases. Relying on the above-mentioned theoretical and empirical findings, I assume that productivity growth is affected by deviation of tax and spending rate from the unconditional mean. I use the following condition for productivity growth:

$$\begin{aligned} \Delta z_t &= \mu + \varphi_\tau(\tau_{t-1} - E(\tau_t)) + \varphi_g(g_{t-1} - E(g_t)) + \epsilon_t \\ \epsilon_t &\sim N(0, \sigma_\epsilon^2), \qquad corr(\epsilon_{\tau^* t}, \epsilon_t) = 0, \quad \varphi_\tau \leqslant 0, \varphi_g \geqslant 0 \end{aligned} \tag{1.19}$$

with the φ_τ being negative and φ_g being positive.

1.5.2 Household

The agent has Epstein and Zin (1989) preferences:

$$U_t = \{(1-\beta)C_t^{1-\frac{1}{\psi}} + \beta(E_t[U_{t+1}^{1-\gamma}])^{\frac{1-\frac{1}{\psi}}{1-\gamma}}\}^{\frac{1}{1-\frac{1}{\psi}}} \tag{1.20}$$

where γ - is a coefficient of relative risk aversion and ψ - is elasticity of intertemporal substitution. Under the assumption that $\psi > \frac{1}{\gamma}$, the agent has a preference for earlier resolution of uncertainty, consistent with the Bansal and Yaron (2004), which ensures that the agent dislikes uncertainty in the future (for example, uncertainty about the long run productivity growth). β - is a discount factor and E_t is the expectation operator conditional on information available at time t. C_t is a consumption of the agent. Under assumption of no disutility of working and fixed working hours, H_t is normalized to one. The stochastic discount factor is

$$M_{t+1} = \beta(\frac{C_{t+1}}{C_t})^{-\frac{1}{\Psi}} \left(\frac{U_{t+1}}{E_t[U_{t+1}^{1-\gamma}]^{\frac{1}{1-\gamma}}} \right)^{\frac{1}{\Psi}-\gamma} \tag{1.21}$$

The optimization problem of the household is the maximization of the utility function, subjected to the following budget constraint:

$$C_t + S_t P_t + B_t^{tot} \leq (1 + r_{f,t-1}) B_{t-1}^{tot} + S_{t-1}(D_t + P_t) + W_t H_t + TR_t \tag{1.22}$$

where

$$B_t^{tot} = B_t + B_t^G \tag{1.23}$$

where B_t - is corporate bonds, B_t^G - is government bonds and B_t^{tot} - is the total number of bonds, the price of which is normalized to one. All the bonds are considered to be risk-free. S_t - is number of stocks (equity shares), P_t - is an ex-dividend price of the stock (so excluding dividends). D_t - is equity payout, W_t is wage and there is an assumption that collected taxes are spent for TR_t - lump sum transfer from the government to the household: $TR_t = g_t(Y_t - W_t H_t - r_{f,t-1} B_{t-1})$.Following Alesina, Barbiero, Favero, Giavazzi, Paradisi (2013) and in order to be realistic, I consider the taxes as corporate direct taxes and expenditures as transfers.

Under the assumption that in equilibrium there is no default, corporate bonds pay $r_{f,t-1}$ - which is a short-term risk free rate. The choice variables for the agent are $C_j, H_j, S_j, B_j, B_j^G$, for $j = \overline{t, \infty}$.

The absence of arbitrage in the markets where investors can trade without transactions costs guarantees the existence of a positive stochastic discount factor. Completeness of the market guarantees the uniqueness of the stochastic discount factor.

$$\begin{aligned} 1 &= E_t[M_{t+1} \frac{P_{t+1} + D_{t+1}}{P_t}] \\ r_{f,t} &= \frac{1}{E_t[M_{t+1}]} - 1 \end{aligned} \tag{1.24}$$

where $\frac{P_{t+1}+D_{t+1}}{P_t}$ is a return.

1.5.3 Firm and Financial Frictions

In the optimization problem the firm has to maximize the shareholder's wealth, $P_t + D_t$,

where P_t - is the price per share, excluding dividends, D_t - is the equity payout. In case of negative D_t firm issue equity in period t. The maximization problem of the firm is the following:

$$
\begin{aligned}
V_t &= \max_{\{D_j, I_j, H_j, K_j, B_j\}_{j=t}^{\infty}} E_t[\sum_{j=t}^{\infty} M_{j|t} D_j] \\
D_t &\leq Y_t - W_t H_t - T_t - I_t + B_t - (1 + r_{f,t-1}) B_{t-1} - C_t^B - C_t^E \qquad (1.25) \\
K_t &\leq (1-\delta) K_{t-1} + \phi(\frac{I_t}{K_{t-1}}) K_{t-1}, \quad (q_t - is\ multiplier)
\end{aligned}
$$

where Y_t - is output and production function is a standard Cobb–Douglas production function:

$$Y_t = (Z_t H_t)^{1-\alpha} K_{t-1}^{\alpha} \qquad (1.26)$$

K_t - is a capital stock, I_t - is investment, T_t - corporate taxes, which is $T_t = \tau_t(Y_t - W_t H_t - r_{f,t-1} B_{t-1})$

There are several features that need to be discussed. First, the capital flow constraint introduced with an adjustment cost. Literature still debates about which type of the capital adjustment cost to use: convex, which could be symmetric and asymmetric, fixed or quasi-fixed, or a proportional (linear for investment and disinvestment, but with the different slopes) adjustment cost. Cooper (2006) finds that by using the fixed adjustment cost and partial investment irreversibility, that the value premium (value stock over the growth stock) is driven mainly by the irreversibility of investment and not fixed adjustment costs. Jermann (1998) concludes that capital adjustment cost is necessary to make it more costly for the households to smooth the consumption by changing capital stock, causing consumers to take more risk. Without this cost, the price of capital would never change since the supply would be perfectly elastic and always equal to one.

Both Croce et. al (2012) and Jermann (1998) demonstrate that the introduction of this cost allows us to match equity return dynamics and high risk premium. Gilchrist et al. (2013), using fixed adjustment cost and partial irreversibility, show that higher irreversibility leads to higher book-market ratio and in distress such a firm will be subjected to higher risk. In the case of both convex and constant, non-convex with partial irreversibility investment costs generate risk, since under distress the firm with a high book to market ratio or high irreversibility may not sell easily.

Following Jermann (1998) and Croce et. al (2012) I introduce the cost of (net) investment (investment over and above what is necessary to replace depreciated capital) which has the following shape

$$\phi(\frac{I_t}{K_{t-1}}) = \frac{\alpha_1}{1 - 1/\xi}(\frac{I_t}{K_{t-1}})^{(1-1/\xi)} + \alpha_2 \qquad (1.27)$$

There are several of Jermann's (1998) assumptions that need to be taken into account: adjustment cost function is additively separable from the production function. The properties of a function such as $\phi'(\cdot) > 0$, $\phi''(\cdot) \geqslant 0$ reaches a minimum value for some positive constant, in particular for the Jermann (1998) it is gross growth rate of capital and in the growing economy it is higher than one. This functional form captures the fact that if the firm has a lot of capital, then the cost of net investment will be higher than for the case of a smaller amount of capital. Also, the marginal adjustment cost is negative for small positive rates of net investment. Parameter ξ states for elasticity of investment adjustment cost. Coefficients α_1 and α_2 are set to yield the same steady-state properties.

Moreover, there are financial distress cost and debt adjustment cost introduced by Croce et al. (2012). The financial distress cost could be modeled in different ways. But, if one would like to capture the costs associated with financial leverage outside of bankruptcy, this can be done through the following functional forms, following Croce et al. (2012):

$$C_t^E = \phi_0 e^{-\phi_1(\frac{\eta K_t}{B_t}-1)} Z_{t-1} \tag{1.28}$$

where η, ϕ_1, ϕ_0 are positive constants and ϕ_1 is an intensity of the distress cost and η - liquidation value of the collateral as a fraction of its book value (debt to book ratio).

While in Glover et al. (2011) - financial leverage outside of bankruptcy is:

$$C_t^E = \frac{1}{\pi}\left(\frac{B_t}{K_t}\right)^{\pi} \tag{1.29}$$

I keep the functional form of Croce et al. (2012) financial distress cost. It is important to keep in mind that the formulation of the distress cost of this type serves for the purpose of convexifying the non-binding constraint:

$$B_t \leq \eta K_t \tag{1.30}$$

and in reality introduces an endogenous default into the model. C_t^E may appear in the highly-levered firms, when finding a new lender is more difficult and requires more time, effort and is more costly. C_t^E is the reason why the firm does not issues an infinite amount of debt even in the situation without default in equilibrium. Following Croce et al. (2012) I introduce debt adjustment cost in the following form:

$$C_t^B = \nu(\frac{B_t}{Y_t} - \frac{B_{ss}}{Y_{ss}})^2 Z_{t-1} \tag{1.31}$$

where ν - is an intensity of debt adjustment cost. This cost is counter-cyclical and makes the issuance of the debt to be pro-cyclical.

Under the assumption that spending is lump sum transfer, market clearing is:

$$Y_t = C_t + I_t - C_t^E - C_t^B \tag{1.32}$$

while under the assumption that spending is simply a waste, market clearing condition is the following:

$$Y_t = C_t + I_t + g_t(Y_t - W_t H_t - r_{f,t-1}B_{t-1}) - C_t^E - C_t^B \tag{1.33}$$

1.5.4 Calibration

There are two exogenous shocks in the model. The first one is the debt-to-GDP ratio target and the second one is a productivity shock. The sample period of the data is 1930 - 2012, and as an additional check, the sample can be cut to be consistent with an empirical part of the model to the one of 1978 - 2012.

Variables & Structural Parameters are available in tables

1) the endogenous variables: $Y_t, C_t, I_t, K_t, H_t, W_t, B_t, B_t^G, D_t, C_t^B, C_t^E,$
$M_t, V_{d,t}, r_{f,t}, r_{b,t}, r_{d,t}, \tau_t, g_t, R_{I,t}$

2) the endogenous states at time t: $Z_{t-1}, Z_t, \tau_t, g_t, K_{t-1}, B_{t-1}$

3) the exogenous states: $b^*_{Gt} = \frac{BG^*_t}{Y_t}$ (driven by AR(2)), $\Delta z_t \equiv \log(Z_t) - \log(Z_{t-1})$

4) the exogenous shocks: $\varepsilon_{b^*,t}, \varepsilon_t$

Parameters of the model can be split into several sets. The first one is the set of standard RBC model parameters, which I am not planning to change: depreciation rate and capital share. The discount factor will be also the standard one.

While the parameters of the average productivity growth μ, short-run productivity volatility σ_ϵ, long-run risk tax exposure φ_τ, long-run risk spending exposure φ_g is estimated using the real data for taxes and expenditures and the productivity growth is computed as a Solow residual. Of course, depending on the type of spending (whether it is simple waste or lump sum transfers or salaries of government employees or total expenditures, etc.) and taxes (whether it is income or corporate taxes) the estimated parameters will be different. To be as close as possible to the reality and using the classification of fiscal consolidation of Alesina, Barbiero, Favero, Giavazzi and Paradisi (2013), for the US case all the tax changes are done through the increase of the direct component (income, corporate, capital gain, property, etc.), while the indirect component (VAT, sales tax, services tax, transaction tax, etc.) is left as unchanged. On the expenditure side, the majority of the changes made are on the component of transfers (money provision made by the government without expecting a direct economic gain, such as subsidies, grants, other social benefits), while there were also changes in the consumption and investment component of the government expenditures; in other words, everything which is not considered as a public transfer. For the basic specification of the model I consider the corporate taxes as direct taxes and expenditures as transfers. As an additional check it is possible to substitute the transfer component of expenditures with the consumption and investment component. Of course, this modification will also affect the market clearing condition and the budget constraint of the household.

The other parameters widely debated in the literature are the Epstein-Zin preference parameters: risk aversion γ and intertemporal elasticity of substitution Ψ. The important assumption I make is that the agent has a preference for the earlier resolution of uncertainty, so in terms of parameters the following inequality should be satisfied:

$$\gamma > \frac{1}{\Psi}$$

Taking commonly-used combinations of these parameters in the literature and combining them with the above-mentioned inequality, one can get the following set of the pares of the parameters to be used:

Ψ / γ	0.5	1	2
1	–	–	$\surd$
5	$\surd$	$\surd$	$\surd$
10	$\surd$	$\surd$	$\surd$
40	$\surd$	$\surd$	$\surd$
100	$\surd$	$\surd$	$\surd$

To show the importance of the financial frictions, first I eliminate them by setting the financial friction parameters to zero. Then, following the commonly-used approach in the literature, I set the elasticity of investment adjustment cost ξ by answering the question of how big adjustment cost would be in order to reproduce the relative volatility of investment. Intensity of debt adjustment cost ν, following Croce et al. (2012) is set to match volatility of investment. The debt to book ratio η or the leverage parameter is consistent with the U.S. data and set under the condition that the liquidation value of the collateral η less than $1-\delta$, which means that distress capital is sold at a discount:

$$\eta < 1-\delta$$

One can do a check using the functional form by Glover et al. (2011) and setting parameter π to 3.5.

Insert the Table 5 (Parameters Values)

The parameters for preferences and technology are standard for long - run risk and real business cycle literature. Parameters for the debt-to-GDP ratio target are set to $\rho_{d_1} = 0.935$ $(0 \leq \rho_{d_1} < 1)$ and $\rho_{d2} = 0.0001$ $(\rho_{d2} > 0)$ following Erceg, Linde (2013), which reaches half of the convergence to the new long - run debt target after three years and fully after ten years. $\nu_{g0} = \nu_{\tau 0} = 0.5$ are set following Erceg, Linde (2013) to allow the convergence of the debt to GDP ratio to a new target after three years, while , $\nu_{\tau 1}, \nu_{g1}, \nu_{\tau 2}, \nu_{g2}$ are chosen in such a way that in the long-run g_t (τ_t) decreased (increased) by 0.5% and 0.25% of trend GDP in response to 1% deviation from the debt and deficit respectively.

Data for the calibration is available in the table 4.

Insert the Table 6 (Theoretical Model Variable's Definitions and Sources)

1.5.5 Intuition of the model mechanism

Suppose that there is a shock to the fiscal target, causing the debt-to-GDP ratio to deviate from the previous optimum level. One can think about the fiscal target as in terms of the Taylor rule for monetary policy. So, government would like to approach new target. Realistically, government may not want to reach the target in one step. So, it will change the debt-to-GDP ratio gradually, using the available fiscal instruments. In the framework of the theoretical model it is possible to run different experiments. For now, I will focus on extreme solutions, such as that the government may choose either to close the gap only by increasing taxes or only by cutting expenditures. Later on I will look at the mixed strategies.

It is important to see what will be an effect of a particular government fiscal policy on the decisions made by both the household and the firm. It is worth noticing that in the current DSGE model equity risk premium is a premium of equity over the bonds both issued by the firm and by the government, since there is an assumption that in the equilibrium there is no default and so bonds issued by the firm have the same interest rate as the ones issued by the government and are considered to be risk free. A tax increase has two side effects on the financial decisions of the firm. On the one hand, with a tax increase the firm will prefer to finance itself with more debt, since there are benefits coming from the tax shield. On the other hand, an increase in taxes will distort future corporate profit, which in turn will decrease the collateral value of the firm, making the debt more costly. At a certain point, the cost of debt will overcome benefits and firms will start to deleverage, decreasing the amount of debt. To maintain the value of the firm the same the firm needs to increase equity, which is not always a good sign, so at some point the firm may prefer to decrease its value and not undertake a new investment project.

$$\begin{aligned} if\ Debt\ &\downarrow\ \ , then\ Lev = \frac{Debt}{Equity}\downarrow \\ Value\ &=\ Debt + Equity \end{aligned} \tag{1.34}$$

A drop in average investment will decrease the possibility of hedging against the exogenous shocks, which in turn will decrease the opportunity for a consumption smoothing, causing the equity risk premium to increase.

From the demand perspective, higher taxes induce higher risk in the long run and a higher stochastic discount factor; under the assumption of the early resolution of uncertainty, the household will move the demand towards safer assets, known as the "fly-to-quality phenomenon," choosing the safer assets to hedge itself against negative shock. An increase in bond demand will decrease the interest rate for bonds and increase the equity risk premium.

Cutting expenditures may cause the expectation of a decrease in taxes in the future, or at least no increase in taxes, under the assumption that one type of government expenditures alters the real economy through expected future taxes. From the firm's perspective, less tax shield is expected in the future, which will shift the supply of bonds towards the equity. From the agent's perspective an expenditure cut, which is expected to cause a future decrease in taxes, and therefore decrease in long run productivity risk, will make an agent be more confident, causing him to shift demand from bonds (less risky assets) towards equity, decreasing cost of equity and reducing equity risk premium.

1.5.6 DSGE model results

The main take-away of the empirical results of this paper is that risk (risk premium), proxied by BAA-AAA corporate bond spread, increases in the case of tax-based fiscal plans and decreases in the case of expenditure-based fiscal plans. The results for uncertainty are ambiguous in the tax-based case, depending on the proxy I use, while uncertainty decreases consistently in the expenditure-based case. Preliminary checks, done through truncated MA representation, shows that the heterogeneity in output response is mainly due to investment and not consumption and net export. Consumption, investment and net export growth increases when expenditure-based policy is applied. In the tax-based case the effect is insignificant and weak for the consumption and net export growth, while investment drops significantly[12].

The idea of this section is to see what will happen with the same economic variables using the simulated data from the DSGE model. Results demonstrate the mapping of the exogenous productivity shock and exogenous shock to fiscal policy target into the endogenous response of taxes, expenditures, consumption and investment growth. I solve the model by using the second order approximation in Dynare 4.4.2. The results from the DSGE model are mainly consistent with the empirical findings.

Figure 1.7 presents the impulse response functions for an exogenous productivity shock and an exogenous shock to fiscal policy target. Panel B of figure 1.7 compares the effects of a 20% reduction in the desired long-run debt target done either through expenditure cuts or tax hikes. So, giving a 1% target shock and setting the parameters for the debt-to-GDP ratio target to $\rho_{d_1} = 0.935$ $(0 \leq \rho_{d_1} < 1)$ and $\rho_{d2} = 0.0001$ $(\rho_{d2} > 0)$ following Erceg and Linde (2013), one may get a convergence to the new long - run debt target after three years and fully after ten years. In the baseline simulations I use extreme cases of fiscal policy, so that government is left out with just one fiscal instrument at a time: either taxes or expenditures. This can be easily done through forcing some of the fiscal

[12] Additional results are available upon request.

rules parameters to zero:

$$\begin{aligned} g_t &= \nu_{g0} g_{t-1} + (1-\nu_{g0})[\nu_{g1}(b_{Gt} - b^*_{Gt}) + \nu_{g2}(\Delta b_{Gt+1} - \Delta b^*_{Gt+1})] \\ \tau_t &= \nu_{\tau 0} \tau_{t-1} + (1-\nu_{\tau 0})[\nu_{\tau 1}(b_{Gt} - b^*_{Gt}) + \nu_{\tau 2}(\Delta b_{Gt+1} - \Delta b^*_{Gt+1})] \end{aligned} \tag{1.35}$$

In the case of taxes (expenditures) I set $\nu_{g1} = 0$ ($\nu_{\tau 1} = 0$) and $\nu_{g2} = 0$ ($\nu_{\tau 2} = 0$), which means that government will not change expenditures (taxes) in response to the deviation from the debt or deficit targets.

Insert figure 1.7

Comparing two extreme policies, one may easily see that consumption growth in the short run for the expenditure-based case is relatively lower than for tax-based policy, while in the long run there is a reverse. Investment growth increases in the expenditure-based case relative to tax-based policy.

Figure 1.8 shows the moments from the DSGE model. The key moment is annualized equity return or equity risk premium. From the upper panel of figure 1.8 it is easy to see that in the tax-based case, risk premium is higher than that of the expenditure-based policy. I also compute the welfare cost, which is "the percentage of lifetime consumption that the agent would be willing to give up to live in an economy without this sort of tax smoothing." Following Croce et al. (2012) this may be accomplished by comparing the utility steady-states of two separate economies under two different fiscal regimes, namely, tax-based economy versus expenditure-based economy. Consistently, my results yielded higher welfare cost in the tax-based economy relative to the expenditure-based economy. The rest of the moments are short-run and long-run volatility of the consumption growth and investment growth.

Insert figure 1.8

1.6 Conclusion

I investigate two potential channels of the heterogeneous output effects of fiscal adjustment plans: uncertainty and monetary policy. I find that uncertainty proxied by corporate bond spread increase significantly as a reaction to the tax-based fiscal adjustment plans. Moreover, uncertainty decreases in the case of expenditure-based fiscal adjustment plans. The baseline model I use is a vector autoregression with exogenous variables (VARX). Fiscal adjustment plans are identified through a narrative approach. The use of plans creates more realistic conditions for estimating fiscal policy effects. I also study the quantitative side of the effects by closing channels. Finally, I investigate whether my empirical results are consistent with the simulation of a general equilibrium model.

1.7 References

Alesina, A., Barbiero, O.,Favero, C., Giavazzi, F. and M. Paradisi, "The Output Effect of Fiscal Adjustment Plans: Disaggregating Taxes and Spending," 2015, working paper.

Alesina, A., Favero, C., & Giavazzi, F. (2012). The output effect of fiscal consolidations (No. w18336). National Bureau of Economic Research.

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

Bachmann, R., & Sims, E. R. (2012). Confidence and the transmission of government spending shocks. Journal of Monetary Economics, 59(3), 235-249.

Baker Scott R., N. Bloom, S. J. Davis, (2013), "Measuring Economic Policy Uncertainty", working paper - papers.ssrn.com

Baker Scott R., N. Bloom, (2012), "Does Uncertainty Reduce Growth? Using Disasters as Natural Experiments", Stanford University Working Paper (Palo Alto, California)

Bakshi, G., N. Kapadia and D. Madan, (2003), "Stock Return Characteristics, Skew Laws, and Differential Pricing of Individual Equity Options" Review of Financial Studies, Vol. 16 (1), pp. 101-143.

Bekaert, G. and E. Engstrom (2010). "Asset Return Dynamics under Bad Environment-Good Environment Fundamentals" working paper, Columbia GSB.

Bekaert, G., E. Engstrom, and Y. Xing, (2009), "Risk, Uncertainty, and Asset Prices," Journal of Financial Economics 91, pp. 59-82.

Bekaert, G., M. Hoerova, M. Lo Duca (2012) "Risk, Uncertainty and Monetary Policy", working paper

Blanchard, Olivier and R. Perotti (2002), "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output", Quarterly Journal of Economics 117.4: 1329-1368.

Bloom, Nick. (2009): "The Impact of Uncertainty Shocks," Econometrica, 77, pp. 623-685

Bloom, N., M. Floetotto, N. Jaimovich, I. Saporta and S. Terry, (2011), "Really Uncertain Business Cycles," Mimeo, Stanford.

Bollerslev, T., M. Gibson, and H. Zhou. (2011), "Dynamic Estimation of Volatility Risk Premia and Investor Risk Aversion from Option-implied and Realized Volatilities". Journal of Econometrics 160, pp 235-245.

Bollerslev, T., G. Tauchen and H. Zhou, (2009), "Expected Stock Returns and Variance Risk Premia," Review of Financial Studies, Vol. 22, No. 11, pp. 4463-4492.

Caceres, C., V. Guzzo, and M. Segoviano, 2010, "Sovereign Spreads: Global Risk Aversion, Contagion or Fundamentals?" IMF Working Paper 10/120 (Washington: International Monetary Fund).

Caldara, Dario, and Christophe Kamps. The Analytics of SVARs: A Unified Framework to Measure Fiscal Multipliers. Division of Research & Statistics and Monetary Affairs, Federal Reserve Board, 2012.

Chicago Board Options Exchange, (2009) "The CBOE volatility index–VIX", White Paper.

Coudert, V. and M. Gex (2008). "Does Risk Aversion Drive Financial Crises? Testing the Predictive Power of Empirical Indicators," Journal of Empirical Finance 15, pp. 167-184.

Devries P., J. Guajardo, D. Leigh, A. Pescatori, (2011), "A New Action-based Dataset of Fiscal Consolidation", IMF Working Paper: 1-90.

Drechsler, I. and A. Yaron (2011). "What's Vol Got to Do with It," Review of Financial Studies 24(1), pp. 1-45.

Favero, C., & Giavazzi, F. (2012). Measuring tax multipliers: The narrative method in fiscal VARs. American Economic Journal: Economic Policy, 4(2), 69-94.

Figlewski, S., (2008), "Estimating the Implied Risk-Neutral Density of the U.S. Market Portfolio, Volatility and Time Series Econometrics" (eds. T. Bollerslev, J. Russell, and M.Watson), Oxford University Press.

Glover, B., Gomes, J. F., & Yaron, A. (2011). Corporate Taxes, Leverage, and Business Cycles. Society for Economic Dynamics.

Guajardo, J., Leigh, D., & Pescatori, A. (2014). Expansionary austerity? International evidence. Journal of the European Economic Association, 12(4), 949-968.

Kilian L., Y.J. Kim (2011). How Reliable Are Local Projection Estimators of Impulse Responses? Review of Economics and Statistics, 93(4), November 2011, 1460-1466.

Laubach T., (February, 2011), "Fiscal Policy and Interest Rates: The Role of Sovereign Default Risk", working paper

Mertens, K., Ravn, M. O. (2011). Understanding the aggregate effects of anticipated and unanticipated tax policy shocks. Review of Economic Dynamics, 14(1), 27-54.

Mertens, Karel and Morten O. Ravn, 2012a, "Empirical Evidence on the Aggregate Effects of Anticipated and Unanticipated U.S. Tax Policy Shocks", American Economic Journal: Economic Policy, 4(2), pp.145-181.

Mertens, Karel and Morten O. Ravn, 2012b, "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States", American Economic Review, forthcoming.

Mertens, K., & Ravn, M. O. (2013). "A reconciliation of SVAR and narrative estimates of tax multipliers", Journal of Monetary Economics.

Perotti, Roberto, (2008), "In Search of the Transmission Mechanism of Fiscal policy"; NBER Macroeconomic Annual.

Ramey, Valerie A. (2011), "Can Government Purchases Stimulate the Economy?" Journal of Economic Literature, 49(3): 673–85.

Romer, Christina and David H. Romer, (2010), “The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks”, American Economic Review, 100, 763-801

Rosenberg, J. V., and R. F. Engle. 2002. Empirical Pricing Kernels. Journal of Financial Economics 64:341–72.

Shu, J., J. E. Zhang, 2003, The Relation Between Implied and Realized Volatility of S&P 500 Index, Wilmott, (January), 83-91.

Table 1. United States: Budgetary Impact of OBRA-90 (Billions of U.S. dollars) By Fiscal Year (October-September)														
Original Data	CBO:The 1990 Budget Agreement							1992 Budget of the US Government						
		1991	1992	1993	1994	1995	1991-1995		1991	1992	1993	1994	1995	1991-1995
CUMULATIVE CHANGE														
Tax		18	33	32	37	39	159		22.5	35.2	32.7	37.5	38.6	166.5
Spending		17	35	49	79	97	277							
CHANGES														
Tax		18	15	-1	5	2	39		22.5	12.7	0	0	0	35.2
Spending		17	18	14	30	18	97							
Reclassification by Calendar Year (January-December)														
	DeVries et al.							Romer&Romer						
	1990	1991	1992	1993	1994	1995	1990-1995	1990	1991Q1	1992	1993	1994	1995	1990-1995
CHANGES														
Tax	4.5	17.25	11	0.5	4.25	1.5	39		35.2					
Spending	4.25	17.25	17	18	27	13.5	97							
Change in percent of GDP														
Tax	0.08	0.29	0.17	0.01	0.06	0.02	0.63		0.59					
Spending	0.07	0.29	0.27	0.27	0.38	0.18	1.48							
	0.15	0.58	0.45	0.28	0.45	0.20	2.11							
Nominal GDP	5757	5947	6287	6604	7018	7342			5888					

Table 1.1: United States: Budgetary Impact of OBRA-90

	Revenue adjustments										Expenditure adjustments								
	R&R	IMF	τ_t^u	$\tau_{t,0}^a$	$\tau_{t,1}^a$	$\tau_{t,2}^a$	$\tau_{t,3}^a$	$\tau_{t,4}^a$	$\tau_{t,5}^a$	$\tau_{t,6}^a$	IMF	g_t^u	$g_{t,0}^a$	$g_{t,1}^a$	$g_{t,2}^a$	$g_{t,3}^a$	$g_{t,4}^a$	$g_{t,5}^a$	$g_{t,6}^a$
1990q4	0.00	0.08	0.08	0.00	0.29	0.00	0.00	0.00	0.17	0.00	0.07	0.07	0.00	0.29	0.00	0.00	0.00	0.27	0.00
1991q1	0.59	0.29	0.00	0.29	0.00	0.00	0.00	0.17	0.00	0.00	0.29	0.00	0.29	0.00	0.00	0.00	0.27	0.00	0.00
1991q2	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
1991q3	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.27
1991q4	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.27	0.00
1992q1	0.00	0.17	0.00	0.17	0.00	0.00	0.00	0.01	0.00	0.00	0.27	0.00	0.27	0.00	0.00	0.00	0.27	0.00	0.00
1992q2	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
1992q3	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00
1992q4	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00
1993q1	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00

Table 1.2: Reclassification: US OBRA-90

	τ_t^u	g_t^u	τ_t^a	g_t^a	$(\tau_t^u + g_t^u)TB_t$	$(\tau_t^u + g_t^u)EB_t$	$(\tau_t^a + g_t^a)TB_t$	$(\tau_t^a + g_t^a)EB_t$
$\neq 0$ *mean*	0.124	0.195	0.137	0.180	0.166	0.304	0.123	0.323
$\neq 0$ *std deviation*	0.119	0.160	0.107	0.107	0.050	0.273	0.078	0.156
# *observations*	10	8	11	8	4	7	3	8

Table 1.3: Descriptive statistics of fiscal plans, sample 1978q1 2012q4

	τ_t^u	g_t^u	$\tau_{t,t}^a$	$g_{t,t}^a$
τ_t^u	1.00	0.56	0.12	-0.02
g_t^u	0.56	1.00	0.46	0.07
$\tau_{t,t}^a$	0.12	0.46	1.00	0.60
$g_{t,t}^a$	-0.02	0.07	0.60	1.00

Table 1.4: Correlation between components of fiscal plans,sample 1978q1 2012q4

Parameters Names	Abbreviation	Calibrated values
	preferences	
discount factor	β^4	0.983
risk aversion	γ	10
intertemporal elasticity of substitution	Ψ	2
	technology	
capital share	α	0.33
depreciation rate	δ	0.021
	frictions	
elasticity of investment adjustment cost	ξ	2
intensity of debt adjustment cost	ν	0.4
debt-book ratio	η	0.33
intensity of distress cost	ϕ_1	2000
	productivity	
average productivity growth	μ	0.006
short-run productivity volatility	σ_ϵ	0.01
long-run risk exposure tax	φ_τ	-0.022
long-run risk exposure spending	φ_g	0.019
	policy	
debt-target evolution	ρ_{d_1}	0.935 $(0 \leq \rho_{d_1} < 1)$
	ρ_{d2}	0.0001 $(\rho_{d2} > 0)$
volatility (uncertainty of debt target)	$\sigma_{\epsilon_{b*,t}}$	
tax rule	ν_{g1}	-0.5
	ν_{g2}	-0.25
	ν_{g0}	0.5
spending rule	$\nu_{\tau 1}$	0.5
	$\nu_{\tau 2}$	0.25
	$\nu_{\tau 0}$	0.5
steady state dependencies		
investment adjustment cost	α_1	$(1+\mu-1+\delta)^{\frac{1}{\xi}}$
investment adjustment cost	α_2	$(1+\mu-1+\delta) - \frac{(1+\mu-1+\delta)^{\frac{1}{\xi}}}{1-\frac{1}{\xi}} *$
		$*(1+\mu-1+\delta)^{1-\frac{1}{\xi}}$

Table 1.5: Parameter's Values

Variable names	Abbreviation	Data source
Consumption (annual, real)	C_t	BEA (NIPA 1.1.3)
Investment (annual, real)	I_t	BEA (NIPA 1.1.3)
Corporate profit (annual, real)		BEA (NIPA 1.)
Corporate tax (annual, real)		BEA (NIPA 1.)
Output (annual, real)	Y_t	$Y_t = C_t + I_t$
US debt	B_t^G	CBO website
persistence of deb-output ratio	ρ_G	$\rho_G = \frac{B_t^G}{Y_t}$
Return (monthly)	$R_{I,t}$	CRSP
Dividends (monthly)	D_t	CRSP
Equity values (monthly)		CRSP
Debt values (monthly)		Compustat
Three month TBill rate return	r_f	FRED
Productivity	Z_t	$Z_t = \frac{Y_t}{K_t^\alpha H_t^{1-\alpha}}$
Labor (annual)	H_t	NIPA (6.4)
Capital (annual)	K_t	low of motion with $K_{1930} = \frac{I_{1930}}{\delta}$
long-run risk exposure tax	φ_τ	estimation of the productivity equation
long-run risk exposure spending	φ_g	estimation of the productivity equation

Table 1.6: Theoretical Model Variable's Definitions and Sources

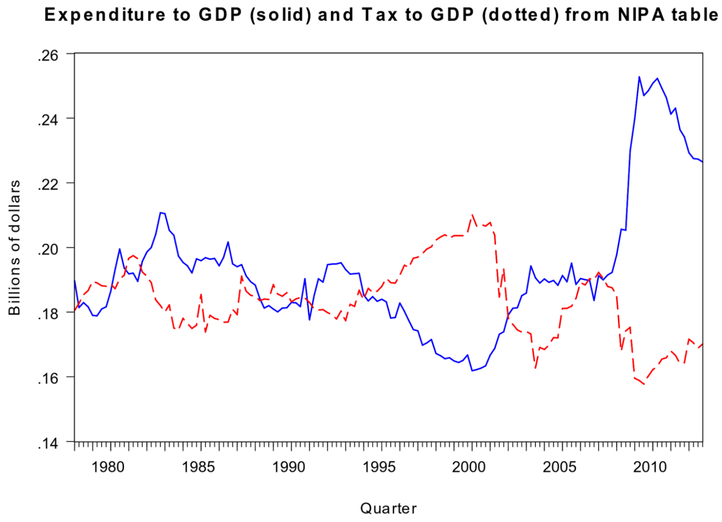

Figure 1.1: NIPA variables

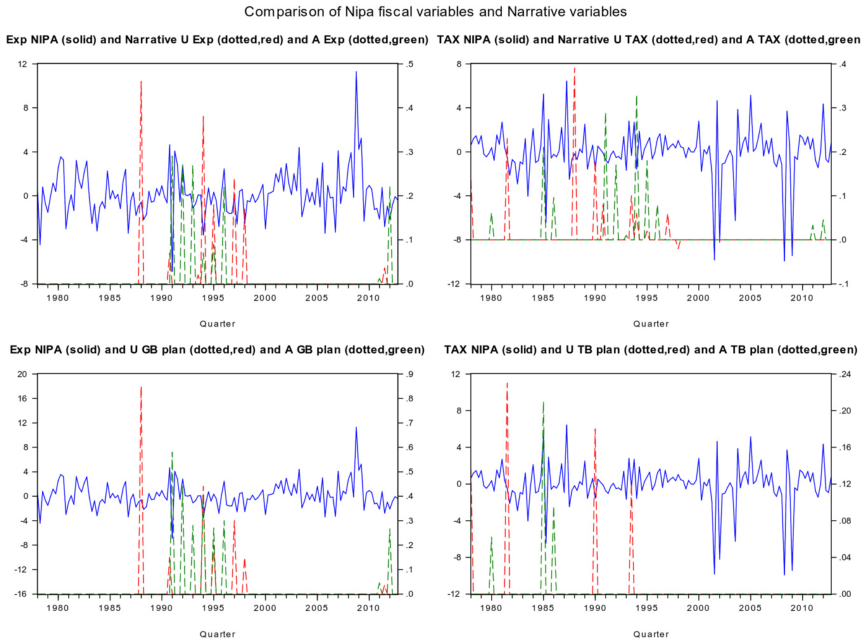

Figure 1.2: NIPA variables (in difference) and Narrative adjustments

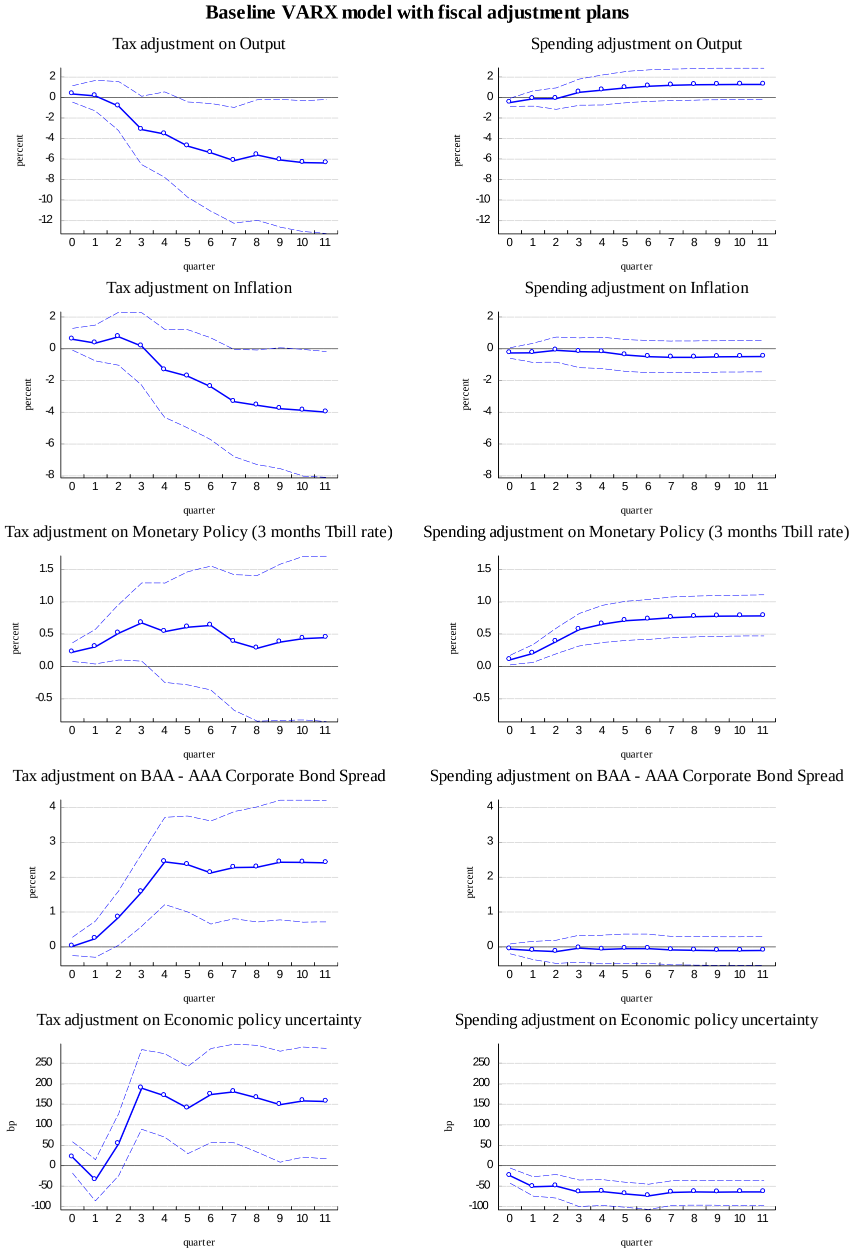

Figure 1.3: Baseline VARX model with fiscal adjustment plans, sample period 1983q1 - 2012q4

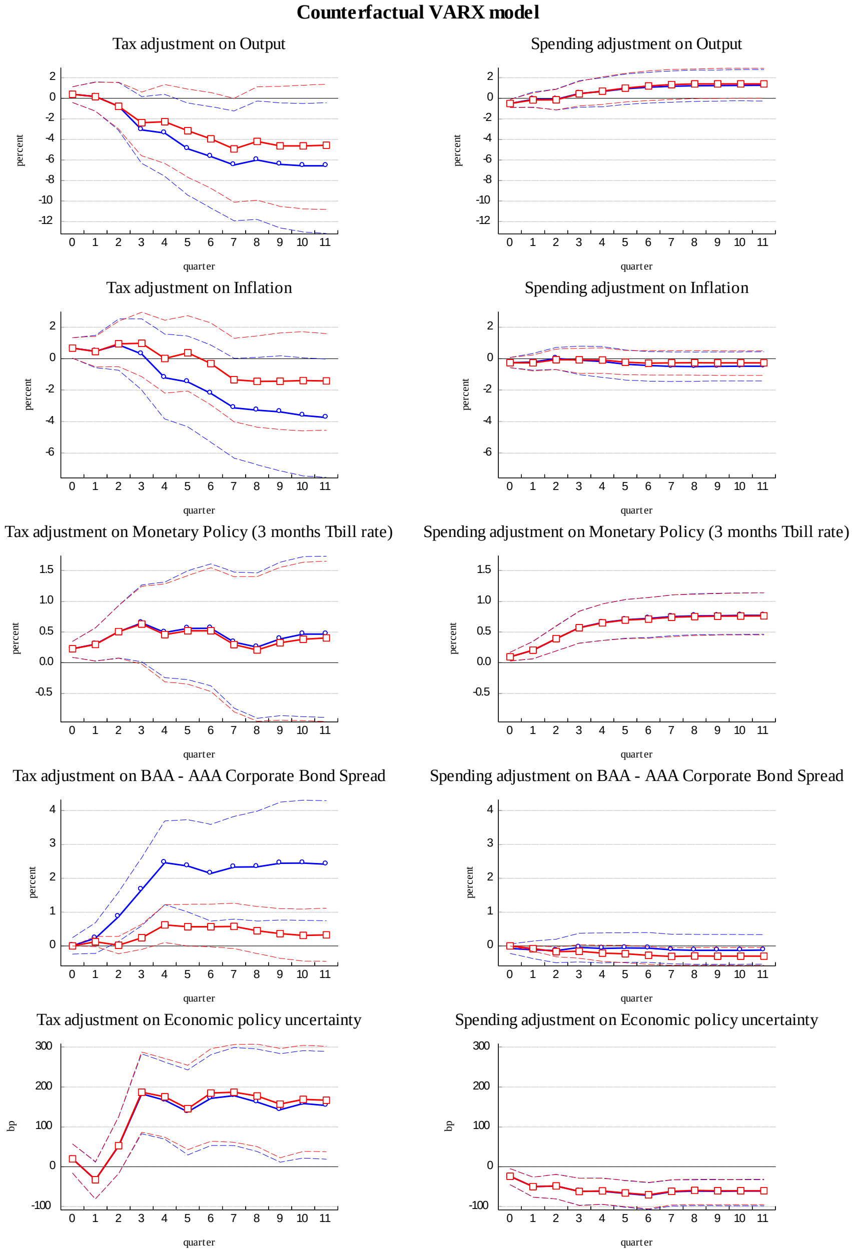

Figure 1.4: Counterfactual VARX model, closing Corporate bond spread, sample period 1983q1 - 2012q4

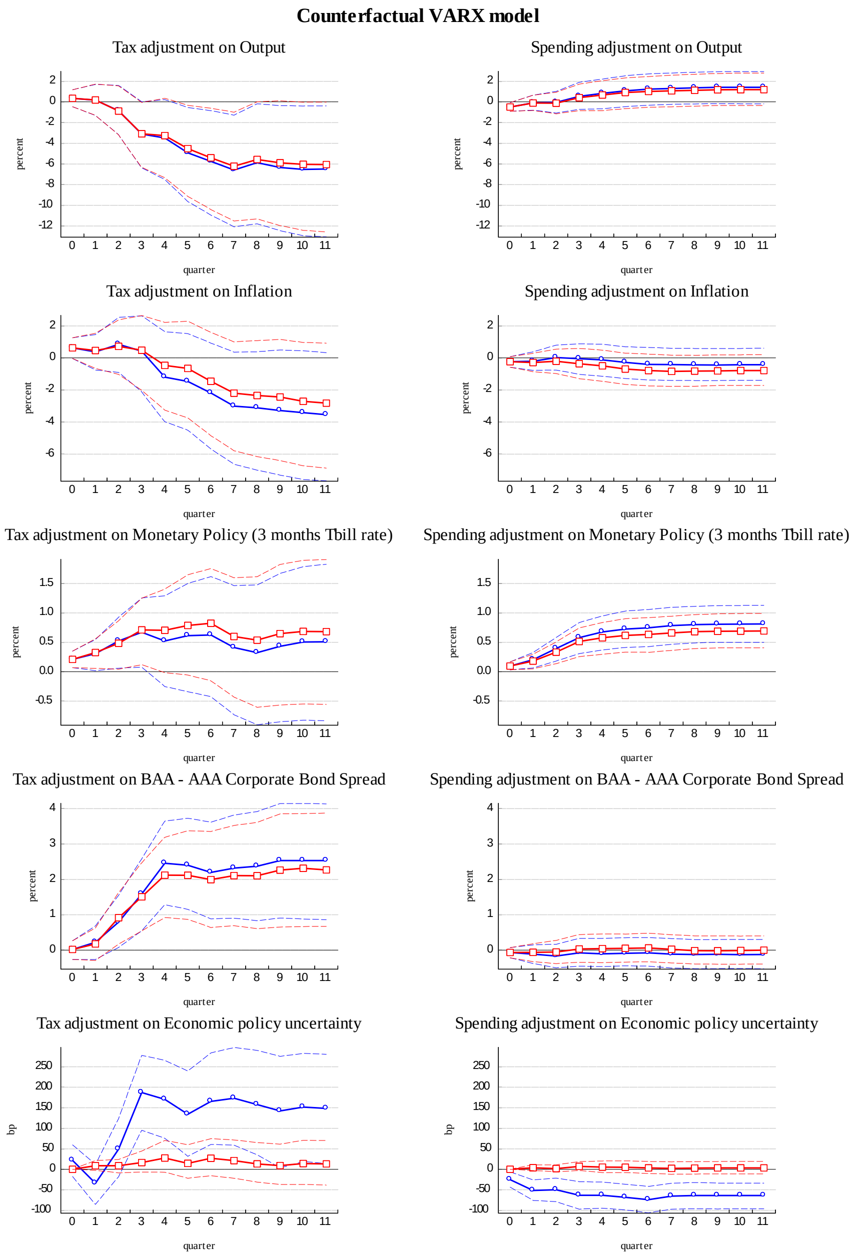

Figure 1.5: Counterfactual VARX model, closing Economic policy uncertainty, sample period 1983q1 -2012q4

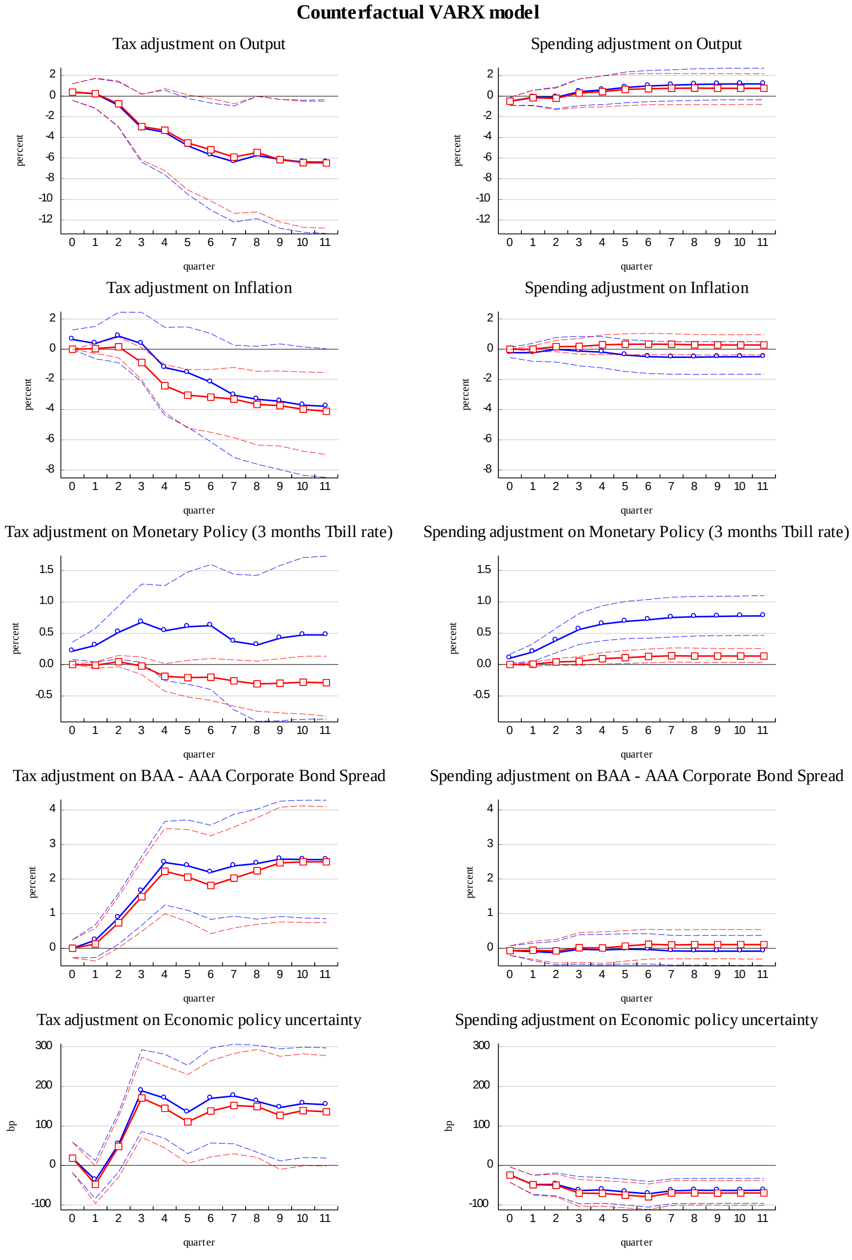

Figure 1.6: Counterfactual VARX model, closing Monetary policy, sample period 1983q1 - 2012q4

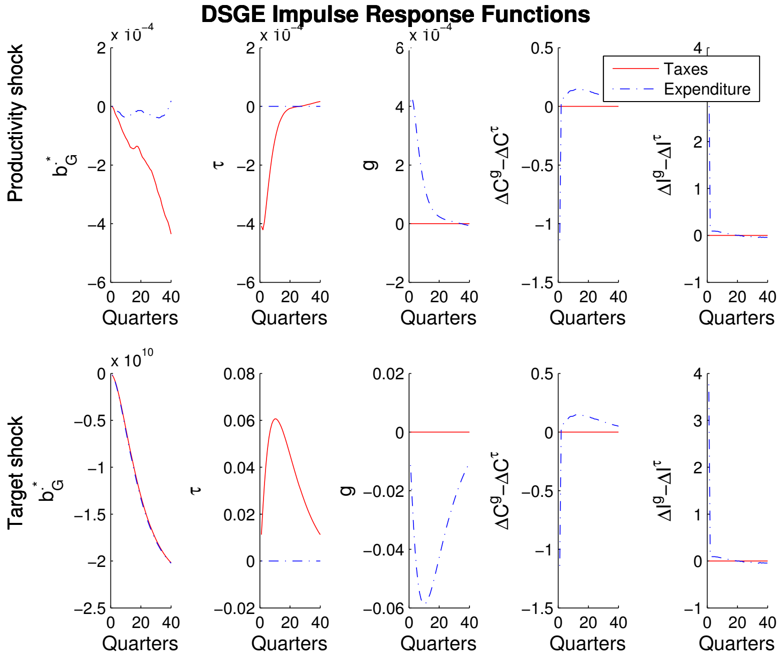

Figure 1.7: DSGE Impulse Response Functions for Exogenous Productivity (upper panel) and Exogenous Target (lower panel) Shocks

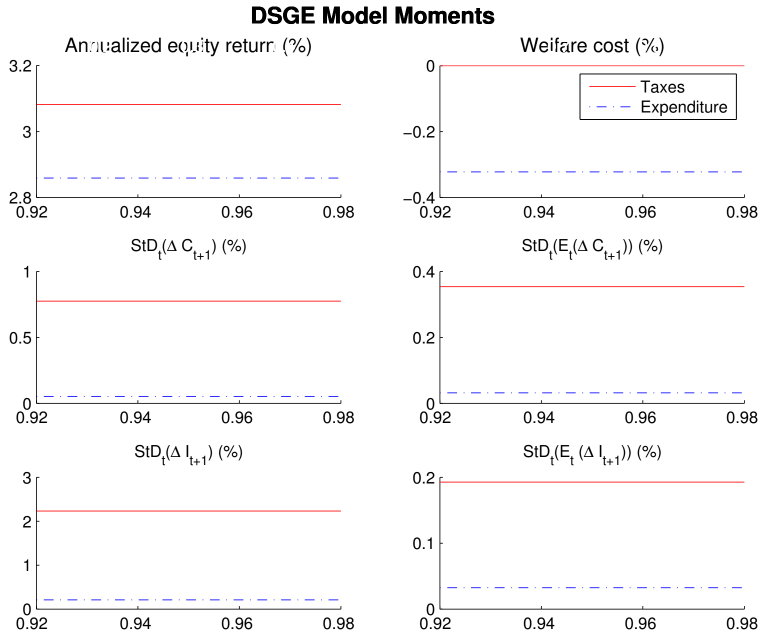

Figure 1.8: DSGE Model Moments

Chapter 2

What Do We Know About Fiscal Multipliers?

2.1 Introduction

Introduction

Fiscal multipliers measure the output effect of fiscal adjustments. This is undoubtedly a controversial issue. Different theoretical models give very different predictions on the magnitude and the sign of the effect of fiscal adjustment on output and other macro variables (see, for example, Baxter and King,1993, De Long and Summers 2012, Christiano et al. (2011). The empirical evidence has produced a plethora of different estimates (see Ramey, 2015). This survey concentrates on the empirical evidence and it is aimed at understanding its heterogeneity. We review the available literature by analyzing the design of the relevant empirical experiment that allows the measurement of multipliers.

Our tenet is that the role of empirical analysis of fiscal policy is to establish the evidence relevant to select the theoretical model capable of matching it. Policy simulation analysis should then be implemented by using the selected relevant model.

It is well understood by now that the validity of experimenting with reduced form empirical models requires that a number of conditions are satisfied. First, empirical reduced form models need to be simulated by keeping all parameters constant, in fact estimated parameters in reduced form model might depend on the parameters determining the economic policy rules. Simulating alternative parameterizations of the rules requires a structural model while simulating deviations from the rules, whilst keeping their systematic component constant, makes the empirical evidence robust to the Lucas (1972) critique. However, deviations from the rules must satisfy further conditions (Ramey 2015) for the investigator to be able to make valid inference on their effect: (i) they must be exogenous for the estimation of the parameters of interest,(ii) they must be uncorrelated with other relevant structural shocks so that their effect can be assessed by keeping all the other shocks constant and the causal effect of deviations from the rule can be uniquely identified, (iii) they must be unanticipated because the relevant response of agents to discriminate among models is the one to modifications in their information sets.

We argue that the relevant experiment to measure multipliers is to consider deviation from fiscal rules that come in the form of multi-year corrections: fiscal adjustment plans. Fiscal adjustment plans are a series of multi-period correlated one-period corrections (shocks). They describe closely the way in which deviation from fiscal rules are currently implemented by policy makers.

Plans consist of the announcement of a sequence of fiscal actions, some to be implemented the same period of the announcement (unanticipated) and some to be implemented in following periods (announced). Plans are also a mix of measures on government expenditures and revenues. The design of plans generates intertemporal and intratemporal correlations among fiscal variables. The intertemporal correlation is the one between the announced (future) and unanticipated (current) components of a plan. The intratemporal correlation is that between the changes in revenues and spending that determines the composition of a plan.

Traditionally the empirical fiscal literature concentrates on shocks. Interestingly plans nest shocks and taking the perspective of plans will allow us to write down a general empirical model and derive virtually all the different specifications adopted as special cases of this model. The general "nesting" empirical model that we will set up is too heavily parameterized to be estimated empirically but it is useful in that it allows to the evaluate the different identification and specification strategies adopted in the literature as choices on the relevant dimensions of the empirical models and therefore to put the heterogeneity of the findings in the empirical evidence in a more general context.

In the next section we will describe exactly how plans are designed and how the most general empirical model can be constructed, we shall then assess all the available literature in terms of the restrictions imposed on such a general model.

In a fourth section we shall give an illustration of the relevance of different strategic choices on the measured multipliers.

The last section concludes.

2.2 A general framework

In this section we build a general framework to describe the empirical evidence on fiscal multipliers. Such a framework is constructed in two steps: the identification of the relevant experiment and the specification of the empirical model to assess its effects.

2.2.1 The Relevant Experiment: Fiscal Stabilization Plans

The analysis of the output effects of economic policy requires – for the correct estimation of the relevant parameters – identifying policy shifts that are exogenous. If the object of interest is the output effect of fiscal stabilization measures, then exogeneity of the shifts in fiscal policy for the estimation of their output effect requires that they are not correlated with news on output growth.

Fiscal policy is conducted through rare decisions and it is typically implemented through multi-year plans. A fiscal plan typically contains three components: (i) unexpected shifts in fiscal variables (announced upon implementation at time t), (ii) shifts implemented at time t but announced in previous years, and (iii) shifts announced at time t, to be implemented in future years. Consider, for simplicity, the case in which the forward horizon of the plan is only one year with reference to a specific country i, and assume that corrections exogenous for the estimation of the parameters of interest can be observed. An exogenous plan can be described as follows:

$$
\begin{aligned}
&f_{i,t} = e^u_{i,t} + e^a_{i,t,0} + e^a_{i,t,1} \\
&e^u_{i,t} = \tau^u_{i,t} + g^u_{i,t} \\
&e^a_{i,t+1,0} = e^a_{i,t,1} \\
&\tau^a_{i,t,1} = \varphi_{1,i}\ \tau^u_{i,t} + v_{1,i,t} \quad \tau^a_{i,t,1} = \varphi_{2,i}\ g^u_{i,t} + v_{2,i,t} \\
&g^a_{i,t,1} = \varphi_{3,i}\ \tau^u_{i,t} + v_{3,i,t} \quad g^a_{i,t,1} = \varphi_{4,i}\ g^u_{i,t} + v_{4,i,t} \\
&g^u_{i,t} = \varphi_{5,i}\ \tau^u_{i,t} + v_{5,i,t}
\end{aligned}
\tag{2.1}
$$

Total fiscal corrections in each year consist of increases in taxes and cuts in expenditures. Unexpected shifts in fiscal variables by the fiscal authorities in country i are labeled respectively $\tau^u_{i,t}$ and $g^u_{i,t}$. We define $\tau^a_{i,t,j}$ and $g^a_{i,t,j}$ the tax and expenditure changes announced at date t with an anticipation horizon of j years (*i.e.* to be implemented in year $t+j$). Finally, $\tau^a_{i,t,0}$ ($g^a_{i,t,0}$) denotes the tax (expenditure) changes implemented in year t that had been announced in the previous years. The fiscal plan is completed by making explicit the relation between the predictable and the unpredictable components and the taxation and the expenditure components. The parameters $\varphi_{1,i}$ to $\varphi_{5,i}$ pin down the intratemporal and the intertemporal correlations of the different components of the fiscal plan. Note the framework allows for modifications of an announced measure upon implementation recording them as an unexpected shift in policy.

2.2.2 The Empirical Model

Simulation of plans requires to embed them in a dynamic model for macroeconomic variables. We consider, for the sake of illustration, an a over-parameterized general model that does not have a sufficient number of degrees of freedom to be estimated but nests most of the specification considered in the empirical literature so far. The main purpose of this general model is to make explicit the specification and identification choices adopted by the different authors. Consider modelling the macroeconomic impact of fiscal policy in i countries as follows

$$
\begin{aligned}
\mathbf{z}_{i,t} &= A_{1,i}(L,S_t)\,\mathbf{z}_{i,t-1} + A_{2,i}(L,S_t)\,\mathbf{z}^*_{i,t-1} + A_{3,i}(L,S_t)\,d_{it-1} \\
&\quad + B_1(S_t)\,\tau^u_{i,t} + B_2(S_t)\,g^u_{i,t} + C_1(S_t)\,\tau^a_{i,t,0} + C_2(S_t)\,g^a_{i,t,0} + \\
&\quad + D_1(S_t)\,\tau^a_{i,t,1} + D_2(S_t)\,g^a_{i,t,1} + \mathbf{u}_{i,t} \qquad (2.2)\\
d_{it} &= \frac{1+i_{it}}{(1+x_{it})}d_{it-1} + \frac{(g_{it})-(t_{it})}{(y_{it})} \qquad (2.3)\\
x_{it} &\equiv \Delta p_{it} + \Delta y_{it} + \Delta p_{it}\Delta y_{it} \\
\mathbf{u}_{i,t} &\sim N(0,\Sigma_t)
\end{aligned}
$$

$$
\begin{aligned}
&f_{i,t} = e^u_{i,t} + e^a_{i,t,0} + e^a_{i,t,1} \\
&e^u_{i,t} = \tau^u_{i,t} + g^u_{i,t} \\
&e^a_{i,t+1,0} = e^a_{i,t,1} \\
&\tau^a_{i,t,1} = \varphi_{1,i}\ \tau^u_{i,t} + v_{1,i,t} \quad \tau^a_{i,t,1} = \varphi_{2,i}\ g^u_{i,t} + v_{2,i,t} \\
&g^a_{i,t,1} = \varphi_{3,i}\ \tau^u_{i,t} + v_{3,i,t} \quad g^a_{i,t,1} = \varphi_{4,i}\ g^u_{i,t} + v_{4,i,t} \\
&g^u_{i,t} = \varphi_{5,i}\ \tau^u_{i,t} + v_{5,i,t}
\end{aligned}
$$

where $\mathbf{z}_{i,t}$ is the vector of domestic macro variable that, in order to be able to dynamically simulate (2.3) , must include i_t, the average nominal cost of financing the debt , Δy_t, real GDP growth, Δp_t, inflation, t_t and g_t are, respectively, government revenues and government expenditure net of interest.

From (2.3) it is immediately obvious that the dynamics of the debt is fully determined at any point in time by the dynamics of a subset of the variables included in the vector $\mathbf{z}_{i,t}$, moreover the relationship between the debt and the variables in $\mathbf{z}_{i,t}$ is non-linear.

Several comments on this specification are in order.

1) The endogenization of the debt-deficit dynamics allows to check that impulse response functions are not computed of diverging paths for fiscal fundamentals. The explicit inclusion of d_{it} in the dynamic model allows to pin down explicitly the debt stabilization motive in the fiscal reaction function and the impact of debt in the macro dynamics

2) The coefficients in the dynamic macro model depend on a regime S_t.

3) Foreign variables $\mathbf{z}^*_{i,t}$ are allowed to have an impact.

4) Fiscal plans are modelled as described in the previous section and, for simplicity, the foresight horizon is limited to one-period. Exogenous fiscal plans are observable and they are available to the econometricians

5) Heteroscedasticity is allowed in the component of fiscal plans and in the model residuals.

6) The model is non linear but impulse responses can be computed as the difference between two forecasts:

$$IR(t,s,d_i) = E(\mathbf{z}_{i,t+s}|v_t = d_i; I_t) - E(z_{i,t+s}|v_t = 0; I_t) \quad s = 0, 1, 2, ...$$

Once impulse response are available multipliers, as argued by Mountford and Uhlig (2009), Uhlig (2010) and Fisher and Peters (2010), can be calculated as the integral of the output response divided by the integral government adjustment (spending or taxation) response.

2.3 Empirical Models

The available contribution in the literature can be discussed by classifying them according to the restrictions they impose on the general structure described in the previous section.

2.3.1 Early SVAR Models

The early studies of the macroeconomic impact on fiscal variables concentrate on shocks by neglecting the intertemporal nature of fiscal plans. therelevant policy shift are identified with shocks. However, The analysis of the output effects of economic policy requires – for the correct estimation of the relevant parameters – identifying policy shifts that are exogenous. Exogeneity of the shifts in fiscal policy for the estimation of their output effect requires that they are not correlated with news on output growth. The traditional steps to identify such exogenous shifts were to first estimate a joint dynamic model for the structure of the economy and the variables controlled by the policy-makers (typically estimating a VAR). The residuals in the estimated equation for the policy variables approximate deviations of policy from the rule. Such deviations, however, do not yet measure exogenous shifts in policy because a part of them represents a reaction to contemporaneous information on the state of economy. In order to recover structural shocks from VAR innovations some restrictions are required. So empirical models can be classified via the restrictions they impose on the specification and the identification restrictions.

Traditional SVAR

Blanchard and Perotti (2002) (BP) is the traditional benchmark for the literature of VAR-based investigation of the output effect of fiscal policy:

BP specify the following restricted model to measure fiscal multipliers:

$$\begin{bmatrix} 1 & 0 & -a_{13} \\ 0 & 1 & -a_{23} \\ -a_{31} & -a_{32} & 1 \end{bmatrix} \begin{bmatrix} T_t \\ G_t \\ Y_t \end{bmatrix} = A_1(L) \begin{bmatrix} T_{t-1} \\ G_{t-1} \\ Y_{t-1} \end{bmatrix} + \begin{bmatrix} \sigma^T & b_{12} & 0 \\ b_{21} & \sigma^G & 0 \\ 0 & 0 & \sigma^Y \end{bmatrix} \begin{bmatrix} e_t^T \\ e_t^G \\ e_t^Y \end{bmatrix}$$

where T_t, G_t and Y_t are the log of real quarterly taxes, spending and GDP all in real per capita terms. Taxes are net taxes defined as the sum of Personal Tax and Non tax Receipts, Corporate Profits Tax Receipts, Indirect Business Tax and Non tax accruals, Contributions for Social Insurance less Net Transfer Payments to Persons and Net Interest Paid by the Government. Government Spending is defined as Purchases of Goods and Services, both current and capital. Data are quarterly and seasonally adjusted for the period 1947:1 to 1997:4. The $e's$ are non observable mutually uncorrelated structural shocks normalized to be of variance 1. However, they can be identified by imposing some restrictions on the $a's$ and the $b's$. Estimate a reduced form VAR in the three variables of interest, the VAR residuals $u's$ will be related to the $e's$ as follows:

$$\begin{bmatrix} 1 & 0 & -a_{13} \\ 0 & 1 & -a_{23} \\ -a_{31} & -a_{32} & 1 \end{bmatrix} \begin{bmatrix} u_t^T \\ u_t^G \\ u_t^Y \end{bmatrix} = \begin{bmatrix} \sigma^T & b_{12} & 0 \\ b_{21} & \sigma^G & 0 \\ 0 & 0 & \sigma^Y \end{bmatrix} \begin{bmatrix} e_t^T \\ e_t^G \\ e_t^Y \end{bmatrix}$$
$$A\mathbf{u}_t = B\mathbf{e}_t$$

from which we can derive the relation between the variance-covariance matrices of $\mathbf{u}_t$ (observed) and $\mathbf{e}_t$ (unobserved) as follows:

$$\begin{aligned} E(\mathbf{u}_t\mathbf{u}_t') &= \mathbf{A}^{-1}\mathbf{B}E(\mathbf{e}_t\mathbf{e}_t')\,\mathbf{B}'\mathbf{A}^{-1} \\ &= \mathbf{A}^{-1}\mathbf{B}\mathbf{B}'\mathbf{A}^{-1} = \mathbf{C}\mathbf{C}' = \Sigma \end{aligned}$$

Substituting population moments with sample moments we have:

$$\widehat{\sum} = \widehat{\mathbf{A}}^{-1}\widehat{\mathbf{B}}\mathbf{I}\widehat{\mathbf{B}}'\widehat{\mathbf{A}}^{-1}, \tag{2.4}$$

$\widehat{\sum}$ contains $n(n+1)/2$ different elements (where n is the dimension of the VAR), which is the maximum number of identifiable parameters in matrices **A** and **B.** Therefore, a necessary condition for identification of the structural shocks is that the maximum number of parameters contained in the two matrices equals $n(n+1)/2$, such a condition makes the number of equations equal to the number of unknowns in system . As usual, for such a condition also to be sufficient for identification no equation in (2.4) should be a linear combination of the other equations in the system.

As there are 9 parameters in the BP model at least three identifying restrictions are needed. First, BP rely on institutional information about tax, transfer and spending programs to restrict the parameters a_{13} and a_{23}. These coefficients, in quarterly data, are assumed to exclusively driven by the automatic effects of economic activity on taxes and spending and they are restricted to the output elasticities of government purchases and net taxes. Using information on the feature of the spending and tax and transfer system BP set $a_{13} = 2.08, a_{23} = 0$.[1]The last restrictions is obtained by considered two alternative scenarios, $b_{12} = 0$ and $b_{21} = 0$,that are observed to have a negligible impact on the final results.

The identification restrictions are combined with the specification restrictions on the general model. Namely, only one country is considered (US), the vector of variables $\mathbf{z}_{US,t}$ consists only of three variables, constant parameters are assumed $A_{1,US}(L, S_t) = A_{1,US}(L)$, no foreign variable enter the specification $A_{2,US}(L, S_t) = 0$, there is no explicit debt feedback $A_{3,US}(L, S_t) = 0$ and the debt dynamics is not modelled, plans are not introduced and shocks are combination of announced, unanticipated and anticipated corrections which are restricted to have the same effect $B_1(S_t) = C_1(S_t) = D_1(S_t) = B_1, B_2(S_t) = C_2(S_t) = D_2(S_t) = B_2$.

Impulse response are then computed and multipliers are calculated by first multiplying the estimates by the sample mean of government spending and net taxes to GDP ratios, and then by comparing the peak output response to the initial government spending or tax impact effect. Note that this is different from computing the integral multipliers described in the previous section.

Two sets of empirical results are reported generated respectively by allowing for stochastic trends (and specifying the model in first differences) or by considering a specification in level with deterministic trends. The Tax multiplier is around one (-1.33 in the ST against -0.78 under DT) and similar in size to the spending multiplier (0.90 in the ST against 1.29 under DT). Some evidence of subsample instability emerges. Follow-up work, such as by Fatas-Mihov(2001), Perotti(2005), Pappa(2005) and Gali, Lopez-Salido and Valles(2007), found similar results.

The BP specification is very restrictive: the set of variables considered is very limited, the model does not allow for debt feedback and tracking of the debt dynamics and identified shocks are convolution of unanticipated, anticipated and announced corrections. The first set of restrictions have not been extensively debated in the literature, the second set can be rationalized by considering that the US debt dynamics has never deviated from stability and therefore the model can be thought of as including a linearized version of the identity driving the debt dynamics. However, Leeper (2010) stresses the importance of avoiding analyses of "unsustainable fiscal policies" and of making sure that the question "What is the fiscal multiplier" is not asked along a path for the debt dynamics that is at odds with the beliefs of government bond-holders.

[1]Caldara(2011) shows that the sensitivity of estimated multipliers to changes in these elasticities can be very large.

As a matter of fact the restrictions that has elicited more debate is the one that implies that identified shocks to government spending and taxation are anticipated. Ramey (2011a, b) argues that distinguishing between announced and unanticipated shifts in fiscal variables, and allowing them to have different effects on output, is crucial for evaluating fiscal multipliers. Leeper et al.(2013) illustrates explicitly that fiscal foresight makes the number of shocks to be mapped out of the VAR innovations is too high to achieve identification: technically the Moving Average representation of the VAR becomes non-invertible (see also Lippi and Reichlin(1994)).

SVAR with sign restrictions

Mountford and Uhlig(2009) (MU) apply to the analysis of fiscal policy the methodology originally introduced by Uhlig(2005) to identify monetary policy shocks. MU represents the VAR of interest as follows

$$\begin{aligned} \mathbf{z}_t &= \sum_{i=1}^{p} \mathbf{A}_i \mathbf{z}_{t-i} + \mathbf{u}_t \\ \mathbf{u}_t &= \mathbf{C}\mathbf{e}_t \\ \Sigma &= \mathbf{C}\mathbf{E}\left(\mathbf{e}_t\mathbf{e}_t'\right)\mathbf{C}' = \mathbf{C}\mathbf{C}' \end{aligned}$$

Consider now C as the Cholesky decomposition of Σ.

The impulse response function, given the Cholesky decomposition could be written as :

$$\mathbf{z}_t = \left[\mathbf{I} - \mathbf{A}(L)\right]^{-1} \mathbf{C}\mathbf{e}_t$$

All the possible rotations of the Cholesky decomposition are obtained as follows:

$$\begin{aligned} & \left[\mathbf{I} - \mathbf{A}(L)\right]^{-1} \mathbf{C}\mathbf{Q}\mathbf{Q}'\mathbf{e}_t \\ \mathbf{Q}\mathbf{Q}' &= I \end{aligned}$$

The impulse response for $\mathbf{Q}'\mathbf{e}_t$, is then $\left[\mathbf{I} - \mathbf{A}(L)\right]^{-1} \mathbf{C}\mathbf{Q}$.

The imposition of the sign restrictions then considers $\mathbf{Q}$ to generate all possible identification and then select only those that satisfy some restriction on their sign.

The vector $\mathbf{y}_t$ contains many more variables than the corresponding one in BP; in fact Mountford-Uhlig specify a VAR in GDP, private consumption, total government expenditure, total government revenue, real wages, private non-residential investment, interest rate, adjusted reserves, the producer price index for crude materials and the

GDP deflator. These 10 variables are considered at a quarterly frequency from 1955 to 2000, the VAR has 6 lags, no constant or a time trend, and uses the logarithm for all variables except the interest rate which is specified level. The definition of the two fiscal variables is the same with BP. Sign restrictions are used to identify shocks of interest. (i) A business cycle shock is defined as a shock which jointly moves output, consumption, non-residential investment and government revenue in the same direction for four quarters following the shock[2]; (ii) A monetary policy shock, which is taken to be orthogonal to the business cycle shock, moves interest rates up and reserves and prices down for four quarters after the shock iii) fiscal policy shocks are orthogonal to business cycle and monetary policy shocks, government spending shocks and government revenue shocks are identified by a positive response of the corresponding variables such response is restricted to be delayed (to take into account fiscal foresight) and permanent (to rule out temporary fiscal adjustment).

If we interpret MU in terms of our general model they take a close economy, constant parameters approach, they restrict $B_1 = B_2 = 0$, they do not track separately the response upon announcement and upon implementation and they impose the restrictions that all the φ parameters are positive, except those determining the cross correlation between revenue and expenditure adjustments, that are set to zero.

The tax multiplier (deficit-financed tax cuts) is almost three times larger than that computed by BP and stands at 3.57 (with a peak effect after 13 quarters) while the deficit-spending multiplier is slightly lower than that of BP as it stands at 0.65 (with a peak effect upon impact). Interestingly, by linearly combining their two base fiscal policy shocks MU analyze also the effect of a balanced budget tax cut. Comparing these three scenarios, they find that a surprise deficit financed tax cut is the best fiscal policy to stimulate the economy, giving rise to a maximal present value multiplier of five dollars of total additional GDP per each dollar of the total cut in government revenue five years after the shock.

Expectational VARs

Expectational VARs try and solve the problems posed by fiscal foresight and endogeneity by constructing an instrument for fiscal corrections using information outside the VAR. Ramey and Shapiro (1998) use narrative techniques to create a dummy variable capturing military buildups. *Business Week* is used as a source to isolate political events the led to buildups exogenous to the current state of the economy, the narrative approach was also used to make sure that the relevant shocks were unanticipated. The effect of the "war

[2] Note that this restrictions implies that when output and government revenues move in the same direction, this must be due to some improvement in the business cycle generating the increase in government revenue, not the other way around.

dates" was measured by estimating single equations for each variable of interest including current value and lags of the war dates and lags of the left hand side variable.

To understand this approach consider the structural representation of a constant parameter closed economy first-order VAR:

$$\mathbf{A}\mathbf{z}_t = \mathbf{C}\mathbf{z}_{t-1} + \mathbf{B}\mathbf{e}_t. \tag{2.5}$$

The MA representation of (2.5) is

$$\mathbf{z}_t = \mathbf{\Gamma}(L)\mathbf{e}_t \tag{2.6}$$

where $\mathbf{\Gamma}(L) \equiv \frac{\mathbf{A}^{-1}\mathbf{B}}{\mathbf{I}-\mathbf{A}^{-1}\mathbf{C}}$. The MA representation is not directly estimated in the VAR, but it can be derived by inversion, after having estimated (2.5) .

We re-write (2.6) as follows

$$\begin{aligned}
\mathbf{z}_t &= \sum_{j=0}^{M} \mathbf{\Gamma}_0^j \mathbf{\Gamma}_1 \mathbf{e}_{t-i} + \mathbf{\Gamma}_1^{M+1} \mathbf{z}_{t-(M+1)} \\
\mathbf{\Gamma}_0 &\equiv \mathbf{A}^{-1}\mathbf{B},\ \mathbf{\Gamma}_1 \equiv \mathbf{A}^{-1}\mathbf{C}.
\end{aligned}$$

and extract from the above system the equation for a variable of interest, say output growth

$$\begin{aligned}
\Delta y_t &= \sum_{j=0}^{M} \gamma_j^{y,t} e_{t-j}^t + \sum_{j=0}^{M} \gamma_j^{y,g} e_{t-j}^g + \sum_{i=1}^{k}\sum_{j=0}^{M} \gamma_j^{y,i} e_{t-j}^i \\
&\quad + \mathbf{\Gamma}_1^{M+1} \mathbf{z}_{t-(M+1)}
\end{aligned} \tag{2.7}$$

where

$$\begin{aligned}
\gamma_j^{y,x} &= \mathbf{s}^x \mathbf{\Gamma}_0 \mathbf{\Gamma}_1^i \mathbf{s}^{t\prime} \qquad x = t, g, x^1, ...x^k \\
\mathbf{s}^g &= \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \end{bmatrix},\ \mathbf{s}^t = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \end{bmatrix} \\
\mathbf{s}^k &= \begin{bmatrix} 0 & 0 & ... & \underset{2+k}{1} & ...0 \end{bmatrix}
\end{aligned}$$

Consider now the relation between the true unobservable expenditure shocks and the narrative instrument

$$\begin{aligned}
e_t^g &= e_t^{WAR} + \varepsilon_t \\
\varepsilon_t &\sim i.i.d.\left(0, \sigma_\varepsilon^2\right)
\end{aligned} \tag{2.8}$$

i.e.. assume that the difference between the expenditure shocks in the VAR and those identified via the narrative method is some error ε_t. This assumption has a number of testable implications, in particular e_t^{WAR} should be orthogonal to all the lags of all the variables included in the VAR.

We can now write

$$\begin{aligned} \Delta y_t \quad = \quad & \sum_{j=0}^{M} \gamma_j^{y,g} e_{t-j}^{WAR} + \sum_{j=0}^{M} \gamma_j^{y,g} \varepsilon_{t-j} + \\ & + \sum_{j=0}^{M} \gamma_j^{y,t} e_{t-j}^{t} + \sum_{i=1}^{k} \sum_{j=0}^{M} \gamma_j^{y,i} e_{t-j}^{i} \\ & + \mathbf{\Gamma}_1^{M+1} \mathbf{z}_{t-(M+1)} \end{aligned} \tag{2.9}$$

(2.9) makes clear that the limited information approach adopted by Ramey and Shapiro in which the variable of interest is regressed on a distributed lag of the instrument and lags of the left hand side since variables can be interpreted as a simplified version of (2.9) that omits variables that are thought of as orthogonal to the regressors (i.e. the distributed lags of other shocks and the measurement error). Within this framework of interpretation there is a potential problem related to the omission of lags M+1 and longer of all the other variables in the dynamic system. This omission is the less problematic the more the system is stationary and the inclusion of lags of the dependent variable might be thought of as a way of swamping this effect.

To overcome the limited information approach a number of follow-up papers (Edelberg, Eichenbaum, and Fisher (1999), Burnside, Eichenbaum, and Fisher (2004), and Cavallo 2005) embedded e_t^{WAR} in a VAR by ordering them first in a Cholesky decomposition. Fisher and Peters(2010) created an alternative forward looking series of news based on the excess returns of defense contractor shocks for the period starting in 1958. These applications typically found that government spending with a multiplier in the range 0.6-1.5 and therefore slightly higher than that of BP, but comparable especially after taking into account the effect of fiscal foresight in BP type models. Ramey (2011a) showed that the shocks from an SVAR were predictable by e_t^{WAR}. After correcting for this effect, the obtained impulse responses become more similar. Barro, Redlick(2011) also use military build-ups as an instrument for defense spending but they also include in the specification a measure for marginal tax rate and allow for non-linearities making the effects of revenue and expenditure shocks function of unemployment. Their estimated multiplier for defense spending is 0.6-0.7 at the median unemployment rate (while holding fixed average marginal income-tax rates) rising in unemployment to reach 1 when the unemployment rate is around 12 per cent. Increases in the average marginal income-tax rates have a significantly negative effect on GDP with an implied magnitude of the multiplier of 1.1.

2.3.2 Narrative Measures

Romer and Romer(2010) (R&R) proceed to non-econometric, direct identification of the shifts in fiscal variables. These are then plugged directly into an econometric specification capable of delivering the impulse response functions that describe the output effect of fiscal adjustments. In this "narrative" identification scheme a time-series of exogenous shifts in taxes or government is constructed using parliamentary reports and similar documents to identify the size, timing, and principal motivation for all major fiscal policy actions. Legislated tax changes are classified by R&R into endogenous for their estimation of their output effect (induced by short-run countercyclical concerns) and exogenous (responses to an inherited budget deficit, or to concerns about long-run economic growth or politically motivated). R&R construct time-series for the US considering quarterly observation over the period 1945:1-2007:1. There is an interesting fact about the two type of exogenous tax changes which is evident from the following figure reported by R&R.

Insert figure3.2

The deficit-driven tax changes are almost exclusively positive (episode of fiscal expansion motivated by inherited surplus are virtually non existent) while all the long-run tax changes are negative (i.e. expansionary).

If the perspective of plans is adopted to interpret the R&R narrative identification we can classify their tax shocks as the sum of corrections announced at time t and immediately implemented (therefore unanticipated) and corrections announced at time t to be implemented in future periods:

$$\tau_t^{RR} = \tau_t^u + \tau_{t,1}^a$$

The effect of tax shocks is then measured by running the following single-equation specification.

$$\Delta \ln Y_t = \alpha + B(L)\tau_t^{RR} + \epsilon_t \tag{2.10}$$

So a truncated constant parameter single country MA representation is adopted, where only the exogenous components of tax adjustments is considered with the restrictions that unanticipated and announced corrections have the same effect and announced corrections have no impact upon implementation. The resulting evidence is that tax increases are highly contractionary : a tax increase of 1% of GDP has a cumulative effect of a reduction of output over the next three years of nearly 3 %.

The narrative approach has been extended to the UK case by Cloyne (2013) who constructs a new narrative dataset of legislated tax changes in the UK, to apply the R&R

empirical approach and find that a 1 percentage point cut in taxes as a proportion of GDP causes a 0.6 percent increase in GDP on impact, rising to a 2.5 percent increase over nearly three years.

Devries et al (2011, D&al) extend the narrative approach to a multi-country sample that identify episodes for 17 OECD countries between 1978 and 2009. These authors concentrate on deficit driven corrections to revenue and expenditure that are not compensated by long-run corrections. Adopting the perspective of plans the Devries et al corrections are constructed by adding up two components: unexpected shifts in fiscal variables occurring in year t (that is announced when they are implemented), e_t^u, and shifts in fiscal variables which also occur in year t but had been announced in previous years, $e_{i,t,0}^a$

$$\begin{aligned} e_{i,t}^{DV} &= e_{i,t}^u + e_{i,t,0}^a \\ e_{i,t}^u &= \tau_{i,t}^u + g_{i,t}^u \\ e_{i,t,0}^a &= \tau_{i,t,0}^a + g_{i,t,0}^a \end{aligned}$$

Guajardo et al (2014) have used these data to estimate fiscal multipliers using constant parameters panel data techniques on the international sample (and therefore by imposing the restrictions $A_{1,i} = A_1, A_{2,i} = A_{3,i} = 0, B_1 = C_1, B_2 = C_2, D_1 = D_2 = 0)$. In practice, in their baseline specification, they estimate the following panel version of the single equation model adopted by R&R:

$$\Delta z_{i,t} = \alpha + A_1(L)\Delta z_{i,t-1} + B_1(L)e_{i,t}^{DV} + \lambda_i + \chi_t + u_{i,t}$$

where λ_i denotes country fixed effect and χ_t denote year fixed-effects.

They estimate that the effect of a 1 per cent of GDP fiscal consolidation has a contractionary effect on GDP with a peak effect of -0.62 per cent within two years (t-stat=-3.82).

The Government Intertemporal Budget Constraint

Leeper(2010) states clearly that "*...Fiscal policy will shed its alchemy label when the question "What is the fiscal multiplier?" is no longer asked and detailed analyses of "unsustainable fiscal policies" are no longer conducted without explicit analysis of expectations and dynamic adjustments ...*".

The traditional VAR literature takes sustainability for granted and interprets the estimated VAR as linearized model around a stable debt/GDP path. Chung and Leeper(2007) impose this equilibrium condition on an identified VAR and characterize the way in which the present-value support of debt varies across various types of fiscal policy shocks and between fiscal and non-fiscal shocks. Favero and Giavazzi(2012) propose an extension of the standard VAR model augmented with observable narrative tax adjustments,e_t^{RR}, capable of explicitly tracking the dynamics of debt/GDP in response to fiscal shocks.

The following empirical specification is introduced for estimating tax multipliers

$$\begin{aligned}
\mathbf{z}_t &= \sum_{i=1}^{k} \mathbf{C}_i \mathbf{z}_{t-i} + \boldsymbol{\delta} e_t^{RR} + \boldsymbol{\gamma}\left(d_{t-1} - d^*\right) + \mathbf{u}_t \qquad (2.11) \\
d_t &= \frac{1+i_t}{\left(1+\Delta p_t\right)\left(1+\Delta y_t\right)} d_{t-1} + \frac{\exp\left(g_t\right) - \exp\left(t_t\right)}{\exp\left(y_t\right)} \\
\mathbf{z}_t^{'} &= \left[\begin{array}{ccccc} i_t & y_t & \Delta p_t & t_t & g_t \end{array}\right]
\end{aligned}$$

where $\mathbf{Z}_t$ includes the five variables present in a fiscal VAR. Debt is explicitly introduced in the VAR. The estimated model on US data never delivers "unsustainable debt paths" and the model augmented with debt and the non-linear debt dynamics equation produces results which are very similar to those obtained by including the R&R shocks in a traditional fiscal VAR. U.S. data are drawn from a sustainable fiscal regime: within this regime it is likely that the feedback between fiscal variables and the (linearized) debt dynamics is captured in a linear VAR specification that includes all the variables that enter in the debt-deficit relationship. Nevertheless, having the possibility of checking that fiscal multipliers are computed along a sustainable path is an important step, that might become relevant for countries other than the US.

Corsetti, Meier and Muller(2012) analyze the effects of an increase in government spending under a plausible debt stabilizing policy that links current stimulus to a subsequent period of spending restraint. They show that accounting for such spending reversals of crucial importance to bring standard new Keynesian model in line with the stylized facts of fiscal transmission.

External Instrument SVARs

Mertens and Ravn(2013, 2014) propose to consider the series based on the narrative evidence as a noisy measure of the true unobservable fiscal shock. They identify exogenous tax changes in a VAR model by proxying latent tax shocks with narratively identified tax liability changes.

Given a VAR in n variables consider again the relationship between the variance covariance of the observed VAR innovations $\mathbf{u}_t$ and the unobserved structural shocks $\mathbf{e}_t$:

$$\begin{aligned}
A\mathbf{u}_t &= B\mathbf{e}_t \\
E\left(\mathbf{u}_t \mathbf{u}_t^{\prime}\right) &= \mathbf{A}^{-1}\mathbf{B}E\left(\mathbf{e}_t \mathbf{e}_t^{\prime}\right)\mathbf{B}^{\prime}\mathbf{A}^{-1} \\
&= \mathbf{A}^{-1}\mathbf{B}\mathbf{B}^{\prime}\mathbf{A}^{-1} = \mathbf{C}\mathbf{C}^{\prime} = \Sigma
\end{aligned}$$

Substituting population moments with sample moments we have:

$$\widehat{\sum} = \widehat{\mathbf{A}}^{-1}\widehat{\mathbf{B}}\mathbf{I}\widehat{\mathbf{B}}'\widehat{\mathbf{A}}^{-1}, \tag{2.12}$$

$\widehat{\sum}$ contains $n(n+1)/2$ different elements (where n is the dimension of the VAR), which is the maximum number of identifiable parameters in matrices **A** and **B.**

Consider now the availability of a vector m_t of $k \times 1$ observable proxy variables that are correlated with the k structural shocks of interest $\mathbf{e}_{1t}$ and orthogonal to the other $n-k$ shocks $\mathbf{e}_{2t}$ (where $\mathbf{e}_t' = [\mathbf{e}_{1t}', \mathbf{e}_{2t}']$). The proxy variables have zero mean and satisfy two conditions:

$$E\left(m_t \mathbf{e}_{1t}'\right) = \Phi, E\left(m_t \mathbf{e}_{2t}'\right) = 0 \tag{2.13}$$

where Φ is an unknown nonsingular $k \times k$ matrix.

Consider the following partitioning of C

$$\begin{aligned} C &= \begin{bmatrix} \underset{nxk}{C_1} & \underset{nx(n-k)}{C_2} \end{bmatrix} \\ C_1 &= \begin{bmatrix} \underset{kxk}{C_{11}'} & \underset{kx(n-k)}{C_{21}'} \end{bmatrix}' \\ C_2 &= \begin{bmatrix} \underset{(n-k)xk}{C_{12}'} & \underset{(n-k)x(n-k)}{C_{22}'} \end{bmatrix}' \end{aligned}$$

with nonsingular C_{11} and C_{22}. Conditions (2.13) together with the relation between structural shocks and VAR innovations imply that

$$\Phi C_1' = \Sigma_{mu'} \tag{2.14}$$

This system, which is of dimension $n \times k$, provides additional identifying restrictions but it also depends on the k^2 unknown elements of Φ. If one is not prepared to make any further assumptions on Φ other than nonsingularity, equation (2.14) provides really only $(n-k)k$ new identification restrictions. Partitioning $\Sigma_{mu'} = \left[\Sigma_{mu_1'}\Sigma_{mu_2'}\right]$, where $\Sigma_{mu_1'}$ is $k \times k$ and $\Sigma_{mu_2'}$ is $k \times (n-k)$ and using (2.14), these restrictions can be expressed as

$$C_{21} = \left(\Sigma_{mu_1'}^{-1}\Sigma_{mu_2'}\right)' C_{11} \tag{2.15}$$

which is a viable set of covariance restrictions as $\left(\Sigma_{mu_1'}^{-1}\Sigma_{mu_2'}\right)$ can be estimated.

In practice, estimation can proceed in three stages

- Estimate the reduced form VAR by least squares.
- Estimate $\left(\Sigma_{mu_1'}^{-1}\Sigma_{mu_2'}\right)$ from regression of VAR residuals on m_t

- impose (2.15) and estimate the objects of interest, if necessary in combination with further identifying assumptions.

Mertens and Ravn (2014) apply this methodology to the standard BP VAR to reconcile the apparently different size of multipliers obtained in BP and R&R, while Martens and Ravn (2013) discriminate between the effects of changes in average personal income tax rates and the effects of changes in average corporate income tax rates to find that unanticipated changes in either tax rates produce large short run effects on aggregate output. Moreover, tax revenue falls in response to cuts in personal income taxes while on average there is a little impact on tax revenues of the corporate income tax cuts.

The Average Treatment Effect of Fiscal Policy

Jorda-Taylor (2013) reinterpret fiscal multipliers in the logic of the measurement of treatment effects.

Consider a very simplified version of our general model which includes the narratively identified fiscal correction episodes:

$$\mathbf{z}_t = A\mathbf{z}_{t-1} + \boldsymbol{\beta}_1 e_t^{DV} + \epsilon_t$$

The MA if the VAR truncated at lag h is

$$\begin{aligned} \mathbf{z}_{t+h} &= A^{h+1}\mathbf{z}_{t-1} + A^h \boldsymbol{\beta}_1 e_t^{DV} + v_{t+h} \\ v_{t+h} &= \boldsymbol{\beta}_1 e_{t+h}^{DV} + ... + A^{h-1}\boldsymbol{\beta}_1 e_{t+1}^{DV} + \\ & \quad + \epsilon_{t+h} + A\epsilon_{t+h-1} + ...A^h \epsilon_t \end{aligned}$$

The impulse response describing the effect of the fiscal correction on the variable of interest, say output growth, is then

$$E\left(y_{t+h} - y_t \mid e_t^{DV} = 1, I_t\right) - E\left(y_{t+h} - y_t \mid e_t^{DV} = 0, I_t\right) = \sum_{i=0}^{h} \frac{\partial \Delta y_{t+i}}{\partial e_t^{DV}} = \sum_{i=0}^{h} e^y A^i \boldsymbol{\beta}_1$$

where e^y is a selector vector that extracts output growth for the vector of variables $\mathbf{z}_t$. This impulse response can be obtained via a series of h regressions by applying the Linear Projection method introduced by Jordà (2005)

$$y_{t+h} = \pi_h' \mathbf{z}_{t-1} + \theta^h e_t^{DV} + v_{t+h}$$

in practice the conditioning set $\mathbf{z}_{t-1}$ can be augmented in LPM as LPM is based on a single equation estimation (after the identification of the shocks) and more degrees of freedom are available:

$$y_{t+h} = \gamma_h' \mathbf{w}_{t-1} + \theta^h e_t^{DV} + v_{t+h}$$

Note also that the LP method also can easily accommodate non-linear impulse responses. The comparison of the LPM regression with the full truncated MA representation makes clear that LPM omits all structural shocks between time t and time t+h. This omitted variables problem would not lead to inconsistent estimates of the parameters of $A^h\boldsymbol{\beta}_1$ ($p\lim \hat{H}_h = A^h\beta_1$) only if e_t^{DV} were orthogonal to all omitted variables, or if $\mathbf{w}_{t-1}$captures the relevant variation in all omitted variables.

The use of LPM to derive IR and multipliers leads naturally to interpret the effect of fiscal policy as the effect of a treatment. In fact the average policy effect on a variable y_t at horizon $t+h$ can be written as

$$E\left[(y_{t+h}(d_j) - y_t) - (y_{t+h}(d_0) - y_t) \mid w_t\right] = \theta^h$$

Where d_j is the policy intervention. Jorda-Taylor note that if the fiscal corrections are to be considered as a treatment, then it is crucial that the policy intervention is not predictable to avoid a standard allocation bias problem. As a matter of fact e_t^{DV} are predictable by their own past, and by past values of debt dynamics (see also Hernandez da Cos and Moral-Benito(2011)). To solve this problem JT propose to apply LPM after having purged the fiscal actions from predictability. They proceed as follows:

(i) redefine e_t^{IMF} innovations as a 0/1 dummy variable,

(ii) estimate a *propensity score* deriving the probability with which a correction is expected by regressing it on its own past and predictors,

(iii) use the propensity score to derive an Average Treatment Effect based on Inverse Probability Weighting.

Denote the policy propensity score $p^j(w,\psi)\ \ for\ j = 1, 0$ (the predicted values from a probit projections of the policy indicator on the set of predictors w).

$$\begin{aligned}\theta^h &= E\left[(y_{t+h}(d_1) - y_t) - (y_{t+h}(d_0) - y_t) \mid w_t\right] \\ &= E\left[(y_{t+h} - y_t)\left(\frac{1\{D_t = d_1\}}{p^1(w,\psi)} - \frac{1\{D_t = d_0\}}{1 - p^1(w,\psi)}\right) \mid w_t\right]\end{aligned}$$

$$\begin{aligned}\hat{\theta}^h &= \frac{1}{T}\sum (y_{t+h} - y_t)\,\hat{\delta}_t \\ \hat{\delta}_t &= \frac{1\{D_t = d_1\}}{\hat{p}^1(w,\psi)} - \frac{1\{D_t = d_0\}}{1 - \hat{p}^1(w,\psi)}\end{aligned}$$

In the LP framework ATE can be combined with LP in the following estimator LP-IWPRA estimator

$$\hat{\theta}^{h} = \frac{1}{T}\sum\left[\left(y_{t,h}-y_t\right)\hat{\delta}_t-\hat{\phi}_t m\left(w_t,\gamma^h\right)\right]$$

$$\hat{\phi}_t = \frac{1\left\{D_t=d_1\right\}-\hat{p}^{1}\left(w,\psi\right)}{\hat{p}^{1}\left(w,\psi\right)}-\frac{1\left\{D_t=d_0\right\}-\left(1-\hat{p}^{1}\left(w,\psi\right)\right)}{1-\hat{p}^{1}\left(w,\psi\right)}$$

where $m\left(w_t,\gamma^h\right)$ is the mean of $\left(y_{t,h}-y_t\right)$ predicted by the LP

By applying the corrected estimator they find and average treatment effect of fiscal consolidation which is not very different form the one estimated by DeVries et al. with a peak effect in year 5 after the consolidation slightly larger than -1, and a cumulative effect after five years at about -3.

To understand this evidence two remarks are in order. First exogeneity in dynamic time-series models is different from predictability. The correct estimation of the effects on output of a fiscal adjustment within our specification requires the use exogenous fiscal shocks, i.e. shocks that cannot be predicted from past output growth, predictability from past shocks or other variables not directly related to output growth is irrelevant to determine the required exogeneity status. This requirement is satisfied by the original IMF shocks. It is no longer satisfied, however, if one transforms those continuous shocks into a 0/1 dummy variable, as in the paper quoted at the beginning. The reason, as a simple regression shows, is that transformation into a 0/1 dummy, and the loss of information it implies, introduces correlation with past output growth. Notice that the exogeneity required to estimate fiscal multipliers within a dynamic model is different from deriving the effect of a treatment randomly assigned, what matters in our model is weak exogeneity for the estimation of the parameters of interest rather then the random assignment of a treatment.

As a matter of fact the DV corrections can be predicted from past debt dynamics and from their past history by construction. They are predictable by debt dynamics as they are defined as shifts in fiscal policy, 'motivated by the objective of stabilizing or reducing the debt ratio'. Predictability in this sense is not inconsistent with exogeneity with respect to past output growth: for this reason Romer and Romer (2010), for instance, include tax shocks motivated by the objective of stabilizing or reducing the debt among their exogenous (for the estimation of the output effect of fiscal policy) shocks.

They are predictable from their past as these corrections are built adding up two components: unexpected shifts in fiscal variables occurring in year t (that is announced when they are implemented), e_t^u, and shifts in fiscal variables which also occur in year t but had been announced in previous years, $e_{t,0}^a$. Dropping the country index

$$e_t^{DV} = e_t^u + e_{t,0}^a$$

Based on this definition, the fact that the e_t^{DV} are correlated across time is not surprising.

A fiscal plan is specified by making explicit the relation between e_t^u, $e_{t,0}^a$ and the fiscal corrections announced in year t for years $t+i \quad (i>1)$. Therefore

$$\begin{aligned} e_{t,1}^a &= \varphi\, e_t^u + v_t && (2.16) \\ e_{t+1,0}^a &= e_{t,1}^a && (2.17) \end{aligned}$$

The first equation describes the style with which fiscal policy is implemented. Plans along which shifts in fiscal variables are persistent will feature a positive value of φ; while temporary plans (*i.e.* plans along which fiscal actions are reversed, at least partially in the future) feature a negative φ. The second relationship simply states that the announced correction implemented at time t is equal to the correction that had been announced in the previous period with a fiscal foresight of one period.

Then

$$\begin{aligned} Cov\left(e_t^{DV}, e_{t-1}^{DV}\right) &= Cov\left(\left(e_t^u + e_{t,0}^a\right), \left(e_{t-1}^u + e_{t-1,0}^a\right)\right) \\ &= \varphi Var\left(e_{t-1}^u\right) \end{aligned}$$

as

$$e_{t,0}^a = e_{t-1,1}^a = \varphi e_{t-1}^u + v_{t-1}$$

However, in a dynamic time-series model, the requirement for valid estimation and simulation are respectively weak and strong exogeneity, that are different from predictability.

To illustrate the point consider the following simplified example:

$$\begin{aligned} \Delta y_t &= \beta_0 + \beta_1 e_t^{DV} + u_{1t} \\ e_t^{DV} &= \rho e_{t-1}^{DV} + u_{2t} \\ \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} &\sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{pmatrix}\right] \end{aligned}$$

The condition required for e_t^{DV} to be weakly exogenous for the estimation of β_1 is $\sigma_{12} = 0$, which is independent of ρ.When weak exogeneity is satisfied the existence of predictability does not have any effect on the consistency of the estimate of β_1, of course neglecting the existence of predictability of e_t^{DV} under simulation might lead to consider scenarios that were never observed in the data and therefore to unreliable results.

Fiscal Plans

A natural alternative approach to deal with the predictability of the e_t^{DV} corrections is to specify a dynamic specification for the variable of interests and the fiscal plans.

Martens and Ravn (2011) take a first step in this direction by studying the different effects of announced and unanticipated adjustments but they do so without modelling the interdependence between these two components.

Alesina, Favero and Giavazzi (2014, AFG) use the fiscal consolidation episodes identified by Devries et al (2011), but propose a methodological innovation. They start from the observation that the shifts in taxes and spending that contribute to a fiscal adjustment almost never happen in isolation: they are typically part of a multiyear plan, in which some policies are announced well in advance, while other are implemented unexpectedly and, importantly, both tax hikes and spending cuts are used simultaneously. Also, as these plans unfold, they are often revised and these changes have to be taken into account as they constitute new information available to economic agents. AFG stress the importance of modelling the connections between changes in taxes and expenditures, and between unanticipated and announced changes. In practice they consider a restricted version of the general model in which a quasi-panel is estimated allowing for two types of heterogeneity: within-country heterogeneity in the effects of Tax-Based(TB) and Expenditure-Based(EB) plans, and between-country heterogeneity in the style of a plan

$$\begin{aligned} \Delta z_{i,t} &= \alpha + B_1(L)e^u_{i,t} * TB_{i,t} + B_2(L)e^u_{i,t} * EB_{i,t} + \\ & C_1(L)e^a_{i,t,0} * TB_{i,t} + C_2(L)e^a_{i,t,0} * EB_{i,t} + \\ & + \sum_{j=1}^{3} \gamma_j e^a_{i,t,j} * EB_{i,t} + \sum_{j=1}^{3} \delta_j e^a_{i,t,j} * TB_{i,t} + \lambda_i + \chi_t + u_{i,t} \end{aligned} \tag{2.18}$$

$$\begin{aligned} e^a_{i,t,1} &= \varphi_{1,i}\ e^u_{i,t} + v_{1,i,t} \\ e^a_{i,t,2} &= \varphi_{2,i}\ e^u_{i,t} + v_{2,i,t} \\ e^a_{i,t,3} &= \varphi_{3,i}\ e^u_{i,t} + v_{3,i,t} \\ e^a_{i,t,0} &= e^a_{i,t-1,1} \\ e^a_{i,t,j} &= e^a_{i,t-1,j+1} + \left(e^a_{i,t,j} - e^a_{i,t-1,j+1}\right)\ j \geqslant 1 \end{aligned}$$

$$if \quad \left(\tau^u_t + \tau^a_{t,0} + \sum_{j=1}^{horiz} \tau^a_{t,j}\right) \quad > \quad \left(g^u_t + g^a_{t,0} + \sum_{j=1}^{horiz} g^a_{t,j}\right)$$

$$\begin{aligned} then\ TB_t &= 1\ and\ \ EB_t = 0, \\ else\ TB_t &= 0\ \ and\ \ EB_t = 1, \forall\ t \end{aligned}$$

where λ_i and χ_t are country and time fixed effects. A moving average representation for the variable of interest $\Delta z_{i,t}$ is considered in (2.18) with no debt feedback and constant parameters. Cross-country restrictions on the B, C and γ coefficients are imposed, but within- and between-country heterogeneity is allowed for. "Within" because responses of $\Delta z_{i,t}$ to fiscal adjustments will be different for TB and EB plans. "Between" because they will also differ across countries as the $\varphi's$ differ, according to each country's specific style. The dynamic effect of fiscal adjustment plans is different across countries because of the different styles of fiscal policy (as captured by the different φ_i) and within countries as a consequence of the heterogenous effects of plans as determined by their composition. The moving average representation is truncated because the length of the $B(L)$ and $C(L)$ polynomials is limited to three-years. The moving-average representation is specified to allow for different effects of unanticipated and anticipated adjustments. Shifts in fiscal policy affect the economy through three components. First, unanticipated changes in fiscal stance, $e^u_{i,t}$, announced at time t and implemented at time t; second, the implementation at time t of policy shifts that had been announced in the past, $e^a_{i,t,0}$; third, the anticipation of future changes in fiscal policy, announced at time t, to be implemented at a future date, $e^a_{i,t,j}$ for $j = 1, 2, 3$. Also different coefficients are allowed for adjustment announced in the past and implemented at time t and adjustments announced at time t for the future. To avoid double counting lags of future of $e^a_{i,t,j}$ are excluded, as their dynamic effect is captured by $e^a_{i,t+j,0}$. The parameters φ_i, are estimated on a country by country basis on the time series of the narrative fiscal shocks. Note that introducing total adjustment with different labeling (TB or EB) rather than introducing separately in the specification adjustments in revenue and in expenditure allows a much more parsimonious parameterization of the dynamic system defining the style of fiscal plans, making estimation viable.

The system is put at work in AFG to simulate the effect of TB and EB average plans on macroeconomic variables. Simulation of fiscal plans adopted by 16 OECD countries over a 30-year period supports the hypothesis that the effects of consolidations depend on their design. Fiscal adjustments based upon spending cuts are found much less costly, in terms of output losses, than tax-based ones and have especially low output costs when they consist of permanent rather than stop and go changes in taxes and spending. The difference between tax-based and spending-based adjustments appears not to be explained by accompanying policies, including monetary policy. It is mainly due to the different response of business confidence and private investment.

Alesina et al. (2015) use the system to perform out of sample simulations of the austerity plans adopted by different countries over the period 2009-2013. Model projections of output growth conditional only upon the fiscal plans implemented since 2009 do reasonably well in predicting the total output fluctuations of the countries in our sample over the years 2010-13 and are also capable of explaining some of the cross-country heterogeneity in this variable.

2.3.3 Non-linearities

Non-linearities in fiscal multipliers are investigated in a number of papers.

Corsetti, G., A. Meier and G.Mueller (2012b) study the determinants of government spending multipliers by investigating how the fiscal transmission mechanism depends on three dimension of economic environment: the exchange rate regime, the level of public debt and deficit, and the presence of a financial crisis. The analysis is implemented on annual data for 17 OECD countries within a sample period 1975–2008. A two-step approach is considered. In the first step the fiscal policy rule, which links government spending and macroeconomic variables, is identified and estimated. The parameters in fiscal policy rules are country-specific and fiscal policy shokcs are identified as the innovations in the rules. In a second step fixed-effects panel regression are estimated to trace the impact of the estimated government spending shocks on the relevant macroeconomic aggregates (output, private consumption, investment, trade balance, real effective exchange rate). To study non-linearities interaction terms of shocks with dummies capturing the exchange rate regime, the state of public finances, and the presence of financial crisis) are included in the regression. The estimated system can be represented as follows:

$$
\begin{aligned}
\mathbf{g}_{t,i} &= \phi_i + \eta_i trend_i + \beta_{i,1} g_{t-1,i} + \beta_{i,2} g_{t-2,i} + \gamma_{i,1} y_{t-1,i} + \gamma_{i,2} y_{t-2,i} + \theta_i cli_{t-1,i} + \delta_i b_{t-1,i} \\
&\quad + \delta_i b_{t-1,i} + \rho_{i,1} peg_{t-1,i} + \rho_{i,2} strain_{t,i} + \rho_{i,3} crisis_{t-1,i} + \boldsymbol{\varepsilon}_{t,i} \\
\mathbf{z}_{t,i} &= \alpha_i + \mu_i trend_t + \chi_i \mathbf{z}_{t-1,i} + \sigma_1 \widehat{\varepsilon}_{t,i} + \sigma_2 \widehat{\varepsilon}_{t-1,i} + \sigma_3 \widehat{\varepsilon}_{t-2,i} + \sigma_4 \widehat{\varepsilon}_{t-3,i} + \kappa_1 (\widehat{\varepsilon}_{t,i} * d_{t,i}) + \\
&\quad + \kappa_2 (\widehat{\varepsilon}_{t-1,i} * d_{t-1,i}) + \kappa_3 (\widehat{\varepsilon}_{t-2,i} * d_{t-2,i}) + \kappa_4 (\widehat{\varepsilon}_{t-3,i} * d_{t-3,i}) + \lambda_1 d_{t,i} + \lambda_2 d_{t-1,i} + \\
&\quad + \lambda_3 d_{t-2,i} + \lambda_4 d_{t-3,i} + \mathbf{u}_{t,i}
\end{aligned}
$$

where $g_{t,i}$ is government spending variable, $y_{t-1,i}, y_{t-2,i}$ - lags of log per capita output, $cli_{t-1,i}$ lag of a composite leading indicator which measures the expectation with respect to next-year growth, $b_{t-1,i}$ debt to gdp ratio. $peg_{t-1,i}$ is a dummy for an exchange rate, $strain_{t,i}$ - is a dummy for strained public finances, and $crisis_{t-1,i}$ is a financial crisis dummy. $\boldsymbol{\varepsilon}_{t,i}$ - is a fiscal policy shock which measures discretionary policy change. The methodoolgy does not allow to disentangle unanticipated corrections from announced and implemented, furthermore it is assumed that innovations in the projections of goverment spending on past information are orthogonal to deviations of all other macroecononomic variables (including government revenues) from their projections. $\mathbf{z}_{t,i}$ - is the macroeconomic variable of interest, $\widehat{\varepsilon}_{t,i}$ is an estimated fiscal shock from the first stage and $d_{t,i}$ - is a dummy for specific economic conditions in the particular year. Importantly σ parameters measure the baseline dynamic effect of the spending shocks, while κ measures additional marginal effects.

Corsetti, G., A. Meier and G.Mueller (2012b) model is multi country economy, however $A_{2,i}(L, S_t) = 0$,since foreign variables are not allowed to have an impact. $\mathbf{z}_{t,i}$ is not a vector of variables of interest, but it denotes one variable of interest at a time (output, private consumption, private fixed investment, trade balance, the real effective exchange rate, CPI inflation, the short-term nominal interest rate, and government spending itself). There is no debt feedback $A_{3,i}(L, S_t) = 0$. Debt dynamic is also absent in the model. The model does not uses plans, but relies instead on general spending shocks identified by imposing some (strong) restrcitions in the first stage regression. There are three sources of non-linearities: exchange rate regimes, the state of public finances, and the state of the economy.

Baseline results feature persistency in government spending shocks and a sizeable response of aggregate output by about 0.7 percentage points. Under the currency peg multipliers are positive: impact and maximum is 0.6. Weak public finance produce negative multipliers, both impact -0.7, maximum 0.2 and cumulative after two years -1.2. The most quantitatively relevant results are for the case of financial crisis: the responses of output to a public spending increase is strongly positive, implying a fiscal multiplier of 2.3 - impact and 2.9 - maximum.

Auerbach, Gorodnichenko (2012) make an attempt to assess how the size of fiscal multipliers vary over the cycle by estimating regime-switching SVAR models, with smooth transitions across the relevant states of the economy (i.e., recession versus expansion).

The basic adopted specification is:

$$\begin{aligned}
\mathbf{z}_t &= (1 - F(s_{t-1}))A_1(L, E)\,\mathbf{z}_{t-1} + F(s_{t-1})A_1(L, R)\,\mathbf{z}_{t-1} + \mathbf{u}_t \\
\mathbf{u}_t &\sim N(0, \Sigma_t) \\
\Sigma_t &= \Sigma_E(1 - F(s_{t-1})) + \Sigma_R F(s_{t-1}) \\
F(s_{t-1}) &= \frac{\exp(-\gamma s_t)}{1 + \exp(-\gamma s_t)}, \gamma > 0 \\
var(s_t) &= 1, E(s_t) = 0
\end{aligned}$$

where $\mathbf{z}_t = [G_t, T_t, Y_t]$, following Blanchard and Perotti (2002) G_t is government purchases, T_t government receipts of direct and indirect taxes net of transfers to businesses and individuals, Y_t is gross domestic product. All variables are in logs and are deflated. Estimation uses quarterly data. Structural shocks are identified form VAR innovations by assuming lower triangularity in the matrix that maps shocks into innovations. Importantly, the model allows for both contemporaneous differences in propagation of structural shocks as well as dynamic. The first one goes through Σ_E and Σ_R, while the second one goes through $A_1(L, E)$ and $A_1(L, R)$. s_t is an index, normalized to have mean of zero and variance of 1, indicating recessions if s is negative and expansion if s is positive. Auerbach, Gorodnichenko (2012) set s_t to a seven quarter moving average of the output growth rate. γ is calibrated to 1.5, which means that the economy spends around 20 percent of the time in recession $Pr(F(s_t) > 0.8) = 0.2$. Under the assumption that $\gamma > 0$, $A_1(L, E)$ and Σ_E characterizes the economy in expansion and $A_1(L, R)$ and Σ_R - in recession.

Auerbach, Gorodnichenko (2012) model is a single country a closed economy model, the vector $\mathbf{z}_t$ consists of three variables: G_t, T_t, Y_t, there are two states of the economy, expansion where $A_1(L, S_t) = A_1(L, E)$ and $\Sigma_t = \Sigma_E(1 - F(s_{t-1}))$ with $F(s_{t-1}) = 0$ versus recession $A_1(L, S_t) = A_1(L, R)$ and $\Sigma_t = \Sigma_R F(s_{t-1})$ with $F(s_{t-1}) = 1$. There is no debt feedback $A_{3,US}(L, S_t) = 0$. The model does not uses plans, but relies instead on shocks restricting announced, unanticipated and anticipated corrections to have the same effect $B_1(S_t) = C_1(S_t) = D_1(S_t) = B_1(S_t), B_2(S_t) = C_2(S_t) = D_2(S_t) = B_2(S_t)$. In alternative to the basic model a more advanced specification is considered. This specification include professional forecasts of the relevant variable in the vector $\mathbf{z}_t = [\Delta G^{Forecast}_{t,t-1}, \Delta T^{Forecast}_{t,t-1}, \Delta Y^{Forecast}_{t,t-1}, G_t, T_t, Y_t]$.

Because of non-linearities the estimation as well as the inference is implemented using the Monte Carlo Markov Chain method with Hastings-Metropolis algorithm, where the parameters estimates as well as confidence intervals are computed directly from the generated chains. Computed multipliers are interpreted as indicating how by how many dollars output increase over time if government expenditure increases by $1. The size of the shock is chosen in such a way that the integral of government spending response over 20 quarters is equal to one.

Baseline results show that in all cases linear, expansion and recession the impact output multiplier is around 0.5 in response to 1$ spending increase. However, after 20 quarters under the recession regime the multiplier is 2.5 and under expansion regime the multiplier is -1. Average multiplier under the recession is 2.24 and under the expansion -0.33. Fiscal policy is considerably more effective in recessions than in expansions. This evidence refers to polar cases, as in the computation of impulse responses the initial regime is maintained constant: the policy innovation cannot cause a shift in s_t.

Ramey, Owyang and Zubairy(2013) remove this restrictions by computing regime-dependent multipliers using the Linear Projections (LP) method of Jordà(2005). In LP non-linearities are easily accommodated and there is no need to impose the restrictions that shock do not affect the state of the economy. A state-dependent model is estimated in which impulse responses and multipliers depend on the average dynamics of the economy in each state. They address the question of the relevance of non-linearities by analyzing new quarterly historical U.S. data covering multiple large wars and deep recessions. Differently from previous studies they do not find higher multipliers during times of slack in the US.

Ramey and Zubairy(2014) extend the investigation to consider the effect of two potentially important features of the economy: (1) the amount of slack and (2) whether interest rates are near the zero lower bound. The main findings indicate no evidence that multipliers are different across states, whether defined by the amount of slack in the economy or whether interest rates are near the zero lower bound.

2.3.4 Quasi Natural Experiments and Descriptive Evidence.

All the literature that we have been discussing so far fits in the general framework as all the empirical models adopted can be considered of specific cases of our general "encompassing" model, however there are exceptions that exploit "case studies" without specifying a dynamic model. Such studies are best interpreted as focusing on some direct measure of the causal effect of fiscal policy on output growth.

Acconcia, Corsetti and Simonelli (2013) exploit the introduction of a law issued to fight political corruption and mafia infiltration of city councils in Italy that has caused episode of large, temporary and unanticipated fiscal contractions arguably exogenous for the estimation on their effect on output. Using these episodes as instruments, while controlling for national monetary and fiscal policy and keeping the tax burden of local residents constant, the output multiplier of spending cuts at provincial level is estimated in the range 1.2-1.8.

Alesina and Ardagna(2010), adopting an approach introduced by Giavazzi and Pagano(1990), consider a case study of large changes in fiscal policy stance, namely large increase or reduction of budget deficits and analyze their effects on both the economy and the dynamics of the debt. In particular, they concentrate on episodes of large changes in fiscal policy. They use a panel of 20 OECD countries with annual data over the sample 1970-2007. Fiscal variables are cyclically adjusted by considering the difference between a measure of the fiscal variable in period t computed as if the predicted value from a regression of the fiscal policy variable as a share of GDP on a constant a time trend and the unemployment rate, where the unemployment rate at time t is kept at the value observed in time t-1. A period of fiscal adjustment (stimulus) is a year in which the cyclically adjusted primary balance improves (deteriorates) by at least 1.5 per cent of GDP.

Focussing on these episodes and using mainly descriptive evidence they find that tax cuts are more expansionary than spending increases in the cases of a fiscal stimulus, fiscal adjustments based upon spending cuts and no tax increases are more likely to reduce deficits and debt over GDP ratios than those based upon tax increases. Finally, adjustments on the spending side rather than on the tax side are less likely to create recessions.

The two very different approaches adopted by Acconcia et al.(2013) and Alesina and Ardagna(2010) have in common the direct analysis of episodes without the specification of a dynamic macro-model. The case of the exogeneity of the chosen episodes for the measurement of the relevant phenomenon is certainly much stronger in the Acconcia et al.(2013) case. In fact, Guajardo et al.(2011) argue convincingly that changes in cyclically adjusted fiscal variables often include non-policy changes correlated with other developments affecting economic activity. For the sake of illustration they consider a boom in the stock market, such a boom creates a cyclically adjusted surplus by increasing capital gains and cyclically adjusted tax revenues. This surplus can be associated with an increase in consumption and investment generated by the stock market boom. The resulting measurement error is likely to bias the analysis towards downplaying contractionary effects of fiscal consolidations.

However, even if the exogeneity of the episodes considered by Acconcia et al. is clearly robust to this type of considerations, the question on how the results produced in the case studies can be extended to the measurement of fiscal multipliers in presence of different dynamics, initial conditions and heterogeneity in the mechanism of formation of expectations remains unsolved.

2.4 The Impact of Different Identification and Specification Strategies. An illustration

To illustrate the relevance of different specification choices we consider quarterly US data over the period 1978:1 2012:4 and compare the BP SVAR approach with a dynamic model of fiscal adjustment plans. We use NIPA variables described in the Appendix. To be as close as possible to Blanchard, Perotti (2002) we use their definitions of the variables[3].

The BP specification is the following one :

$$\begin{bmatrix} 1 & 0 & -2.08 \\ 0 & 1 & 0 \\ -a_{31} & -a_{32} & 1 \end{bmatrix} \begin{bmatrix} T_t \\ G_t \\ Y_t \end{bmatrix} = A_1(L) \begin{bmatrix} T_{t-1} \\ G_{t-1} \\ Y_{t-1} \end{bmatrix} + \begin{bmatrix} \sigma^T & 0 & 0 \\ b_{21} & \sigma^G & 0 \\ 0 & 0 & \sigma^Y \end{bmatrix} \begin{bmatrix} e_t^T \\ e_t^G \\ e_t^Y \end{bmatrix}$$

where $[T_t, G_t, Y_t]$ is a vector of quarterly taxes, spending, and output. All variables are in the logarithms and in real, per capita, terms. $\mathbf{e}_t = [e_t^T, e_t^g, e_t^y]$ are structural shocks, orthogonal to each other with. $A_1(L)$ is a lag polynomial with the length of four quarters. Following Blanchard, Perotti 2002 we include constant, linear and quadratic trends into the model. Sample period is 1978q1 to 2012q4. Since our sample starts with the first quarter of 1978 we do not need to include a dummy variable for the second quarter of 1975 as in Blanchard, Perotti 2002. BP identifying restrictions are imposed on the matrices relating the unobserved structural shocks to the VAR innovations.

[3]From NIPA tables: output is nominal GDP (NIPA 1.1.5.1); government spending is General Government consumption expenditures and gross investment (NIPA 1.1.5.21); total tax revenue is General Government Current receipts (NIPA 3.1.1) less General Government Current Transfers to persons (NIPA 3.1.21) less General Government Interest Payments to persons (NIPA 3.1.25) plus General Government Income receipts on assets (NIPA 3.1.8). All series are deflated by GDP deflator (NIPA 1.1.9.1) and by FRED Population (Midperiod, Thousands, Quarterly, Seasonally Adjusted Annual Rate).

Results are reported in the form of impulse response functions. Note that a unit shock to the structural innovations of taxes transforms to less than a unit change in the reduced form tax residuals, because output falls in response to the tax increase and in turn tax revenue falls. Figure 2.2 reports impulse responses where impulse response of output has an interpretation of the tax (expenditure) multipliers, i.e. dollar changes in GDP as a ratio of the dollar changes in tax revenues (expenditure). Following BP multipliers are obtained by expressing impulse responses as shares of average gdp with initial impulse normalized to 1% of average gdp. Unless mentioned otherwise, we provide one standard deviation confidence intervals that are computed using a bootstrap algorithm with 1000 replications. The solid line gives the point estimates, while the dotted lines are confidence bounds.

Insert Figure 2.2

the BP model produces response of output insignificant and close to zero in response to the 1% of structural tax shock . There is a negative response of output in the short run and positive in the long run in response to 1% cut of structural expenditure innovations.

We compare this impulse response with those obtained from a truncated MA in a model with plans. Plans for quarterly data are reconstructed for the US on the basis of DeVries et al. in Favero, Karamysheva(2015). In the wording of R&R we consider only deficit driven plans and we adopt the following empirical model to assess their effects

$$\begin{gathered}\Delta y_t = \alpha + B_1(L)(\tau_t^u + g_t^u) * TB_t + B_2(L)(\tau_{t,t}^a + g_{t,t}^a) * TB_t + \\ + C_1(L)(\tau_t^u + g_t^u) * EB_t + C_2(L)(\tau_{t,t}^a + g_{t,t}^a) * EB_t + \\ + \sum_{i=1}^{horz} D_i(\tau_{t,t+i}^a + g_{t,t+i}^a) * TB_t + \sum_{i=1}^{horz} E_i(\tau_{t,t+i}^a + g_{t,t+i}^a) * EB_t + \mathbf{u}_t \\ \mathbf{u}_t \sim N(0, \Sigma) \\ (\tau_{t,t+i}^a + g_{t,t+i}^a) * TB_t = \delta_i^{TB}(\tau_t^u + g_t^u) * TB_t + \nu_{t+i}^1, \ for \ i = \overline{1, horz} \\ (\tau_{t,t+i}^a + g_{t,t+i}^a) * EB_t = \delta_i^{EB}(\tau_t^u + g_t^u) * EB_t + \nu_{t+i}^2, \ for \ i = \overline{1, horz}\end{gathered} \tag{2.19}$$

Δy_t is the growth rate of GDP (quantity index for real GDP, data source National Income and Product Accounts (NIPA) - table 1.1.3).

The specification generalizes the MA adopted by Romer and Romer by allowing different coefficients on the unanticipated expenditure, g_t^u, and revenue, τ_t^u adjustments (announced at time t and implemented at time t), on the anticipated correction currently implemented (announced before time t, and implemented at time t) $\tau_{t,t}^a, g_{t,t}^a$, and on the future corrections (announced at time t, to be implemented in the future),$\tau_{t,t+i}^a, g_{t,t+i}^a$. The length of the polynomials $B_1(L)$, $B_2(L)$, $C_1(L)$, $C_2(L)$ - is set to 6. The anticipating horizon is set by considering the median implementation lag, which is again six quarters. The MA representation is then augmented by a number of auxiliary equations that capture the nature of the plan via the correlation between the intertemporal and intratemporal component of fiscal adjustments.

EB_t and TB_t are dummies that label plans into Expenditure Based or Taxed Based according to the larger present value of the types of correction.

Results are in the form of the impulse response functions, which are obtained by forward simulation of the model. Since our dependent variable is in differences, we report cumulative impulse response functions. The length of the IRF is limited to the number of lags included into the system. One Standard deviation confidence intervals are built by bootstrap with 1000 replications . We use block bootstrap to take into account potential serial correlation in residuals, restricting the length of the block to 2. Working with the quarterly data we give a shock of 1% to the total plan. To do so we give initial shock to unanticipated component of the plan TB plan - 0.58%, and for unanticipated component of EB plan - 0.79%. Sample period is from 1978 quarter one to 2012 quarter four. Figure 2.3 shows the responses of output growth to the TB and EB plans.

Insert figure2.3

A positive shock to the tax based plan produces a significantly negative effect on the output growth. While the shock to the expenditure based plan gives a marginally significant exapnsionary effect. These results are very different from those obtained by applying the BP method on the same data-set with the difference being generated by different identification and specification strategies.

2.5 What Have We Learned ?

This paper represent an attempt to answer to the question "What do we know about Fiscal Multipliers?" by setting up a general "encompassing" model flexible enough to consider all the different empirical specifications adopted in the literature as specific cases that can be derived by imposing set of restrictions on the general model. This framework allows us to take into account of two crucial remarks on the empirical analysis of fiscal policy made by Ramey(2015) and Leeper(2010). First, the measurement of fiscal multipliers is a question for which dynamics are all-important, general equilibrium effects are crucial, and expectations have powerful effects. Second, multipliers depend on the type of spending or tax change, as well as on a host of other factors: expected sources and timing of future fiscal financing, whether the initial change in policy was anticipated or not, how monetary policy behaves, what is the state of cycle when the policy is implemented. There is not such a thing as a unique fiscal multiplier and the evidence obtained by a specific investigation on the multiplier can be understood only within a general dynamic framework which clearly indicates the specification and identification choices made in that investigation.

2.6 References

Acconcia A., G. Corsetti and S.Simonelli (2013) ”Mafia and Public Spending: Evidence on the Fiscal Multiplier from a Quasi-Experiment” The American Economic Review 104 (7), 2185-2209

Alesina A. and R. Perotti (1997) ”The Welfare State and Competitiveness” *American Economic Review 87, 347-66*

Alesina A. and S. Ardagna (2010), “Large Changes in Fiscal Policy: Taxes versus Spending”, *Tax Policy and the Economy*, vol. 24, 35–68, edited by J.R. Brown.

Alesina A., S. Ardagna, R. Perotti and F. Schiantarelli (2002), “Fiscal Policy, Profits and Investment”, *American Economic Review*, 92(3), 571–589.

Alesina, Alberto, Carlo Favero and Francesco Giavazzi (2014), “The output effects of fiscal stabilization plans”, forthcoming in Journal of International Economics, available at http://igier.unibocconi.it/favero

Alesina A., O. Barbiero, C.Favero, F.Giavazzi and M.Paradisi(2014) ”Austerity in 2009-2013”, paper prepared for 60th panel meeting of Economic Policy, October 2014

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

Bachmann R. and E. Sims, (2011),“Confidence and the Transmission of Government Spending Shocks”, NBER Working Paper No. 17063, National Bureau of Economic Research, Inc.

Barro R. J. and C. J. Redlick (2011), “Macroeconomic Effects from Government Purchases and Taxes”, *The Quarterly Journal of Economics*, 126(1), 51–102.

Baxter M. and R. G. King (1993), “Fiscal Policy in General Equilibrium”, *American Economic Review*, 83(3), 315–334.

Blanchard O. and R. Perotti (2002), “An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output”, *Quarterly Journal of Economics*, 117(4), 1329–1368.

Blanchard, Olivier, and Daniel Leigh (2013), “Growth Forecast Errors and Fiscal Multipliers,” IMF Working Paper No. 13/1 (Washington: International Monetary Fund).

Beetsma R., J.Cimadomo, O.Fortuna, M.Giuliodori (2014) “The Confidence Effects of Fiscal Consolidations”, paper presented at the 60th Economic Policy Panel

Bloom N. (2009), “The Impact of Uncertainty Shocks”, *Econometrica*, 77(3), 623–685.

Caldara, Dario (2011), ”The Analytics of SVARs: A Unified Framework to Measure Fiscal Multipliers,” IIES working paper,

Cavallo, Michele (2005), “Government Employment Expenditure and the Effects of Fiscal Policy Shocks,” Federal Reserve Bank of San Francisco Working Paper 2005-16, Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1998). ‘Monetary Policy shocks: what have we learned and to what end?’. NBER working paper No. 6400.

Christiano, L., M. Eichenbaum and S. Rebelo (2011), ”When is the Government Spending Multipliers Large?”, *Journal of Political Economy*, 119 (1), 78-121.

Chung H. and E.M. Leeper(2007) ”What has Financed Government Debt?” NBER Working Paepr No W12345

Cloyne, J. (2013), “Discretionary Tax Changes and the Macroeconomy: New Narrative Evidence

from the United Kingdom”, The American Economic Review, 103(4): 1507-1528.

Corsetti, G., A. Meier and G.Mueller (2012), ”Fiscal Stimulus with Spending Reversals”, The Review of Economics and Statistics, 94, 4: 878-895.

Corsetti, G., A. Meier and G.Mueller (2012b), ”What Determines Government Spending Multipliers”, Economic Policy, 523-564

de Cos, Pablo Hernandez and E. Mora (2012), ”Fiscal Consolidations and Economic Growth”. working paper, Banco de Espana.

DeLong J. B. and L. H. Summers (2012), “Fiscal Policy in a Depressed Economy ”, Working Paper.

Drautzburg T. and H.Uhlig (2013) ”Fiscal Stimulus and distortionary taxation”, mimeo

Dell’Erba, Salvatore, Todd Mattina and Augustin Roitman (2013), “Pressure or Prudence? Tales of Market Pressure and Fiscal Adjustment,” IMF Working Paper No. 13/170 (Washington: International Monetary Fund).

Devries, Pete, Jaime Guajardo, Daniel Leigh and Andrea Pescatori (2011), “A New Action-based Dataset of Fiscal Consolidations.” IMF Working Paper No. 11/128 (Washington: International Monetary Fund).

Eggertsson, G. B. (2010), ”What Fiscal Policy is Effective at Zero Interest Rates?”, *NBER Macroeconomic Annual*, D. Acemoglu and M. Woodford (eds), Chicago University Press.

Eggertsson, Gauti B., and Paul Krugman (2012), “Debt, Deleveraging, and the Liquidity Trap,” Quarterly Journal of Economics, 127(3): 1469–513.

Fatás, Antonio and I. Mihov (2001) ”The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence”, mimeo, INSEAD

Favero, Carlo and Francesco Giavazzi (2012), “Measuring Tax Multipliers: the Narrative Method in Fiscal VARs”, American Economic Journal: Economic Policy, 4(2): 69-94.

Favero C., F.Giavazzi and J.Perego (2011) ”Country Heterogeneity and the International Evidence on the Effects of Fiscal Policy”, IMF Economic Review, 59,4, 652-682

Fisher, Jonas D.M., and Ryan Peters (2010), “Using Stock Returns to Identify Government Spending Shocks,” The Economic Journal, 120 (May 2010): 414-436.

Galí J., J. D. López-Salido and J. Vallés (2007), "Understanding the Effects of Government Spending on Consumption", *Journal of the European Economic Association*, 5 (1), 227–270.

Garratt A., K. Lee, M. H. Pesaran and Y. Shin (2012), *Global and National Macroeconometric Modelling: A Long-Run Structural Approach* Oxford University Press.

Giavazzi F. and M. Pagano (1990), "Can Severe Fiscal Contractions Be Expansionary? Tales of Two Small European Countries ", NBER Chapters in *NBER Macroeconomics Annual 1990*, vol. 5, 75-122.

Giavazzi F. and M. McMahon (2013), "The Household effects of Government Spending", in A. Alesina and F. Giavazzi (eds.), *Fiscal Policy After the Great Recession*, University of Chicago Press and NBER, 2013

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

Hernandez da Cos P. and E.Moral-Benito(2011) "Endogenous Fiscal Consolidations", Working Paper 1102, Banco de Espana

Jalil A.(2012), "Comparing Tax and spending Multipliers: it is all about controlling for monetary policy" mimeo, Dept of Economics, Reed College

Jordà, Oscar (2005), "Estimation and Inference of Impulse Responses by Local Projections", American Economic Review, 95(1): 161-182

Jordà, Òscar and Alan 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.

Leeper E. M. (2010), "Monetary Science, Fiscal Alchemy", NBER Working Papers No. 16510, National Bureau of Economic Research, Inc.

Leeper E. M., T. B. Walker and S.-C. Yang (2013), "Fiscal Foresight and Information Flows", Econometrica 81(3) 115-1145

Lippi M. and L. Reichlin (1994), "VAR Analysis, Non Fundamental Representations, Blaschke Matrices", *Journal of Econometrics*, 63(1), 307–325.

Mertens K. and M. O. Ravn (2011), "Understanding the Aggregate Effects of Anticipated and Unanticipated Tax Policy Shocks", *Review of Economic Dynamics*, 14(1), 27–54.

Mertens K. and M. O. Ravn (2013), "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States", The American Economic Review , 103,4, 2012-47

Mertens, Karel, and Morten O. Ravn(2014)., "A Reconciliation of SVAR and Narrative Estimates of Tax Multipliers," Journal of Monetary Economics 68: S1-S19.

Mountford, Andrew and Harald Uhlig(2009), "What are the Effects of Fiscal Policy Shocks? Journal of Applied Econometrics 24 : 960-992.

Pappa ( ) to be added

Perotti, Roberto [2008]: “In Search of the Transmission Mechanism of Fiscal policy”; *NBER Macroeconomic Annual*.

Perotti, Roberto (2013), “The Austerity Myth: Gain without Pain”, in Fiscal Policy after the Financial Crisis, edited by Alberto Alesina and Francesco Giavazzi. (Cambridge, MA: National Bureau of Economic Research)

Perotti R (2013), ”The Austerity Myth: Gain without Pain?” forthcoming in A. Alesina and F. Giavazzi (eds.) *Fiscal Policy After the Great Recession*, University of Chicago Press and NBER.

Ramey, V. (2011a), “Identifying Government Spending Shocks: It’s All in the Timing.” *Quarterly Journal of Economics* 126 (1): 1-50.

Ramey V. (2011b), “Can Government Purchases Stimulate the Economy?”, *Journal of Economic Literature*, 49(3), 673–685.

Ramey V. (2013), ”Government Spending and Private Activities” in A. Alesina and F. Giavazzi (eds) *Fiscal Policy after the Great Recession* University of Chicago Press and NBER forthcoming

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, Papers and Proceedings* forthcoming

Ramey, Valerie A. and Sarah Zubairy(2014), “Government Spending Multipliers in Good Times and in Bad: Evidence from 20th Century Historical Data,” November 2014 working paper.

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.

Uhlig, Harald (2005): “What are the Effects of Monetary Policy? Results from an Agnostic Identification Procedure” Journal of Monetary Economics.

Uhlig, Harald (2012), “Economics and Reality,” Journal of Macroeconomics 34 (March 2012): 29-41.

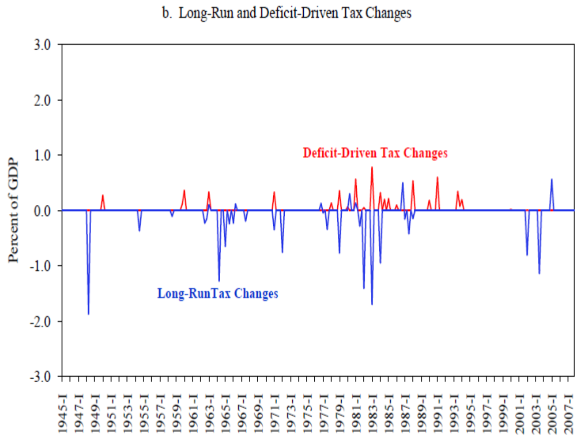

Figure 2.1: Romer and Romer shocks

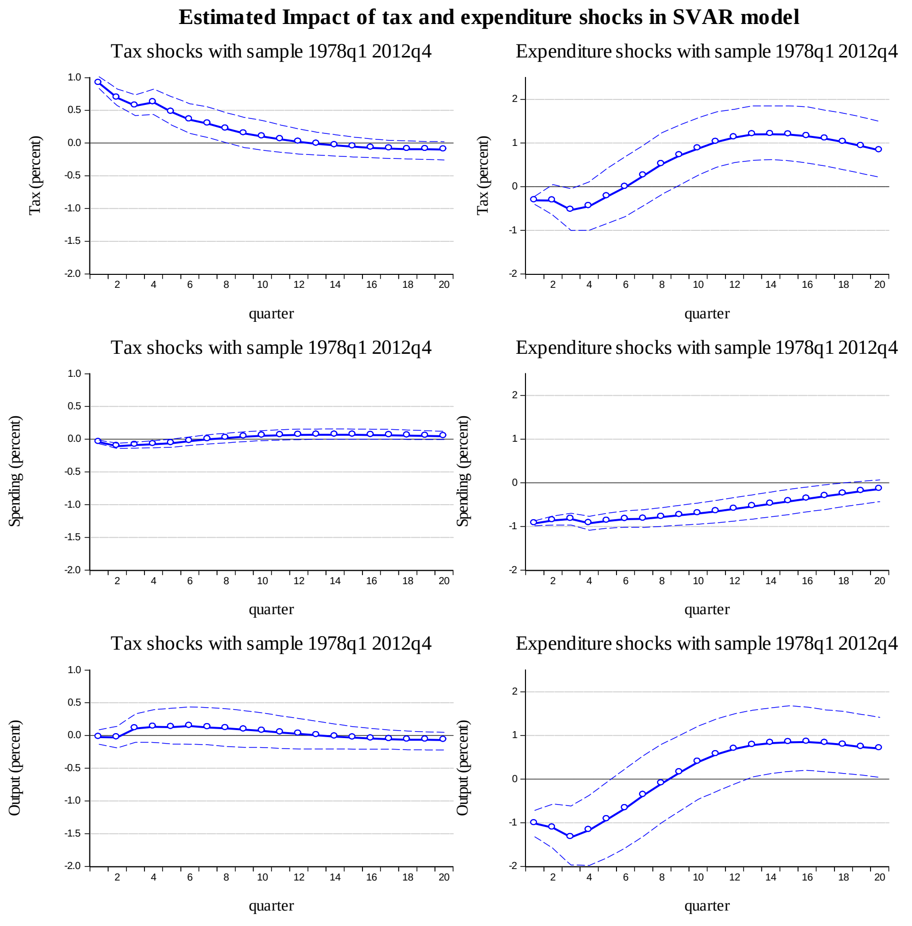

Figure 2.2: Impulse response functions to Tax and Spending Shocks with SVAR (Blanchard, Perotti 2002)

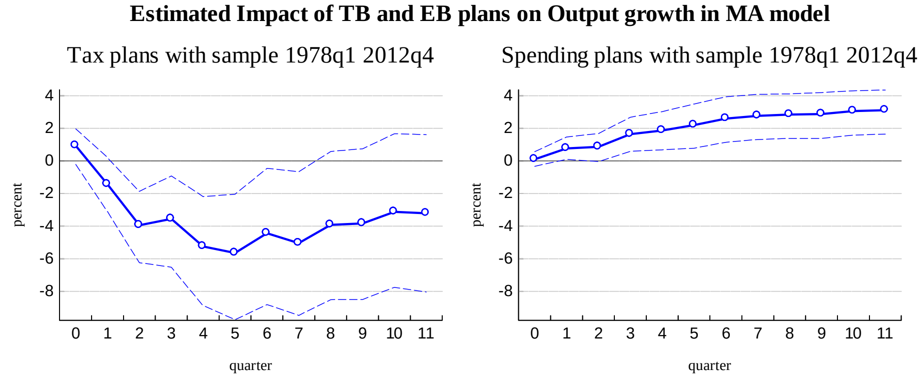

Figure 2.3: Impulse response function of output growth using truncated moving average with plans (Favero, Karamysheva 2015)

Chapter 3

The Measurement of the Output Effect of Fiscal Adjustment

3.1 Introduction

This paper analyzes the measurement of the output effects of fiscal stabilization policies,by assessing the relevance of different methods in determining the heterogeneity of available results and by evaluating comparatively the different approaches proposed in the literature.

The output effect of fiscal adjustment is very controversial: different theoretical models give very different predictions on the magnitude and the sign of the effect (see, for example, Baxter and King,1993, De Long and Summers 2012, Christiano et al. (2011). The role of empirical analysis of fiscal policy is then crucial to select the theoretical model capable of matching the data and relevant for policy simulation analysis.

The objective of this project is to evaluate the different econometric approaches that have been proposed to measure the output effects of fiscal policy. Measuring the output effect of fiscal consolidations requires a sample of exogenous shifts in fiscal stance. The exogeneity of the relevant policy adjustment for the estimation of its output effect requires that they are not correlated with news on the current state of the economy.

The traditional procedure to identify exogenous adjustments begins with the estimation of a joint dynamic model for the structure of the economy and the variables controlled by the policy-makers (typically a VAR). The residuals in the estimated equation for the policy variable approximate deviations of policy from the rule. Such deviations are not yet the object of interest because part of them represents reaction to contemporaneous information on the state of economy. Some restrictions are required to map the structural shocks of interest out of the VAR innovations. In the case the policy of interest is monetary policy identification can be achieved by exploiting the fact that monetary policy decisions are taken regularly at a rather high frequency (we have eight FOMC meetings every year) and there is consensus on the fact that it takes at least one period between two meetings before the economy reacts to monetary policy. This triangular structure, where innovation in the monetary policy variable reflect both monetary policy shocks and macroeconomic shocks but macroeconomic variables are not contemporaneously affected by monetary policy shocks, allows identification. After their identification shocks are considered the correct experiment to gather the empirical evidence for the selection of the relevant theoretical model. Empirical reduced form models need to be simulated by keeping all parameters constant and only the simulation of shocks allows this. As the validity of the simulation requires shocks to be exogenous, some identification structure has to be imposed on estimated reduced form dynamic models to derive them. In fact, to conduct valid experiments with reduced form model two requirements must be satisfied: simulate exogenous policy actions and consider experiments that do not change the correlation in the data used to estimate the parameters in the empirical model.

Fiscal policy is different in the sense that it is conducted through rare decisions and it is implemented through multi-year plans. When fiscal policy is conducted in country i through multi-year plans, narrative exogenous fiscal adjustments in each year are made of three components: the unexpected adjustments (announced upon implementation at time t), the past announced adjustments (implemented at time t but announced in the previous years) and the future announced corrections.

These features of fiscal policy generates "fiscal foresight"(Leeper et al 2008, Leeper 2010), agent know in advance future announced, measures. Fiscal foresight causes a misalignment between the information set used by the econometrician in a VAR and that available to economic agents (see Lippi and Reichlin, 1994): exogenous combination of unanticipated and announced fiscal corrections that characterizes a plan cannot be uniquely recovered from VAR innovations, technically the Moving Average representations of the VAR becomes non-invertible.

As a consequence of this specific feature of fiscal policy, after some initial effort of adapting the identification scheme used for monetary policy, the strategy of mapping the VAR innovations into fiscal shocks has become less successful than an alternative procedure that it is based on a non-econometric direct identification of the correction of interest that are then plugged in directly in an econometric specification capable of delivering the impulse response functions of interest. In this "narrative" (Romer and Romer, R&R 2010) identification scheme a time-series of exogenous shifts in taxes is constructed using Congressional reports, etc.to identify the size, timing, and principal motivation for all major postwar tax policy actions. Legislated tax and expenditure changes are classified into endogenous (induced by short-run countercyclical concerns) and exogenous, responses to an inherited budget deficit, or to concerns about long-run economic growth or politically motivated.

After identification of the relevant fiscal shocks a (truncated) moving average representation is used to derive the dynamic effect of the exogenous fiscal policy on the variables of interest by simply projecting these variables on current and past values of the shocks. Under the null of the validity of the identification assumptions the empirical model adopted allows to compute impulse responses, in fact although large part of the information set available to agents is omitted, the omitted information is orthogonal to that included in the empirical model and therefore it does not affect the consistency of the relevant estimates. The truncated moving average representation allows to validly reconstruct the effect on the variables of interest of the policy under evaluation. The narrative identification scheme has been adopted by Devries et al.(2013) produce a data set which documents exogenous shifts in fiscal policy (both tax and expenditure) by applying the narrative approach to a set of seventeen OECD countries. Amongst all fiscal actions, these authors have selected those that were designed to reduce a budget deficit and/or to put the public debt on a sustainable path. Cloyne(2013) has produced a database for the UK.

The introduction of the narrative approach to fiscal policy led to striking results: Romer and Romer(2010) analyses the effect of an exogenous shock in taxation to find a multiplier statistically different from that typically found in the empirical literature Devries et al. extend the evidence to analyze the output effect of fiscal consolidation in 17 IMF countries. Jordà and Taylor (2013) argue that the episodes of fiscal consolidation identified by Devries et al are not exogenous, and thus are not valid instruments because they can be predicted using their own past (strongly), past values of output growth (very weakly) and past values of debt dynamics (weakly). Jordà and Taylor (2013) address this problem implementing the following correction of the narrative innovations : *(i)* redefine narrative innovations as a 0/1 dummy variable, *(ii)* estimate a *propensity score* deriving the probability with which a correction is expected by regressing it on its own past and predictors, *(iii)* use the propensity score to derive an Average Treatment Effect based on Inverse Probability Weighting. The apply this method to find different evidence on the effects of fiscal stabilization policies.

Alesina Favero and Giavazzi (2013) and Alesina et al.(2014) propose a different framework that explicitly recognizes that fiscal plans generate inter-temporal and intra-temporal correlations among changes in spending and revenues. The inter-temporal correlation is the one between the announced (future) and the unanticipated (current) components of a plan — the ”style” of a plan. The intra-temporal correlation is that between the changes in revenues and spending that determines the composition of a plan. As argued by Ramey (2011a, b) distinguishing between announced and unanticipated shifts in fiscal variables, and allowing them to have different effects on output, is crucial for evaluating fiscal multipliers. The literature, however, (see e.g. Mertens and Ravn 2011) has so far studied the different effects of anticipated and unanticipated shifts in fiscal variables assuming that they are orthogonal.

A fiscal plan is specified by making explicit the relation between the unpredictable component of the plan and the other two components.Within this framework the authors take into account of the intratemporal correlations of plans by allowing for heterogenous effects of Tax-Based corrections and Expenditure-Based corrections. This innovation leads to observe striking difference between the output effects of EB and TB fiscal corrections.

This project combines the narrative databases of Romer&Romer and Devries et al. (2011) to produce a database of exogenous fiscal plans on US quarterly data. This database is used to assess the output effect of fiscal consolidation plans using all the different methods . To this end we propose a general econometric specification which extends the simple truncated MA representation considered by R&R and that takes into account the intertemporal and the intratemporal correlations. All the approaches proposed in the literature based on collapsing plans into shocks (R&R and DeVries et al.) or on cleaning narrative shocks (Jordà and Taylor(2013) are then evaluated in the context of this nesting model.

3.2 Exogenous fiscal plans

Measuring the output effect of fiscal consolidations requires a sample of exogenous shifts in fiscal stance. Fiscal foresight does not allow to treat exogenous shifts in fiscal policy as unobservables and identify them by imposing restrictions on reduced form dynamic specifications of macroeconomic and fiscal variables. The narrative method allows instead to construct a time-series of the relevant shocks without the need to estimate a model. R&R refer to presidential speeches and Congressional reports, to identify the size, timing, and principal motivation for all major postwar tax policy actions. They then classify legislated changes into endogenous (those induced by short-run countercyclical concerns and those taken because of change in government spending) and exogenous (those that are responses to the state of government debt or to concerns about long-run economic growth).

Similarly Devries et al.(2013) produce a data set which documents exogenous shifts in fiscal policy (both tax and expenditure) by applying the narrative approach to a set of seventeen OECD countries. Amongst all fiscal actions, these authors have selected those that were designed to reduce a budget deficit and/or to put the public debt on a sustainable path.

In this paper we use database of quarterly time-series of exogenous fiscal stabilization episodes for the US economy.

When fiscal policy is conducted in country i through multi-year plans narrative exogenous fiscal adjustments in each year are made of three components: the unexpected adjustments (announced upon implementation at time t), the past announced adjustments (implemented at time t but announced in the previous years) and the future announced corrections

We identify plans as sequences of fiscal corrections announced at time t to be implemented between time t and time $t+k$; we call k the anticipation horizon. We define the unanticipated fiscal shocks at time t as the surprise change in the primary surplus at time t:

$$e_t^u = \tau_t^u + g_t^u$$

where τ_t^u is the surprise increase in taxes announced at time t and implemented in the same year, and g_t^u is the surprise reduction in government expenditure also announced at time t and implemented in the same year. We denote instead as $\tau_{t,j}^a$and $g_{t,j}^a$ the tax and expenditure changes announced by the fiscal authorities of country i at date t with an anticipation horizon of j years (*i.e.* to be implemented in year $t+j$). In the D&al dataset fiscal plans almost never extend beyond a 3-year horizon: thus we take $j=3$ as the maximum anticipation horizon [1]. We therefore define the observed anticipated shocks in period t as follows

$$\begin{aligned}
\tau_{t,0}^a &= \tau_{t-1,1}^a \\
\tau_{t,j}^a &= \tau_{t-1,j+1}^a + \left(\tau_{t,j}^a - \tau_{t-1,j+1}^a\right) \;\; j \geqslant 1 \\
g_{t,0}^a &= g_{t-1,1}^a \\
g_{t,j}^a &= g_{t-1,j+1}^a + \left(g_{t,j}^a - g_{t-1,j+1}^a\right) \;\; j \geqslant 1 \\
e_{t,j}^a &= \tau_{t,.j}^a + g_{t,.j}^a
\end{aligned}$$

Imoplementing fiscal policy thruogh plans means that fiscal corrections in each year can be written as follows

$$f_t = e_t^u + e_{t,t}^a + \sum_{j=1}^{horz} e_{t,t+j}^a$$

Moreover we label plans as Tax_Based or Expenditure-Based by adopting the following rule:

$$\begin{aligned}
if \quad \left(\tau_t^u + \tau_{t,t}^a + \sum_{j=1}^{horz} \tau_{t,t+j}^a\right) \quad &> \quad \left(g_t^u + g_{t,t}^a + \sum_{j=1}^{horz} g_{t,t+j}^a\right) \\
then\; TB_t \quad &= \quad 1 \; and \;\; EB_t = 0, \qquad (3.1) \\
else\; TB_t \quad &= \quad 0 \;\; and \;\; EB_t = 1, \forall\, t
\end{aligned}$$

[1]In the sample there are a few occurences of policy shifts anticipated four and five years ahead. Their number is too small to allow us to include them in our estimation.

In total we have 53 observations with some non zero adjustment for a total of 20 plans divided into EB and TB (21 quarters of adjustment are labeled TB and 32 are labelled EB). The mean of non zero total historical adjustments is 0.286, the mean of TB plans is lower than that of EB plans than stands at 0.32.

3.3 Econometric Modelling of the effects of narrative shocks and plans

Implementing fiscal policy through plans means that fiscal corrections in each year can be written as follows

$$f_t = (\tau_t^u + g_t^u) + \left(\tau_{t,t}^a + g_{t,t}^a\right) + \sum_{j=1}^{horz} \left(\tau_{t,t+j}^a + g_{t,t+j}^a\right)$$

Plans feature intertemporal and intratemporal dimensions, modelling of these dimensions requires the specification of a system to determine the relevant interactions in the plans:

$$\begin{array}{cc} \multicolumn{2}{c}{g_t^u = \rho_1^u \tau_t^u + \epsilon_t^{gu}} \\ \tau_{t,t+i}^a = \delta_i^{\tau\tau} \tau_t^u + \epsilon_{t+i}^{\tau a} & \tau_{t,t+i}^a = \delta_i^{g\tau} g_t^u + \epsilon_{t+i}^{\tau ga} \\ g_{t,t+i}^a = \delta_i^{gg} g_t^u + \epsilon_{t+i}^{ga} & g_{t,t+i}^a = \delta_i^{g\tau} \tau_t^u + \epsilon_{t+i}^{g\tau a} \\ g_{t,t}^a = g_{t-1,t}^a & \tau_{t,t}^a = \tau_{t-1,t}^a \end{array} \tag{3.2}$$

The first relationship is a behavioral relation that captures the intratemporal dimension of the plan. The second set of relationships capture the style with which fiscal policy is implemented. Permanent plans will feature a significantly positive $\delta's$, while temporary plan (to be reversed, at least partially in the future) will feature a significantlly negative $\delta's$.

The last set of relationships simply states that the announced correction implemented at time t is equal to that that was announced in the previous period with a fiscal foresight of one period. Note that this does not imply that all announced corrections are effectively realized but it does imply that deviations of implemented corrections from those announced are always considered as surprises by all agents

The simulation of the effect of the plan can then be obtained by augmenting the above system with a relation to capture the effect of the plan on the variable of interest. A simple parameterization can be obtained by adopting an extension of the truncated MA framework proposed by R&R:

$$\begin{gathered}
\Delta Y_t = \alpha + B_1(L)(\tau_t^u) + B_2(L)(g_t^u) + C_1(L)(\tau_{t,t}^a) + C_2(L)(g_{t,t}^a) + \\
+ \sum_{i=1}^{horz} D_i * (\tau_{t,t+i}^a) + \sum_{i=1}^{horz} E_i * (g_{t,t+i}^a) + \epsilon_t \\
g_t^u = \rho_1^u \tau_t^u + \epsilon_t^{gu} \\
\tau_{t,t+i}^a = \delta_i^{\tau\tau} \tau_t^u + \epsilon_{t+i}^{\tau a} \qquad \tau_{t,t+i}^a = \delta_i^{g\tau} g_t^u + \epsilon_{t+i}^{\tau g a} \\
g_{t,t+i}^a = \delta_i^{gg} g_t^u + \epsilon_{t+i}^{ga} \qquad g_{t,t+i}^a = \delta_i^{g\tau} \tau_t^u + \epsilon_{t+i}^{g\tau a} \\
g_{t,t}^a = g_{t-1,t}^a \qquad \tau_{t,t}^a = \tau_{t-1,t}^a
\end{gathered} \tag{3.3}$$

The specification generalizes the MA adopted by Romer and Romer by allowing different coefficients on the unanticipated expenditure, g_t^u, and revenue,τ_t^u adjustments (announced at time t and implemented at time t), on the anticipated correction currently implemented (announced before time t, and implemented at time t) $\tau_{t,t}^a, g_{t,t}^a$, and on the future corrections (announced at time t, to be implemented in the future),$\tau_{t,t+i}^a, g_{t,t+i}^a$. The possibility of different coefficients on announced, anticipated and unanticipated corrections is well grounded in the theoretical literature and has already been introduced in empirical work (Perotti(2010), Mertens and Ravn (2009)). The MA representation is then augmented by a number of auxiliary equations that capture the nature of the plan via the correlation between the inter-temporal and intratemporal component of fiscal adjustments.

Two potential problems arise with this specification. First the model is very heavily parameterized (with quarterly data the anticipation horizon of 3 year implies i=12) and the estimation of some of the δ_i coefficients might in some cases be based on a very limited number of observations. The interpretation of the effect of a simulated shock is not immediate: in fact the intertemporal and the intratemporal dynamics of the plans might be such that an initial correction to expenditure might generate a plan that is much more tax-based than expenditure based. To overcome these two problems we shall work with the following modified version of (3.3) :

$$\begin{gathered}
\Delta Y_t = \alpha + B_1(L)(\tau_t^u + g_t^u) * EB_t + B_2(L)(\tau_t^u + g_t^u) * TB_t + \\
+ C_1(L)(\tau_{t,t}^a + g_{t,t}^a) * EB_t + C_2(L)(\tau_{t,t}^a + g_{t,t}^a) * TB_t + \\
+ \sum_{i=1}^{horz} D_i * (\tau_{t,t+i}^a + g_{t,t+i}^a) * EB_t + \sum_{i=1}^{horz} E_i * (\tau_{t,t+i}^a + g_{t,t+i}^a) * TB_t + \epsilon_t \\
(\tau_{t,t+i}^a + g_{t,t+i}^a) * TB_t = \delta_i^{TB} (\tau_t^u + g_t^u) * TB_t + \epsilon_{t+i}^1, \ for \ i = \overline{1, horz} \\
(\tau_{t,t+i}^a + g_{t,t+i}^a) * EB_t = \delta_i^{EB} (\tau_t^u + g_t^u) * EB_t + \epsilon_{t+i}^2, \ for \ i = \overline{1, horz} \\
\tau_{t,t}^a + g_{t,t}^a = \tau_{t-1,t}^a + g_{t-1,t}^a
\end{gathered} \tag{3.4}$$

where we use the EB_t and TB_t dummies to label plans and we use the total correction to pin down the intertemporal dimension of the plan and exploit the fact that when simulated the total correction we shall implicitly take into account the intertemporal dimension of plans. Following Mertens and Ravn(2009) $horz$ is set by considering the median implementation lag, which is six quarters.The specification is now more parsimonious and it allows to identify separately the output effect of tax-based corrections from that of expenditure-based corrections.

3.3.1 What's new in our approach

The benchmark for econometric modelling of the output effect of shocks identified via the narrative methods is offered by Romer and Romer (2010) and Devries at al. (2012). Both specifications omits potentially relevant dimensions of fiscal plans. R&R. estimate, by OLS, the following empirical model:

$$\begin{aligned} \Delta \ln Y_t &= \alpha + B(L)\tau_t^{RR} + \epsilon_t \qquad (3.5) \\ \tau_t^{RR} &= \tau_t^u + \sum_{i=1}^{horz} \tau_{t,t+i}^a \end{aligned}$$

where the exogenous tax shocks are derived by summing corrections announced at time t and immediately implemented (therefore unanticipated) and corrections announced at time t to be implemented in future periods, the dependent variable is the growth rate of real GDP. So the response of the level of output at time $t+i$ to a one-period shock of the size of 1% of GDP is measured by the appropriate sum of the coefficients in $B(L)$. The most natural way of interpreting (3.5) as a truncated partial moving-average representation of the equation for $\Delta \ln Y_t$ in a structural VAR. The representation is truncated because it is finite (while the inversion of a VAR will generate an infinite MA representation) and it is partial because the only shocks included are those of interest., i.e. the shocks to taxation. However, if all the omitted information is orthogonal to the variables included in the specification, then the estimates of the relevant parameters, although inefficient, will be consistent. The model serve the only purpose of evaluating the output effect of fiscal shocks and it is a limited information representation of the macroeconomy, where the omitted information is considered irrelevant for the relevant task at hand. The specification omits the intratemporal dimension of the plans and imposes strong restrictions on the intertemporal dimension in the sense that the impact of announced and implemented adjustments is restricted to be same.

DeVries et al. consider a different specification:

$$\begin{aligned} \Delta \ln Y_t &= \alpha + B_1(L)e_t^{IMF} * TB_t^{IMF} + B_2(L)e_t^{IMF} * EB_t^{IMF} + \epsilon_t \qquad (3.6) \\ e_t^{IMF} &= \tau_t^{IMF} + g_t^{IMF} \\ \tau_t^{IMF} &= \tau_t^u + \tau_{t,0}^a \qquad (3.7) \\ g_t^{IMF} &= g_t^u + g_{t,0}^a \end{aligned}$$

which poses strong restrictions on the intertemporal dimension of the plan, as it rules any effect of fiscal adjustment before implementation.

Jordà and Taylor (2013), have argued that e_t^{IMF} are not exogenous shocks, and thus are not valid instruments, because they can be predicted using *their own past*, *past values of debt dynamics* and *past values of output growth*. The third source of predicatibility — the fact that the D&al episodes appear to be predicted by past output growth — only arises if one transforms those episodes from a continuous variable into a 0/1 dummy variable, as done in Jordà and Taylor (2013). The reason, as a simple regression shows, is that transformation into a 0/1 dummy, and the loss of information it implies, introduces correlation with past output growth.

The first two sources of predictability — from past episodes of fiscal adjustment and past values of debt dynamics — do not invalidate the type of exogeneity that is relevant for the estimation of the output effects of fiscal policy within a plan: this is because exogeneity is different from predictability. The correct estimation of the effects on output of a fiscal adjustment only requires the use exogeneous fiscal adjustments, *i.e.* those that cannot be predicted from past output growth. The exogeneity required to estimate fiscal multipliers within a dynamic model like the one used in this paper is different from the condition required if one were to estimate these parameters from an *average treatment effect (ATE),* as we shall further discuss later What matters here is *weak exogeneity* for estimation, and *strong exogeneity* for simulation, not the random assigment of a treatment. Weak and strong exogeneity are satisfied by the original D&al episodes.

To further illustrate this points, consider our plans and, for simplicity, drop the country index and restrict the anticipation horizon to only one period. Then

$$\begin{aligned} f_t &= e_t^u + e_{t,0}^a + e_{t,1}^a \\ e_{t,1}^a &= \varphi\, e_t^u + v_t \\ e_{t,0}^a &= e_{t-1,1}^a \end{aligned}$$

Based on this definition, the fact that e_t^{IMF} are correlated across time is not suprising. In fact

$$\begin{aligned} Cov\left(e_t^{IMF}, e_{t-1}^{IMF}\right) &= Cov\left(\left(e_t^u + e_{t,0}^a\right), \left(e_{t-1}^u + e_{t-1,0}^a\right)\right) \\ &= Cov\left(\left(e_t^u + e_{t-1,1}^a\right), \left(e_{t-1}^u + e_{t-1,0}^a\right)\right) \\ &= \varphi Var\left(e_{t-1}^u\right) \end{aligned}$$

since

$$e_{t,0}^a = e_{t-1,1}^a = \varphi e_{t-1}^u + v_{t-1}$$

Importantly, however, the predictability of e_t^{IMF} by their own past does not violate the weak exogeneity of e_t^u, $e_{t,0}^a$ and $e_{t,1}^a$, the condition required if one estimates the output effect of fiscal studying plans, rather than individual shocks. Consider, for the sake of illustration, this simple model

$$\begin{aligned}
\Delta y_t &= \beta_0 + \beta_1 e_t^{IMF} + u_{1t} \\
e_t^{IMF} &= \rho e_{t-1}^{IMF} + u_{2t} \\
\begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} &\sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{pmatrix}\right]
\end{aligned}$$

The condition required for e_t^{IMF} to be weakly exogenous for the estimation of β_1 is $\sigma_{12} = 0$, and it is independent of ρ.

3.4 The importance of simulating plans

Measuring the output effect of fiscal policy by simulating plans requires first the narrative identification of adjustment episodes exogenous with respect output fluctuations, second the decomposition of adjustments in their expected an unexpected part , third the simulation of the effect of adjustment. This last step is accomplished obtained by giving an impulse to the unexpected (and not predictable) component of the plan, simulating the response of announced component of the plan to the unanticipated one to eventually derive the response of variables of interest to fiscal adjustment plans. To understand what happens when plans are not modelled we shall consider in turn the effect of two types of misspecifications related respectively to the omission of the intra-temporal and the intertemporal dimension of fiscal plans.

3.4.1 The econometric implications of the intratemporal dimension of plans

To illustrate the econometric implications of the mis-specification of the intertemporal dimension of plans consider a simplified case where plans have no intertemporal dimension and the estimated model contains a mis-specification cause by the omission of the intratemporal dimension.

In this case the Data Generating Process can be represented as follows:

$$\begin{gathered}
\Delta Y_t = \beta_1 \tau_t + \beta_2 g_t + \epsilon_t \\
g_t = \gamma \tau_t + \nu_t
\end{gathered} \tag{3.8}$$

Where τ_t and g_t are the exogenous fiscal adjustment and ϵ_t, ν_t are two i.i.d orthogonal shocks. In this case there two alternative ways in which the intratemporal dimension of fiscal policy can be neglected.

In the first instance the estimated model omits g_t, and the relation linking exogenous expenditure and revenue is not estimated. An estimate of the tax multiplier is obtained by regressing directly by OLS output growth on τ_t :

$$\Delta Y_t = \alpha \tau_t + \xi_t \tag{3.9}$$

In this case we shall have

$$p \lim \hat{\alpha} = (\beta_1 + \beta_2 \gamma)$$

we have an unbiased estimate of the total response of output growth to an exogenous adjustment in revenue but the interpretation of this estimates is very likely to be incorrect. In fact, the econometrician who estimates (3.9), would probably interpreted $\hat{\alpha}$ as the output effect of a tax cut. In fact $\hat{\alpha}$ is the output effect of a tax cut of paired with a coordinated change in expenditure. Think for example of the case in which $\beta_1 = \beta_2 = \gamma = 1$, the estimated model would lead to the conclusion that the tax multiplier is 2, while to output response is generated by a simultaneous change in taxation and expenditure of the same size.

In the second instance the estimated model includes correctly g_t in the specification for output growth but it omits the second equation from the relevant model

$$\Delta Y_t = \alpha_1 \tau_t + \alpha_2 g_t + \xi_t \tag{3.10}$$

as τ_t and g_t are weakly exogenous for the estimation of the parameters of interest, we shall have

$$\begin{aligned} p \lim \hat{\alpha}_1 &= \beta_1 \\ p \lim \hat{\alpha}_2 &= \beta_2 \end{aligned}$$

But the possible inference that the output effect of a change in taxation $\hat{\alpha}_1$, while keeping g_t unaltered, is wrong.

In fact, $\hat{\alpha}_1$ and $\hat{\alpha}_2$ depend on the relation linking g_t and the correct response of output to a change in taxation is :

$$\frac{d\Delta Y_t}{d\tau_t} = \hat{\alpha}_1 + \hat{\alpha}_2 \gamma$$

γ cannot be set equal to zero under simulation because that will break the correlation between τ_t and g_t that has generated the estimates $\hat{\alpha}_1$ and $\hat{\alpha}_2$.Technically speaking τ_t and g_t are weakly exogenous for the estimation of the parameters of interest but not strongly exogenous for the simulation of the model (see Engle-Hendry(1991)). Strong exogeneity fails exactly because of the lack of modelling of the intratemporal dimension of fiscal plans.

3.4.2 The econometric implications of the intertemporal dimension of plans

To analyze the effect of the mis-specification of the intertemporal dimension of the plan, consider the following Data Generating Process, in which for simplicity we limit the horizon of the announcement to one period:

$$\begin{gathered}\Delta Y_t = \beta_1 \tau_t^u + \beta_2 \tau_{t,t+1}^a + \beta_3 g_t^u + \beta_4 g_{t,t+1}^a + \beta_5 \tau_{t,t}^a + \beta_6 g_{t,t}^a + \epsilon_t^y \\ g_t^u = \rho_1 \tau_t^u + \epsilon_t^{gt} \\ \tau_{t,t+1}^a = \rho_2 \tau_t^u + \epsilon_t^{ta} \\ g_{t,t+1}^a = \rho_3 g_t^u + \epsilon_t^{ga}\end{gathered} \tag{3.11}$$

If the estimated model is

$$\Delta Y_t = \alpha \tau_t^u + \xi_t \tag{3.12}$$

we shall have:

$$p \lim \hat{\alpha} = (\beta_1 + \beta_3 \rho_1 + \beta_2 \rho_2 + \beta_4 \rho_3 \rho_1)$$

and again we would have estimate of the total response of output growth to an exogenous adjustment in revenue with a very complex interpretation, which would be unbiased only if the effect of announced corrections is zero upon implementation. Even if this would be the case, then the total effects captures both the intratemporal and the intertemporal dimension of the plan

If the estimated model becomes instead:

$$\Delta Y_t = \alpha_1 \tau_t^u + \alpha_2 g_t^u + \xi_t \tag{3.13}$$

we have then:.

$$\begin{aligned} p \lim \hat{\alpha_1} &= \beta_1 + \beta_2 \rho_2 \\ p \lim \hat{\alpha_2} &= \beta_3 \rho_1 + \beta_4 \rho_3 \end{aligned}$$

and the estimate would reflect the combination of announced and implemented policy, without considering the impact upon implementation of past announcement. The same strong exogeneity problem noted in the case of the intratemporal dimension of the plan applies and simulation of the effects of the correction would not be valid as the intertemporal dimension of the plan is neglected and the effect of announced plan upon implementation is not included.

consider last the case of the R&R specification

$$\Delta Y_t = \alpha_1 \left(\tau_t^u + \tau_{t,t+1}^a\right) + \xi_t \tag{3.14}$$

this empirical model imposes several restrictions on the general model: $\beta_1 = \beta_2, \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$. If these restriction were invalid, than the size and the interpretation of the estimated tax multiplier would be affected.

3.4.3 Jorda-Taylor and the Average Treatment Effect of Fiscal Policy

The autocorrelation of e_{t+1}^{IMF} is problematic for the application of Local Projections to derive Impulse Response Functions.

To illustrate the point consider the following simple VAR(1) augmented with the observable narratively identified adjustments:

$$Y_t = AY_{t-1} + \boldsymbol{\beta}_1 e_t^{IMF} + \epsilon_t$$

The impulse response :

$$E\left(Y_{t+i} \mid \tau_t^u = 1, I_t\right) - E\left(Y_{t+i} \mid \tau_t^u = 0, I_t\right) = \frac{\partial Y_{t+i}}{\partial \tau_t^u} = A^i \boldsymbol{\beta}_1$$

can be validly obtained by a series a regressions:

$$y_{t+i} = \pi_i' Y_{t-1} + h_i e_t^{IMF} + v_{t+i} \tag{3.15}$$

In general, if e_t^{IMF} were not correlated, this regression would deliver unbiased estimates of the parameters of interest:

$$p \lim \hat{h}_i = A^i \beta_1$$

The consistency results depends on the fact that, the MA representation of the DGP , is:

$$\begin{aligned} Y_{t+i} &= A^{i+1} Y_{t-1} + A^i \beta_1 e_t^{IMF} + v_{t+i} \\ v_{t+i} &= \beta_1 e_{t+i}^{IMF} + A \beta_1 e_{t+i-1}^{IMF} + ... A^{i-1} \beta_1 e_{t+1}^{IMF} + \\ &\quad + \epsilon_{t+i} + A \epsilon_{t+i-1} + ... A^i \epsilon_t \end{aligned}$$

and therefore e_t^{IMF} is orthogonal to v_{t+i}, if they are orthogonal to the other structural shocks and not autocorrelated.

Unfortunately, this orthogonality is lost when fiscal policy is implemented trough plans and they are not properly accounted for as in the De Vries et al. identification strategy , as the very nature of plans generates a correlation in the exogenous fiscal corrections.

Jorda- Taylor stick to e_t^{IMF} innovations and propose a corrections based on the following steps.

- categorize the innovations as a 0/1 variable
- estimate a propensity score deriving the probabilty with which a correction is expected by regressing it on its own past and predictors
- use the propensity score to derive an Average Treatment Effect based on Inverse Probability Weighting

This method has a number of limitations. First, the categorization of the adjustment in 1, 0 variable not only gives up relevant info on the intensity of the adjustment, but it is also dangerous. Think of an extreme situation in which the policy maker always accompain a deficit driven adjustment with a ciclically driven adjustment. The narrative identification will take care of this by separating the two motives but the categorization will not. Second, the links between announced and anticipated part of stabilization plans are lost. Third, the presence of the forward looking component, which is omitted from the specification, will cause bias in the local projections computed IR if there is a systematic relation between the forward looking component and the unexpected component of the adjustment.

3.5 Empirical Results

3.5.1 R&R no intratemporal dimension

We replicate the results in R& & using the following specification:

$$\begin{aligned} \Delta \ln Y_t &= \alpha + B(L)\tau_t^{RR} + \epsilon_t \\ \tau_t^{RR} &= \tau_t^u + \sum_{i=1}^{horz} \tau_{t,t+i}^a \end{aligned} \tag{3.16}$$

The reported figures are the original results with total exogenous shocks (long run +deficit), deficit driven only and deficit driven not compensated by long-run. The number of episodes of exogenous shocks is 28 and deficit driven is 18. While the number of fiscal adjustments: deficit driven shocks, which are not offset by the long-run is 13.

A TABLE WITH PARAMETER ESTIMATES NEEDS TO BE ADDED

We estimate the model using only the Romer and Romer measure of the exogenous tax changes as a percent of GDP and $z_t = \Delta \ln Y_t$ - is the growth rate of the quantity index for real GDP. Thus dependent variable is the same as in our model. Sample period is 1978 - 2007, the data frequency is quarterly. Figure 3.2 (a) shows the impact of the exogenous tax changes on the GDP growth. And we could see negative impact of the tax shock, which is consistent with other empirical evidence in the literature. Figure3.2 (b)- is the impact of Romer and Romer deficit driven adjustments only, and the results fluctuates around zero. Panel (c) of figure3.2 - is the response of the same regression but using our data for tax adjustments. The impact is negative and it is different from panel (b). This result is driven mainly by the specificity construction of the shock: it is not all deficit driven shocks, but only those that are not offset by long-run shocks. To be as close as possible to Romer and Romer we consider the sum of unanticipated and anticipated adjustments. Panel (d) as panel (c) represent response of output growth on deficit driven shocks, which are not offset by long run driven but for the larger sample up to 2012. Romer and Romer conclude that negative result of the effect of exogenous tax is mainly driven by the long run component, and not by the one to stabilize deficit, since the point estimates of the last is even positive. On the other hand, if one would consider the deficit driven component as those which are not offset by long run component the result is different, and we obtain negative effect.

Insert figure3.1 ,3.2

3.5.2 Devries et al: no intertemporal dimension

Add here results form the Devries et al approach

$$\begin{aligned} \Delta \ln Y_t &= \alpha + B_1(L)(\tau_t^{IMF} + g_t^{IMF}) * TB_t^{IMF} + B_2(L)(\tau_t^{IMF} + g_t^{IMF}) * EB_t^{IMF} + \epsilon_t \quad (3.17) \\ \tau_t^{IMF} &= \tau_t^u + \tau_{i,t,0}^a \\ g_t^{IMF} &= g_t^u + g_{i,t,0}^a \end{aligned}$$

ADD RESULTS AND A TABLE WITH ESTIMATES

Insert figure3.3

3.5.3 A model with plans

$$\begin{gathered} \Delta Y_t = \alpha + B_1(L)(\tau_t^u + g_t^u) * EB_t + B_2(L)(\tau_t^u + g_t^u) * TB_t + \\ + C_1(L)(\tau_{t,t}^a + g_{t,t}^a) * EB_t + C_2(L)(\tau_{t,t}^a + g_{t,t}^a) * TB_t + \\ + \sum_{i=1}^{horz} D_i * (\tau_{t,t+i}^a + g_{t,t+i}^a) * EB_t + \sum_{i=1}^{horz} E_i * (\tau_{t,t+i}^a + g_{t,t+i}^a) * TB_t + \epsilon_t \quad (3.18) \\ (\tau_{t,t+i}^a + g_{t,t+i}^a) * TB_t = \delta_i^{TB}(\tau_t^u + g_t^u) * TB_t + \epsilon_{t+i}^1, \ for\ i = \overline{1, horz} \\ (\tau_{t,t+i}^a + g_{t,t+i}^a) * EB_t = \delta_i^{EB}(\tau_t^u + g_t^u) * EB_t + \epsilon_{t+i}^2, \ for\ i = \overline{1, horz} \end{gathered}$$

ADD IMPULSE RESPONSES and a TABLE with estimates

where τ_t^u - is unanticipated tax adjustment, g_t^u - is unanticipated expenditure adjustment, τ_{t0}^a - anticipated tax adjustment executed in year t, g_{t0}^a - anticipated expenditure adjustment executed in year t, τ_{ti+t}^a - anticipated tax adjustment which is announced in year t and will be executed in year $t+i$, g_{ti+t}^a - anticipated expenditure adjustment which is announced in year t and will be executed in year $t+i$, EB_t and TB_t are dummies for expenditure based and tax based plans. z_t - is the dependent variable, and in the baseline specification we use the growth rate of GDP (quantity index for real GDP, data source National Income and Product Accounts (NIPA) - table 1.1.3). Before estimating the model we do an important check, to make sure that our independent variables are exogenous with respect to output growth and debt growth.

The length of the polynomials $B_1(L)$, $B_2(L)$, $C_1(L)$, $C_2(L)$ - is 12, since the horizon we choose is three years and we work with the quarterly data. While anticipating horizon, which is different from the one of the impulse response functions, is equal to 6 - a medium implementation lag (for the robustness we try also 8).

Results are in the form of the impulse response functions, which are obtained by forward simulation of the model. Since our dependent variable is in differences, we use cumulative impulse response functions. The length of the IRF is limited to the number of lags included into the system. Bootstrap confidence intervals are built by 1000 replications and are with one standard deviation (68%). We use a block bootstrap to take into account the serial correlation in residuals, restricting the length of the block to 2. Working with the quarterly data we give a shock of 0.25 to the unanticipated TB (EB) component of the plan. Sample period is from 1978 quarter one to 2012 quarter 4. Figure 3.4 shows the responses of output growth to the TB and EB plans.

Insert figure3.4

A positive shock to the tax based plan produces a significantly negative effect on the output growth. While the shock to the expenditure based plan gives an insignificantly result, which is close to zero. Our one country evidence is consistent with the previous multicountry level study (AFG, 2013). The effect of TB policy riches the maximum in six quarters, while later, it does not move a lot.

Obtained results are robust to the inclusion of the lagged dependent variable and also to the change of the implementation lag. Interestingly, when we exclude the recent crisis from the sample the difference between the tax based and expenditure based effects become much bigger. This is consistent with the evidence provided by Blanchard, Leigh, 2013 who mentioned that the forecast error in multipliers has been changed either due to learning process, or because of the smaller multipliers than in the early years.

3.6 ATE

Add here Jorda Taylor

A basic model we first estimate is

$$\begin{aligned}
\Delta Y_{t+i} &= \alpha^i + \beta_1^i e_t^{IMF} * TB_t^{IMF} + \beta_2^i e_t^{IMF} * EB_t^{IMF} + \beta_3^i \Delta Y_{t-1} + v_{t+i},\ i = \overline{1, horz} \\
e_t^{IMF} &= \tau_t^{IMF} + g_t^{IMF} \qquad (3.19) \\
\tau_t^{IMF} &= \tau_t^u + \tau_{i,t,0}^a \\
g_t^{IMF} &= g_t^u + g_{i,t,0}^a
\end{aligned}$$

where TB_t^{IMF} and EB_t^{IMF} are two IMF dummies. They can be easily substituted with our dummies and bothe results are presented on the figures below.

Insert figure 3.5 and **3.7**

The second model we estimate mimics first step in Jorda Taylor approach. Building the residuals from IMF adjustments is an alternative to the Jorda-Taylor inverse propensity waiting method, in particularly it substitute the first step: based on the propensity score creates a synthetic sample in which the distribution of measured baseline covariates is independent of treatment assignment. Covariates we use are the same as in the Jorda-Taylor paper: debt to GDP ratio; the cyclical component of log real GDP (from HP filter with $\lambda = 100$); real GDP growth; CPI inflation; the change in the investment to GDP ratio; the short-term interest rate on government securities (3-months in maturity); the long-term rate on government securities (10 year bonds); net export to GDP ratio. In all cases, we consider the first lag of the variable. As an additional regressor we take three lags of the dependent variable - IMF adjustments. The results are presented on the following graph:

Insert figure 3.6

The next test we do is the modification of the dependent variable in the basic Jorda - Taylor model. As a dependent variable we take bootstrap series from our model with plans.

Insert figure 3.8

Finally we produce complete replication of the Jorda - Taylor ATE model. First, we reproduce tables 7 and 8 from the Jorda - Taylor paper. Importantly table 7 indeed coincides and it produces the p-value of the Wald test, showing the joint significance of the variables and its lags. Results of table 8 are different: as in the Jorda - Taylor paper in our experiment it is true that treatment is more likely when public debt to gpd ratio is high, while the other variables such as cyclical component of gdp, past treatment and real gdp growth are not always signifficant. This could be explained by the fact that we use one country -US and Jorda - Taylor use a panel of countries. So for example in the major part of the countries the treatment is more likely when the economy is below the potential, while for the US it is not the case. Nevertheles the fitted probabilities and the weights we get are reasonable and make sense. Next figure support the results of Jorda - Taylor in the way that the fiscal austerity is contractionary. The bigger size in absolute value of the multiplier we get could be due to several reasons: first the focus of our study is one country US, second, the data we use is quaterly and not annual.

Insert figure 3.9

3.7 References

Alesina, A., Favero, C., & Giavazzi, F. (2012). The output effect of fiscal consolidations (No. w18336). National Bureau of Economic Research.

Baxter, M., & King, R. G. (1993). Fiscal policy in general equilibrium. The American Economic Review, 315-334.

Blanchard, O. & Leigh, D.(2013). Growth Forecast Errors and Fiscal Multipliers. American Economic Review, 103(3).

Christiano, L., M. Eichenbaum and S. Rebelo (2011), "When is the Government Spending Multipliers Large?", Journal of Political Economy, 119(1), 78-121.

DeLong, J. B., Summers, L. H., FELDSTEIN, M., & RAMEY, V. A. (2012). Fiscal Policy in a Depressed Economy [with Comments and Discussion]. Brookings Papers on Economic Activity, 233-297.

Devries, P., Guajardo, J., & Leigh, D. A. Pescatori, 2011. A new action based dataset of fiscal consolidation. International Monetary Fund (No. 128). IMF Working Paper.

Engle, R. F., & Hendry, D. F. (1993). Testing superexogeneity and invariance in regression models. Journal of Econometrics, 56(1), 119-139.

Guajardo, J., Leigh, D., & Pescatori, A. (2014). Expansionary Austerity? International Evidence. Journal of the European Economic Association.

Jorda, T., & Taylor, A. M. (2013). The time for austerity: estimating the average treatment effect of fiscal policy (No. w19414). National Bureau of Economic Research.

Leeper, E. M. (2010). Monetary science, fiscal alchemy (No. w16510). National Bureau of Economic Research.

Leeper, E. M., Walker, T. B., & Yang, S. C. S. (2008). Fiscal foresight: analytics and econometrics (No. w14028). National Bureau of Economic Research.

Lippi, M., & Reichlin, L. (1994). VAR analysis, nonfundamental representations, Blaschke matrices. Journal of Econometrics, 63(1), 307-325.

Mertens, K., & Ravn, M. O. (2011). Understanding the aggregate effects of anticipated and unanticipated tax policy shocks. Review of Economic Dynamics, 14(1), 27-54.

Mertens, K., & Ravn, M. O. (2012). Empirical Evidence on the Aggregate Effects of Anticipated and Unanticipated US Tax Policy Shocks. American Economic Journal - Economic Policy, 4(2), 145-181.

Mertens, K., & Ravn, M. O. (2013). The dynamic effects of personal and corporate income tax changes in the United States. The American Economic Review, 103(4), 1212-1247.

Perotti, R. (2012). The Effects of Tax Shocks on Output: Not So Large, but Not Small Either. American Economic Journal: Economic Policy, 4(2), 214-37.

Ramey, V. A. (2011a). Identifying Government Spending Shocks: It's all in the Timing. The Quarterly Journal of Economics, 126(1), 1-50.

Ramey, V. A. (2011b). Can government purchases stimulate the economy?. Journal of Economic Literature, 49(3), 673-685.

Romer, C. D., & Romer, D. H. (2009). A narrative analysis of postwar tax changes. Unpublished paper, University of California, Berkeley (June).

Romer, C. D., & Romer, D. H. (2010). The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks. The American Economic Review, 763-801.

3.8 Appendix1: Database of fiscal adjustment plans

Classification of Fiscal Adjustments for US

Date	Tax								Spending								Dummy		Total	IMF				RR	
	$\tau^u_{i,t}$	$\tau^a_{i,t,0}$	$\tau^a_{i,t,1}$	$\tau^a_{i,t,2}$	$\tau^a_{i,t,3}$	$\tau^a_{i,t,4}$	$\tau^a_{i,t,5}$	$\tau^a_{i,t,6}$	$g^u_{i,t}$	$g^a_{i,t,0}$	$g^a_{i,t,1}$	$g^a_{i,t,2}$	$g^a_{i,t,3}$	$g^a_{i,t,4}$	$g^a_{i,t,5}$	$g^a_{i,t,6}$	TB	EB		τ	g	TB	EB	τ_d	τ_{lr}
1978q1	0.135	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.135	0.135	0.000	1	0	0.135	0.000
1978q3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1978q4	0.000	0.000	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1979q1	0.000	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.357	-0.767
1979q2	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1979q3	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1979q4	0.000	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1980q1	0.000	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.062	0.062	0.000	1	0	0.062	0.000
1980q2																								0.000	0.300
1981q1																								0.563	0.134
1981q3	0.230	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.230	0.230	0.000	1	0	0.000	-0.280
1982q1																								0.047	-1.403
1983q1																								0.780	-1.694
1983q3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.210	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1983q4	0.000	0.000	0.000	0.000	0.000	0.000	0.210	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1984q1	0.000	0.000	0.000	0.000	0.000	0.210	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.318	-0.948
1984q2	0.000	0.000	0.000	0.000	0.210	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1984q3	0.000	0.000	0.000	0.210	0.000	0.000	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.201	0.000
1984q4	0.000	0.000	0.210	0.000	0.000	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1985q1	0.000	0.210	0.000	0.000	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.210	0.210	0.000	1	0	0.214	0.000
1985q2	0.000	0.000	0.000	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1985q3	0.000	0.000	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1985q4	0.000	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.000	0.000	0.000	0	0	0.000	0.000
1986q1	0.000	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.096	0.096	0.000	1	0	0.096	0.000
1986q4																								0.000	0.499
1987q1																								0.000	-0.156
1987q3																								0.000	-0.419
1988q1	0.390	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	1	0.850	0.390	0.460	0	1	0.531	-0.145
1990q1	0.180	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1	0	0.180	0.180	0.000	1	0	0.180	0.000
1990q4	0.080	0.000	0.290	0.000	0.000	0.000	0.170	0.000	0.070	0.000	0.290	0.000	0.000	0.000	0.270	0.000	0	1	0.150	0.080	0.070	1	0	0.000	0.000
1991q1	0.000	0.290	0.000	0.000	0.000	0.170	0.000	0.000	0.000	0.290	0.000	0.000	0.000	0.270	0.000	0.000	0	1	0.580	0.290	0.290	1	0	0.598	0.000
1991q2	0.000	0.000	0.000	0.000	0.170	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1991q3	0.000	0.000	0.000	0.170	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.270	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1991q4	0.000	0.000	0.170	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.270	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1992q1	0.000	0.170	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.270	0.000	0.000	0	1	0.440	0.170	0.270	0	1	0.000	0.000
1992q2	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1992q3	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1992q4	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1993q1	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.000	0.000	0.000	0	1	0.280	0.010	0.270	0	1	0.000	0.000
1993q3	0.100	0.000	0.000	0.330	0.000	0.000	0.000	0.180	0.020	0.000	0.000	0.070	0.000	0.000	0.000	0.090	1	0	0.120	0.100	0.020	1	0	0.342	0.000
1993q4	0.000	0.000	0.330	0.000	0.000	0.000	0.180	0.000	0.000	0.000	0.070	0.000	0.000	0.000	0.090	0.000	1	0	0.000	0.000	0.000	0	0	0.078	0.000
1994q1	0.060	0.330	0.000	0.000	0.000	0.180	0.000	0.000	0.380	0.070	0.000	0.000	0.000	0.090	0.000	0.000	0	1	0.840	0.390	0.450	0	1	0.194	0.000
1994q2	0.000	0.000	0.000	0.000	0.180	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.090	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1994q3	0.000	0.000	0.000	0.180	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.090	0.000	0.000	0.000	0.220	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1994q4	0.000	0.000	0.180	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.090	0.000	0.000	0.000	0.220	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1995q1	0.020	0.180	0.000	0.000	0.000	0.080	0.000	0.000	0.180	0.090	0.000	0.000	0.000	0.220	0.000	0.000	0	1	0.470	0.200	0.270	0	1	0.000	0.000
1995q2	0.000	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1995q3	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.000	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1995q4	0.000	0.000	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.000	0.000	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0	0.000	0.000
1996q1	0.000	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0	1	0.300	0.080	0.220	0	1	0.000	0.000
1997q1	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.240	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	1	0.300	0.060	0.240	0	1	0.000	0.000
1998q1	-0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.170	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	1	0.150	-0.020	0.170	0	1	0.000	0.000
2000q1																								0.018	0.000
2002q1																								0.006	-0.803
2003q3																								0.000	-1.140
2005q1																								0.000	0.560
2010q2	0.000	0.000	0.000	0.000	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0		
2010q3	0.000	0.000	0.000	0.033	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.085	0	1	0.000	0.000	0.000	0	0		
2010q4	0.000	0.000	0.033	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.085	0.000	0	1	0.000	0.000	0.000	0	0		
2011q1	0.000	0.033	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.085	0.000	0.000	0	1	0.045	0.033	0.012	1	0		
2011q2	0.000	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.085	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0		
2011q3	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.000	0.036	0.000	0.000	0.221	0.000	0.000	0.000	0.000	0	1	0.036	0.000	0.036	0	1		
2011q4	0.000	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.221	0.000	0.000	0.000	0.000	0.000	0	1	0.000	0.000	0.000	0	0		
2012q1	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.221	0.000	0.000	0.000	0.000	0.000	0.000	0	1	0.266	0.045	0.221	0	1		

Table 3.1: Fiscal Adjustment Plans

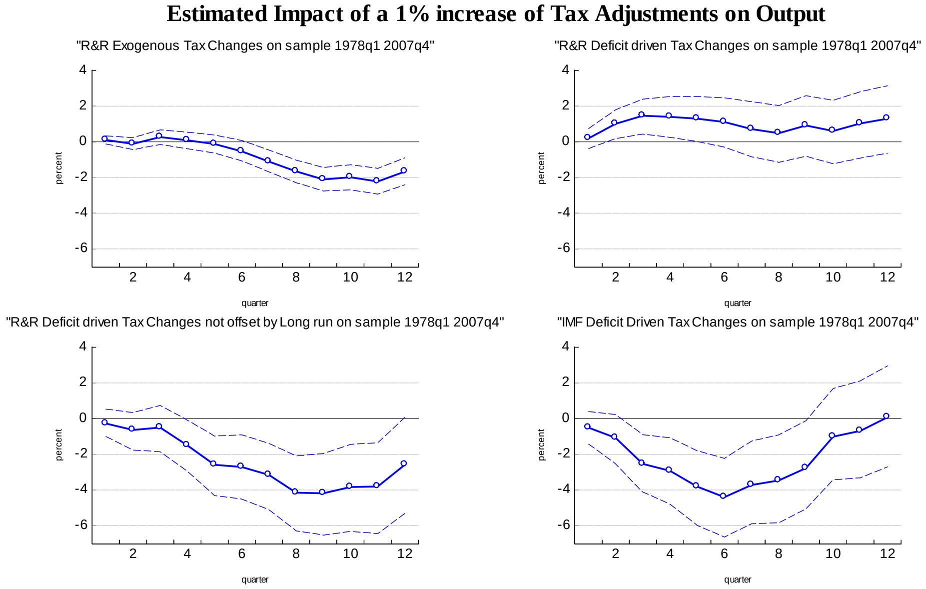

Figure 3.1: Romer&Romer results with different data

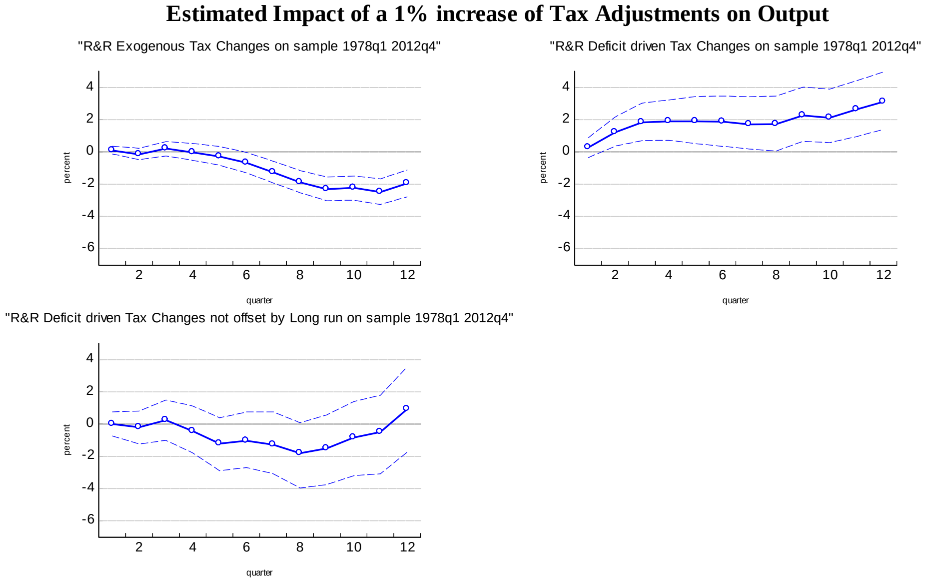

Figure 3.2: Romer&Romer results with different data

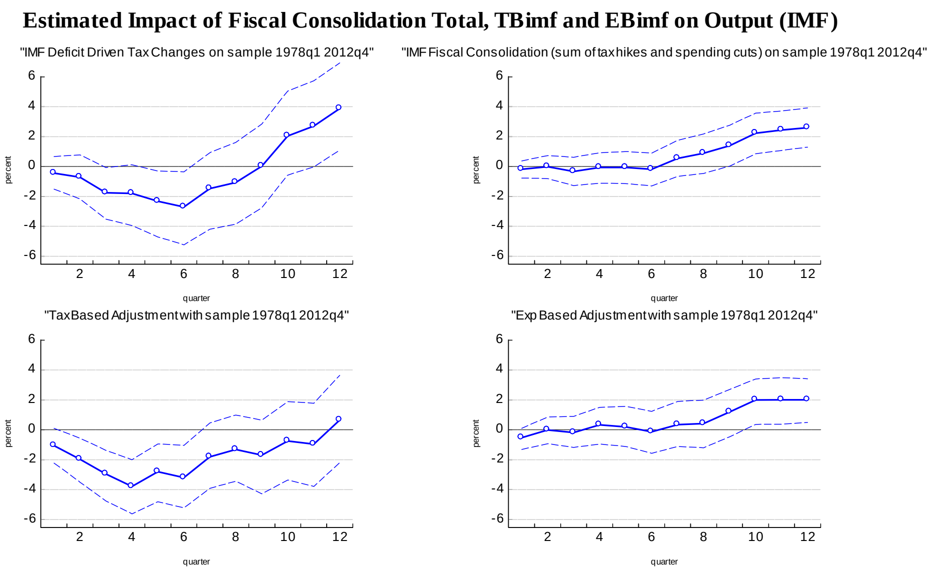

Figure 3.3: Using IMF specification

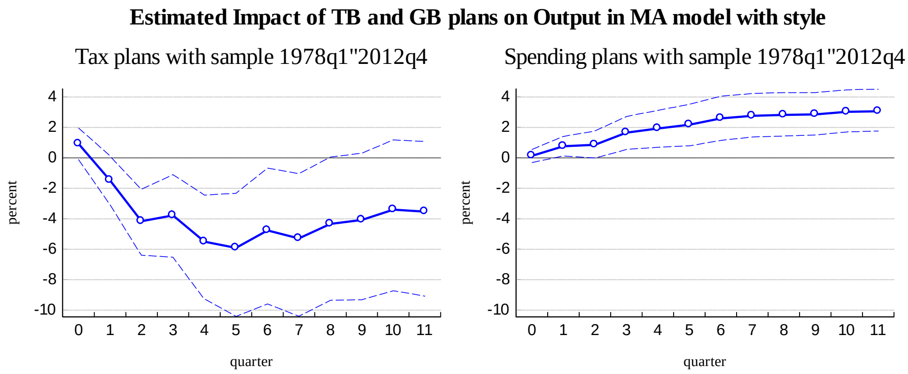

Figure 3.4: Baseline MA model with fiscal plans

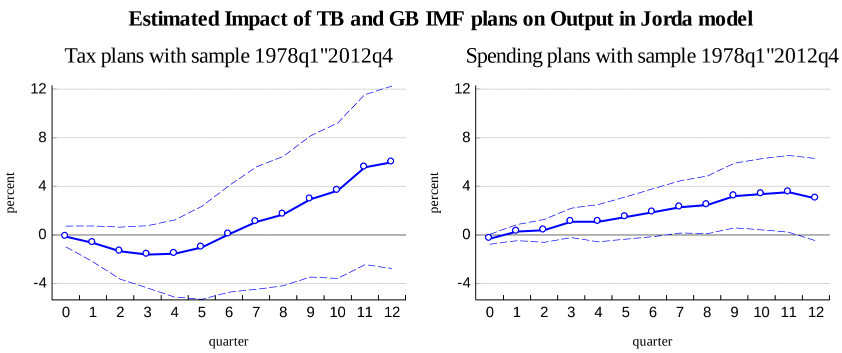

Figure 3.5: Jorda - Taylor LP, using total consolidation (sut+satt+sug+sagg) with IMF dummies

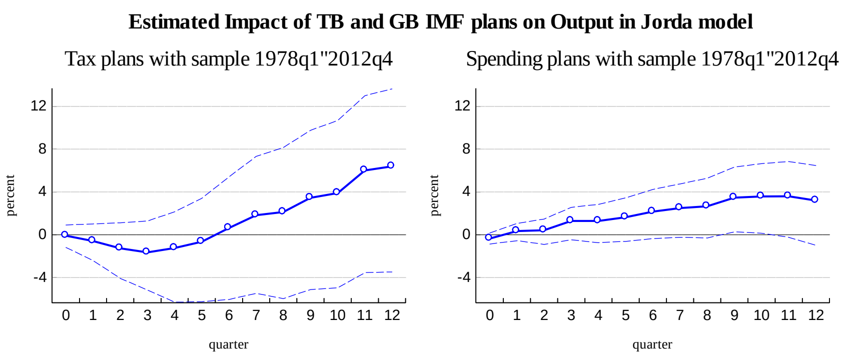

Figure 3.6: Jorda - Taylor LP, using residuals, mimicking the first step of ATE, with IMF dummies

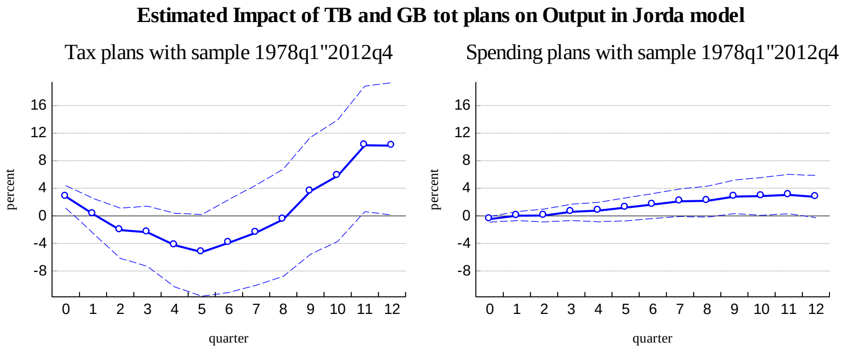

Figure 3.7: Jorda - Taylor LP, using total consolidation (sut+satt+sug+sagg) with our dummies

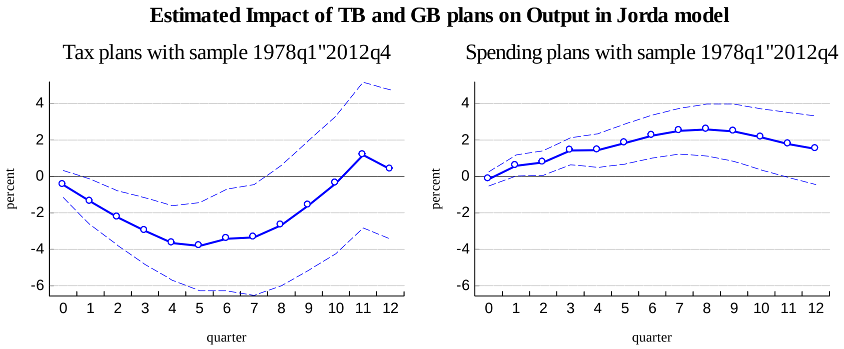

Figure 3.8: Jorda - Taylor LP, using as a dependent variable the bootstraped series form our model, LP uses total consolidation (sut+satt+sug+sagg) with IMF dummies

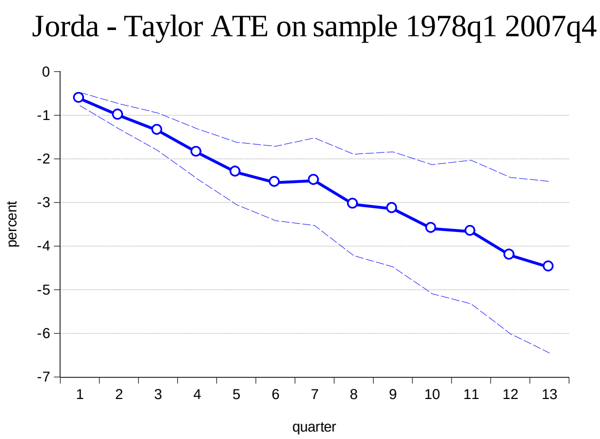

Figure 3.9: Jorda - Taylor LP, using ATE approach