Estimating Fiscal Multipliers: News From a Non-linear World*

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Abstract

We estimate non-linear VARs to assess to what extent fiscal spending multipliers are countercyclical in the United States. We deal with the issue of non fundamentalness due to fiscal foresight by appealing to cumulated revisions of expectations of fiscal expenditures. This measure of anticipated fiscal shocks is shown to carry valuable information of future evolutions of public spending. Preliminary results based on state-dependent (conditionally-linear) impulse responses suggest that fiscal spending multipliers are larger in recessions. Our estimates point to short-run multipliers well above unity.

Keywords: Cumulated fiscal news, Fiscal foresight, Countercyclical fiscal spending multipliers, Smooth Transition Vector-AutoRegressions.

JEL codes: C32, E32, E52.

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1 Introduction

How large is the fiscal spending multiplier? When it comes to take policy decisions, the answer to this question is key. Suppose the multiplier of public expenditure is large. Then, if the economy is slack, a debt stabilization operating via a reduction in public expenditures risks to worsen the macroeconomic scenario. Differently, if the multiplier is small, a reduction in public spending may be preferred to, say, an increase in taxes.

Following the lead of Blanchard and Perotti (2002), a number of VAR models featuring fiscal aggregates and exploiting assumptions on the timing of the impact of fiscal shocks have been estimated to compute fiscal multipliers. However, the quantification of fiscal multipliers with standard linear VARs is controversial for two reasons. Firstly, as stressed by Parker (2011), fiscal spending shocks may very well be countercyclical. Theoretical support for a larger multiplier in periods of slack comes from the textbook IS-LM-AD-AS model, in which a steeper AS curve in economic booms suggest a larger crowding out of private consumption and investments, as well as from microfounded DSGE models when the zero-lower bound is binding (Eggertsson (2009), Christiano, Eichenbaum, and Rebelo (2011), Woodford (2011)). Evidence in favor of state-dependent fiscal multipliers is provided by, among others, Auerbach and Gorodnichenko (2012, 2013), Batini, Callegari, and Melina (2012), Fazzari, Morley, and Panovska (2013).[1] Secondly, anticipation effects are likely to be of great relevance in the transmission of fiscal policy effects, a phenomenon often referred to as "fiscal foresight" (see, among others, Yang (2005), Mertens and Ravn (2011), Ramey (2011), Gambetti (2012a, 2012b), Leeper, Walker, and Yang (2013)). Fiscal foresight makes the identification of fiscal shocks complicated. If agents in the economy adjust their expectations on the basis of anticipated, future shocks, the information set available to agents in the economy is larger than that of the VAR econometrician. Unfortunately, standard VARs, which rely on current and past shocks to interpret the dynamics of the modeled variables, are ill-suited to capture the effects of future, anticipated shocks that affect agents' expectations and, consequently, current realizations of the variables embedded in the VAR. Therefore, VARs estimated with variables subject to anticipations (i.e., affected by anticipated, "news" shocks) are "non-fundamental".[2] Leeper, Walker,

[1] Differently, Ramey, Owyang, and Zubairy (2013) and Ramey and Zubairy (2013) support the idea of multipliers being relatively similar over the business cycle even in presence of low interest rates.

[2] Early analysis on non-fundamentalness in a macroeconomic context with rational expectations are Hansen and Sargent (1980), Hansen and Sargent (1991), and Lippi and Reichlin (1993). A presentation on issues related to VAR analysis and non-fundamentalness is provided by Lï£¡tkepohl (2012).

and Yang (2013) work with a variety of fiscal models to show that the anticipation of tax policy shocks severely affects VAR exercises aiming at identifying fiscal shocks. Forni and Gambetti (2011) and Ramey (2011) show that government spending shock estimated with standard fiscal VARs are predictable, i.e., they are non-fundamental.

This paper addresses both issues and estimates *state-dependent fiscal multipliers* by paying particular attention to the issue of *fiscal foresight*. We deal with a non-linear Smooth Transition Vector AutoRegressive (STVAR) model featuring a measure of *cumulated revisions of expectations* along which a set of standard macro-fiscal variables. The computation of fiscal revisions relies on data coming from the Survey of Professional Forecasters. As shown by Gambetti (2012a, 2012b), this measure of fiscal shocks has the potential to isolate exogenous, anticipated variations of public expenditures in a more precise manner with respect to alternatives proposed in the literature. Importantly, cumulated revisions allows us to capture the effects of fiscal spending shocks occurring h quarter-ahead, with h larger than one.

Our measure of fiscal news is constructed by considering cumulated revisions of expectations of government purchases. Gambetti (2012b) shows that this measure contains valuable information to predict future evolutions of fiscal expenditures.When employed in a VAR modeling a standard set of US macroeconomic data, the cumulated fiscal news variable predicts Keynesian-type effects of a set of macroeconomic indicators, with the fiscal multiplier being estimated around one. Gambetti (2012a) extends this analysis to an open-economy VAR. He shows that an expansionary fiscal shock leads to an appreciation of the real exchange rate and to a deterioration of the trade balance, a finding in line with a textbook Mundell-Fleming framework. In this paper, we incorporate this information in an otherwise standard macro-fiscal vector and allow for different estimated coefficients of the contemporaneous relationships as well as dynamic ones during recessions vs. expansions. This enables us to simulate state-dependent impulse responses to a fiscal spending news shock. In so doing, we provide a generalization of Gambetti (2012a, 2012b) by allowing for (and, de facto, unveiling) state-dependent fiscal multipliers.

Other measures of fiscal news have recently been used in the literature to isolate the unanticipated component of fiscal shocks. Most notably, in the latest of a series of papers on fiscal shocks, Ramey (2011) computes a SPF-based fiscal shock by computing the unpredicted component of the contemporaneous growth rate of federal spending. However, as shown by Perotti (2013), this forecast revision has high explanatory power for government spending due to the very noisy expectational component. As shown by

Gambetti (2012b), however, cumulated fiscal revisions anticipate and predict Ramey's SPF-based fiscal shock, and overcome Perotti's critique due to the longer time-span considered. For these reasons, we measure fiscal news by using Gambetti (2012b)'s proposal.

Our result suggest that i) anticipated fiscal expenditure shocks trigger a significant reaction of output; ii) such reaction is statistically different across different phases (recessions/expansions) of the US business cycle; iii) the reaction is larger under recessions; iv) fiscal multipliers in recessions are clearly larger than one.[3]

One limit of our analysis relates to the short sample of data we use. The information regarding fiscal spending cumulated revisions we need is available only from 1981Q3. Hence, our sample does not embed the spectacular variations in fiscal spending due to World War II and the Korean War exploited in other studies to isolate fiscal spending shocks via a narrative approach (Ramey and Shapiro (1998), Ramey (2011)). As pointed out by Christiano (2013), however, such exogenous increases in fiscal spending were i) accompanied by strong increases in taxes, and ii) likely to be perceived as quite persistent by the private sector (the last point being mainly related to the Korean War episode). Moreover, rationing was in place during World War II, a phenomenon that refrained public spending to increase further. All these elements are likely to contaminate the computation of the fiscal spending multiplier when including the two War episodes, therefore reducing the cost we bear of not having such episodes in our sample.[4] Moreover, measurement errors are likely to play a non-negligible role in affecting the computation of the fiscal multipliers (Mertens and Ravn (2013)).[5]

The structure of the paper is the following. Section 2 deals with the issue of non-fundamentalness in the macro-fiscal context due to the presence of fiscal foresight, and explains why the cumulated revisions of fiscal expectations variable employed in our analysis helps solving the issue. Section 3 offers statistical support to the role of non-linearities in this context. Section 4 presents the Smooth Transition VAR model

[3]These results are obtained by working with conditionally linear VARs. In other words, after estimating the non-linear VARs, we treat the two states (recessions/expansions) as independent. The computation of generalized impulse response functions allowing for a switch from a regime to another conditional on a fiscal news shock is in our agenda.

[4]Gordon and Krenn (2010) argue that the 1939-1941 recovery from the Great Depression was largely due to fiscal spending. In such period, there was a considerable slack in the economy, spending increased (about 18 months before Pearl Harbor) while the interest rate remained roughly constant, and no rationing was in place. They estimate the fiscal spending multiplier to be as high as 2.5.

[5]To be precise, Mertens and Ravn (2013) investigate the relevance of measurement errors in the computation of tax multipliers via a narrative approach. Their very same logic can be applied to fiscal multipliers.

employed in our analysis. Section 5 presents our results. Section 6 concludes.

2 The role of revisions

The well-know phenomenon of fiscal foresight, i.e. the existence of legislative and implementation lags such that private agents receive clear signals about changes in government spending and tax rates that will take place in the future, has important consequences for the identification of fiscal shocks from estimated Structural VARs (see Leeper, Walker, and Yang (2013) for an extensive discussion). In presence of fiscal foresight, the agents' information set is larger than the econometricians' one. The equilibrium time series variables $\mathbf{y}_t$ have a non-invertible moving average component. This in turn implies that by estimating the Wold representation of the VAR of interest, the econometrician will not be able to recover the shock, i.e. the shock is non-fundamental for $\mathbf{y}_t$. Recovering the shock of interest from a non-fundamental VAR requires knowledge of present *and* future values of $\mathbf{y}_t$. Econometric analyses that fail to correctly account for the misalignment between the agents' and the econometrician's information set are then likely to produce distorted inference about the effects of fiscal shocks.

To see the nature of the problem, consider the following Vector Moving Average representation of a vector of time series $\mathbf{y}_t$

$$\begin{aligned} \mathbf{y}_t &= \mathbf{C}(L)\,\mathbf{u}_t \\ &= \sum_{k=0}^{\infty} C_k L^k u_{t-k} \end{aligned} \tag{1}$$

where $\mathbf{u}_t \sim W.N.(\mathbf{0}, \sigma_u^2 \mathbf{I})$. The VMA (1) is a fundamental representation of $\mathbf{y}_t$ if all the roots of the determinant of $\mathbf{C}(L)$ are outside the unit circle. This in turn implies that $\mathbf{y}_t$ admits a Wold representation and can be expressed as the sum of two orthogonal components, one linearly predictable and one linearly unpredictable. Clearly, if $\mathbf{y}_t$ does not admit a Wold representation then "shocks" estimated via a VAR would not be structural shocks but rather objects that are linear combinations of all the exogenous disturbances at various leads and lags.

A simple example would help clarifying the issue in the context of fiscal shocks. Suppose that fiscal authorities do not react instantaneously to exogenous shocks that hit the economy because of legislative and implementation lags. After an exogenous shock, there is a legislative lag between when the change in government spending is proposed and when it is approved and then an implementation lag between when it is

passed into law and when it actually takes place. Assuming that the total lag is equal to h periods, then the data generating process for government spending would look like (see Gambetti (2012b)):

$$\begin{aligned} g_t &= \phi_1 \varepsilon_{t-1} + \ldots \phi_{h-1} \varepsilon_{h-1} + \phi_h \varepsilon_{t-h} + \phi_{h+1} \varepsilon_{t-h-1} + \ldots \phi_q \varepsilon_{t-q} \\ &= \Phi(L) \varepsilon_t \end{aligned} \tag{2}$$

where $\phi_1 = \ldots = \phi_{h-1} = 0$. The process (2) implies that any shock at time t will affect government spending only after h lags. Such a process is clearly non-fundamental since not all the roots of $\Phi(L)$ are outside the unit circle.

Adding extra variables is not a solution. A VAR which includes g_t generated by (2) will also be non-fundamental. Suppose g_t is included in a bivariate VAR with real GDP:

$$\begin{aligned} \begin{pmatrix} g_t \\ x_t \end{pmatrix} &= \begin{pmatrix} \phi(L) & 0 \\ \alpha(L) & \beta(L) \end{pmatrix} \begin{pmatrix} \varepsilon_t \\ u_t \end{pmatrix} \\ &= \mathbf{A} \begin{pmatrix} \varepsilon_t \\ u_t \end{pmatrix}. \end{aligned} \tag{3}$$

Then the roots of the determinant of $\mathbf{A}$ will inherit the roots of $\phi(L)$ and the VAR in (3) would be nonfundamental.

Various solutions have been proposed in the literature. Most notably, use of Blaschke matrices (see Lippi and Reichlin (1993)) and augmenting the VAR with as much information as possible, e.g. by adding factors (see Alessi, Barigozzi, and Capasso (2008)). However, in presence of fiscal foresight, the mistaken inference based on standard VARs has a discernible cause: the agents' information set and the econometricians' one are misaligned because the discount patterns are different. Private agents discount recent news more heavily because they provide information about fiscal policy in the distant future whereas the econometrician discounts in the usual way, attaching decreasing weights to more distant news. Hence, tackling the presence of foresight is necessary to correctly identify fiscal shocks.

Based on this argument, a third, and more desirable, solution to tackle the issue of nonfundamentalness due to fiscal foresight has been to include some measures of expectations about fiscal policy decisions in a VAR with government spending. However, simply adding expectations to (2) does not solve the problem. To see this point, suppose that in (2) $h = 1$ and $q = 2$. Then, taking expectations:

$$E_t g_{t+1} = \phi_1 \varepsilon_t + \phi_2 \varepsilon_{t-1}. \tag{4}$$

Clearly, if $\phi_2 > \phi_1$, the process in (4) cannot be inverted in the past and is nonfundamental. The problem might instead be solved by taking expectation revisiona (see Gambetti (2012b)). By taking the difference between the expectation of g_{t+h} formed at time t and that formed at time $t-1$ one obtains

$$E_t g_{t+h} - E_{t-1} g_{t+h} = \phi_h \varepsilon_t.$$

As an example, consider for simplicity $h = 1$ and $q = 2$. The expectation revision is given by

$$\begin{aligned} E_t g_{t+1} - E_{t-1} g_{t+1} &= \phi_1 \varepsilon_t + \phi_2 \varepsilon_{t-1} - (\phi_1 E_{t-1} \varepsilon_t + \phi_2 \varepsilon_{t-1}) \\ &= \phi_1 \varepsilon_t. \end{aligned}$$

In general, however, h is unknown. Hence, taking the difference between the expectation of g_{t+j} at time t and the expectation of g_{t+j} at time $t-1$, $E_t g_{t+j} - E_{t-1} g_{t+j}$, with either $j < h$ or $j > q$ would not provide information since in both cases $E_t g_{t+h} - E_{t-1} g_{t+h} = 0$. The solution would then be to include in the VAR a measure of expectation revision taken over a longer horizon:

$$\sum_{j=1}^{J} \left(E_t g_{t+j} - E_{t-1} g_{t+j} \right) = \left(\phi_1 + \phi_2 + \ldots + \phi_J \right) \varepsilon_t. \tag{5}$$

The non-invertibility problem in (3) is clearly solved by stimating a VAR with the news variable in (5) and x_t.

In our paper, we follow Gambetti (2012a,b) and augment our VAR with a measure of cumulated news constructed as follows:

$$News_{13} = \sum\nolimits_{j=1}^{3} (E_t g_{t+j} - E_{t-1} g_{t+j}) \tag{6}$$

where $E_t g_{t+j}$ is the forecast of the growth rate of real government spending from period $t+j-1$ to period $t+j$ based on the information available at time t. Hence, $E_t g_{t+j} - E_{t-1} g_{t+j}$ represents the new information that becomes available to private agents between time $t-1$ and t about the growth rate of government spending j periods ahead. Preliminary checks on the predictive power of the news (6) confirm that cumulated revisions are informative as for the future evolutions of public spending. A OLS regression of public spending on a constant and three lags of public expenditures, public receipts, real GDP, and the cumulated news offers statistical support to fiscal

news, with the p-value associated to the Wald-test on the exclusion of the last variable being vero close to numerical zero.[6]

3 VAR models

Modeling choices. We assess the state-dependence of fiscal spending multipliers to news shocks by estimating a Smooth-Transition VAR framework. Extensive presentations are offered, along with a variety of applications, by Granger and Terï£¡svirta (1993) and van Dijk, Terï£¡svirta, and Franses (2002). Our STVAR framework reads as follows:

$$\begin{aligned}
\boldsymbol{X}_t &= F(z_{t-1})\boldsymbol{\Pi}_R(L)\boldsymbol{X}_t + (1 - F(z_{t-1}))\boldsymbol{\Pi}_E(L)\boldsymbol{X}_t + \boldsymbol{\varepsilon}_t, && (7)\\
\boldsymbol{\varepsilon}_t &\sim N(0, \boldsymbol{\Omega}_t), && (8)\\
\boldsymbol{\Omega}_t &= F(z_{t-1})\boldsymbol{\Omega}_R + (1 - F(z_{t-1}))\boldsymbol{\Omega}_E, && (9)\\
F(z_t) &= \exp(-\gamma z_t)/(1 + \exp(-\gamma z_t)), \gamma > 0, z_t \sim N(0, 1). && (10)
\end{aligned}$$

where $\boldsymbol{X}_t$ is a set of endogenous variables which we aim to model, $F(z_{t-1})$ is a transition function which captures the probability of being in a recession, γ regulates the smoothness of the transition between states, z_t is a transition indicator, $\boldsymbol{\Pi}_R$ and $\boldsymbol{\Pi}_E$ are the VAR coefficients capturing the dynamics of the system during recessions and expansions (respectively), $\boldsymbol{\varepsilon}_t$ is the vector of reduced-form residuals having zero-mean and whose time-varying, state-contingent variance-covariance matrix is $\boldsymbol{\Omega}_t$, and $\boldsymbol{\Omega}_R$ and $\boldsymbol{\Omega}_E$ are covariance matrices of the reduced-form residuals computed during recessions and non-recessions, respectively.

The modeling assumption is that our variables can be described with a combination of two linear VARs, one suited to describe the economy during recessions and the other one during expansions. The transition from a state to another is regulated by the standardized transition variable z_t.[7] The smoothness parameter γ affects the probability

[6] Regression conducted by considering variables in (log-)levels and the News13 variable in cumulated sums to preserve the same order of integration. The choice of running this regression in log-levels is to be consistent with the modeling choices related to our VAR analysis (specified in the next Section).

[7] As suggested by van Dijk, Terï£¡svirta, and Franses (2002), one may think of this model as a regime-switching framework that allows for two different regimes associated with extreme values of the transition function, i.e., "recessions" when $F(z_t) = 1$, which (under the assumption of $\gamma > 0$) occurs for large negative values of z_t (formally, when $z_t \to -\infty$), and "non-recessions" when $F(z_t) = 0$ (which realizes when $z_t \to \infty$). Alternatively, one may think of a "continuum" of regimes, each associated with a different value of the transition function $F(z_t)$. For simplicity, we will refer in this paper to the two regime-interpretation.

of being in a recession $F(z_t)$, i.e., the larger the value of γ, the faster the transition from a state to another. Notably, the model (7)-(10) allows for non-linearities to arise both from the contemporaneous relationships and the dynamics of our economic system.

Our baseline analysis refers to the vector $\boldsymbol{X}_t = [G_t, T_t, Y_t, News_{13}]'$, where G is the log of real government (federal, state, and local) purchases (consumption and investment), T is the log of real government receipts of direct and indirect taxes net of transfers to business and individuals, Y is the log of real GDP.[8] The variable $News_{13}$ is the public expenditure news variable (6) as in Gambetti (2012a,b). The sample spans the 1981Q3-2013Q1 period, 1981Q3 being the first available quarter as for the news variable. The construction of our G and T variables closely follows the one in Auerbach and Gorodnichenko (2013).[9] The variables are expressed in levels because of possible cointegration relationships.

A key-role is played by the transition variable z_t. Following Auerbach and Gorodnichenko (2012) and Bachmann and Sims (2012), we employ a standardized moving average involving seven realizations of the real GDP quarter-on-quarter percentage growth rate.[10] Granger and Terï£¡svirta (1993) suggest to fix γ to ease the estimation of the remaining parameters of highly non-linear STVARs like ours. We calibrate the smoothness parameter γ by referring to the duration of recessions in the U.S. according to the NBER business cycle dates (15% percentage of the time in our sample according to the dating proposed by the NBER). Then, we define as "recession" a period in which $F(z_t) \geqslant 0.85$, and calibrate γ to obtain $\Pr(F(z_t) \geqslant 0.85) \approx 0.15$. This metric implies a calibration $\gamma = 1.7$, which is quite close to the 1.5 value employed by Auerbach and Gorodnichenko (2012) and Bachmann and Sims (2012).[11]

[8] Our fiscal aggregates are constructed by referring to the Bureau of Economic Analysis' NIPA Table 3.1. Current tax receipts are constructed as the difference between current receipts and government social benefits. Fiscal expenditures are the sum of consumption expenditures and gross government investments from which we subtract the consumption of fixed capital. The data regarding the real GDP and the implicit GDP deflator (which we used to deflate all nominal series) are provided by the Federal Reserve Bank of St. Louis.

[9] Auerbach and Gorodnichenko (2013) check and verify the robustness of the results in Auerbach and Gorodnichenko (2012) to the employment of a different definition of the net tax series that avoids the double-counting of mandatory Social Security contributions.

[10] The transition variable z_t is standardized to render our calibration of the slope parameter γ comparable to the ones employed in the literature.

[11] Our transition function $F(z_t)$ is shown in Figure 1. Clearly, high realizations of $F(z_t)$ tend to be associated with NBER recessions. Notice that the a priori choice of a transition function provides us with an information that we would otherwise need to recover from the data by estimating a latent factor dictating the switch from a state to another, as it occurs when Markov-Switching VAR frameworks are taken to the data. Our transition function $F(z_t)$ is extremely close to that employed in Auerbach and Gorodnichenko (2012) and Bachmann and Sims (2012) as for common samples.

The (linear/non-linear) VAR features three lags. This choice is justified by the Akaike criteria when applied to a linear model estimated on the full-sample 1981Q3-2013Q1. Results are robust to reasonable variations of the number of lags (results available upon request).

Given the high non-linearity of the model, we estimate it by Monte-Carlo Markov-Chain simulations. The Technical Appendix reports details on the estimation methodology.[12] Notice that the indicator variable z_t is not embedded in our vector of modeled variables $\boldsymbol{X}_t$. It is worth stressing that our STVAR framework exploits information coming from all the observations in the dataset, which are "indexed" by the transition function $F(z_t)$. Differently, the estimation of two different VAR models (one for each given regime) would imply more imprecise estimates due to the smaller number of observations, especially for recessionary periods.

Statistical evidence in favor of non-linearity. We check for the presence of non-linearities in the modeled relationships between the variables included in our VAR. We consider the multivariate test proposed by Terï£¡svirta and Yang (2013). In particular, we test the null hypothesis of linearity versus a specified nonlinear alternative, that of a (Logistic) Smooth Transition Vector AutoRegression with a single transition variable. In performing this multivariate test, we consider our vector of endogenous variables $\mathbf{X}_t$. The test suggests a clear rejection of the null hypothesis of linearity. Details on this test and its implementation are reported in our Technical Appendix available upon request.

The construction of the variable $News_{13}$ is performed to isolate exogenous variations in fiscal spending. However, shocks other than the fiscal spending one may very well contribute to the revisions of agents' expectations. To purge the $News_{13}$ from other macroeconomic shocks hitting the economic system, we order the $News_{13}$ variable last in our vector and orthogonalize the reduced-form residuals of the VAR via a Cholesky-decomposition of the variance-covariance matrix. This choice implies that $News_{13}$ exerts, by construction, no on-impact effect on the remaining variables of the vector. llow for on-impact macroeconomic effects by our identified uncertainty shocks.[13]

[12] Note that, in principle, this model could be estimated by maximum-likelihood. However, as pointed out by Terï£¡svirta and Yang (2013), finding the optimum of the target function may be problematic due to its flatness in some directions and its many local optima. An alternative to the MCMC pursued in our paper is the search of a suitable starting value of the vector of parameters of interest (Teräsvirta and Yang, 2013).

[13] The robustness of our results to ordering the $News13$ variable first in the vector is to be investigated in Section X (to come).

4 IRFs and multipliers

IRFs. Figure 1 depicts the impact of an expenditure news shock computed with our linear and non-linear VARs. The linear model predicts a delayed short-run increase in government expenditures and output, and a decrease in government recepits. Public spending reaches its peak value after about three years. Differently, output increases for the first three quarters after the shock, then gradually goes back to zero, and crosses the zero line about 10 quarters after the shock. A positive response of output is supported also by our non-linear VAR. Interestingly, the short-run response of output is stronger under recessions. However, expansions are associated to a gradual but quite persistente increase in output, whose puntual value becomes larger than the one recorded under recessions after three years.[14] Interestingly, another difference betweeen the two states regards the short-run reaction of taxes, which is positive in expansions and negative in recessions.

Are the reactions of output in recessions vs. expansions different from a statistical standpoint? Figure 2 plots the state-contingent responses along with their 90% confidence intervals. All four variables appear to react asymmetrically across the two phases of the business cycle. Focusing on output, one can easily verify that the response of output in recession is significantly larger than in expansion for the third quarter (second after the shock), during which the two confidence bands just do not overlap. The following quarter is also characterized by a minimum overlap between the two confidence bands. We take this evidence as supportive to the idea of countercyclical multipliers.[15]

Quantification of the multipliers. We now turn to the computation of the multipliers. Following most of the literature, we compute the fiscal spending multiplier as the ratio of the integral of the impulse response of output over the integral of the impulse response of fiscal spending. Given that output and public expenditures enter our VARs in log-terms, we scale such ratio by the sample average values of the Y/G

[14] This evidence may be due to the presence in our sample of the 2007-2009 crisis. When estimating our STVAR model with 1981Q3-2007Q3 data, we find the response of output under recessions to remain larger than the one under expansions over the entire 20-quarter horizon.

[15] Admittedly, the differences between the responses based on our linear VAR and those associated to recessions are likely to be over-estimated by the assumption of no change of the very strong recessionary phase we focus on. One should therefore interpret the estimated responses under recessions as a upper bound, more than a mean estimate. On the other hand, the coefficients of our recessions-related VAR are estimated by using also information about the dynamics of the system in the non-recessionary regime, a strategy which is likely to bias the non-linear estimates towards those associated to the linear VAR.

(taken in levels) to convert percent changes into dollar changes.[16] Following Auerbach and Gorodnichenko (2012, 2013), we perform our analysis by exploiting the *conditionally linear* IRFs depicted in Figure 1. This implies that we assume zero probability of switching regime once we start in a given state. While being defendable for a short-run analysis, this assumption becomes clearly unpalatable when going over the reasonable duration of a given state. In our sample, recessions are much shorter than expansions (a regularity of the US economy, indeed). In particular, the longest recession is the 2007-09 crisis, which last for about 6 quarters (December 2007-June 2009). We then compute fiscal multipliers by focusing on a six quarter-period.

We measure fiscal multipliers in two ways. The first one computes the fiscal multipliers as the peak response of output divided by the peak response of fiscal expenditures. This method has been widely adopted since Blanchard and Perotti (2002). The second one computes the multipliers as the integral of the responses of output divided by the integral of the responses of fiscal expenditures. This second measure is designed to account for the persistence of fiscal shocks (Woodford (2011)).

Table 1 collects our spending multipliers. Our evidence clearly speaks in favor of larger (short-run) fiscal spending multipliers in recessions, with values around 2.2-2.3. The multipliers conditional on expansions are substantially lower (1.28-1.47). All short-run multipliers take values above one.

5 Conclusions

Knowing the size of fiscal multipliers is key for macroeconomic policy makers who aim at stabilizing the business cycle. Estimating fiscal multipliers is, however, a highly non-trivial task because fiscal multipliers might change across the business cycle. Moreover, estimates of fiscal multiplier are likely to be biased if the process used by private agents to form expectations about future fiscal policy changes is not properly taken into account by the econometrician. In presence of fiscal foresight, the information set of private agents is larger than that used by the econometrician. Fiscal shocks identified by a standard VAR are not structural shocks but are linear combination of all the exogenous

[16] Ramey and Zubairy (2013) warn against this practice by noticing that, in a long US data sample spanning the 1889-2011 period, the Y/G ratio varies from 2 to 24 with a mean of 8. Hence, the choice of a constant value for the ratio Y/G may importantly bias the estimation of the multipliers. In our sample, the mean value of such ratio is 6, and it varies from 5.39 to 6.76. Hence, the commonly adopted ex-post conversion from the estimated elasticities to dollar increases does not appear to be an issue for our exercise.

shocks at various leads and lags.

This paper provides estimates of the fiscal multiplier in the U.S. by addressing both issues. First, the possibility that the effects of fiscal shocks on economic activity might vary across the business cycle is accounted for by estimating a Smooth Transition VAR. Second, the phenomenon of fiscal foresight and its econometric consequences for the identification of fiscal policy shocks in a VAR is tackled by augmenting the VAR with a measure of fiscal news which accounts for the existence of legislative and implementation lags for fiscal policy changes.

Our empirical model includes measures of real GDP, real government spending, real tax revenues and cumulated news. First, we show that there is ample evidence that a linear model is statistically ill-suited to model the relationship between these variables. We then estimate a STAVR and show that fiscal multipliers are state-dependent: they are larger in recessions, providing evidence in line with, among others, Auerbach and Gorodnichenko (2012).

One drawback of our nonlinear analysis is that we estimate impulse response functions that are state-dependent. While on the one hand this is convenient because the impulse responses do not depend on initial conditions, the size and the sign of fiscal shocks, they do not allow to take into account that, following a fiscal impulse, the economy can switch from one phase of the business cycle to another. The estimation of generalized impulse responses are in our agenda.

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	$\frac{\max_{h=1,\ldots,6}(Y_h)}{\max_{h=1,\ldots,6}(G_h)}$	$\sum_{h=1}^{6} \frac{Y_h}{G_h}$
Linear	1.33	1.64
Expansion	1.28	1.47
Recession	2.20	2.30

Table 1: **Fiscal spending multipliers.** Figures conditional on our baseline VAR analysis. Log-values of the government spending and output of our impulse responses scaled by the sample average values of Y/G to more from elasticities to dollar changes.

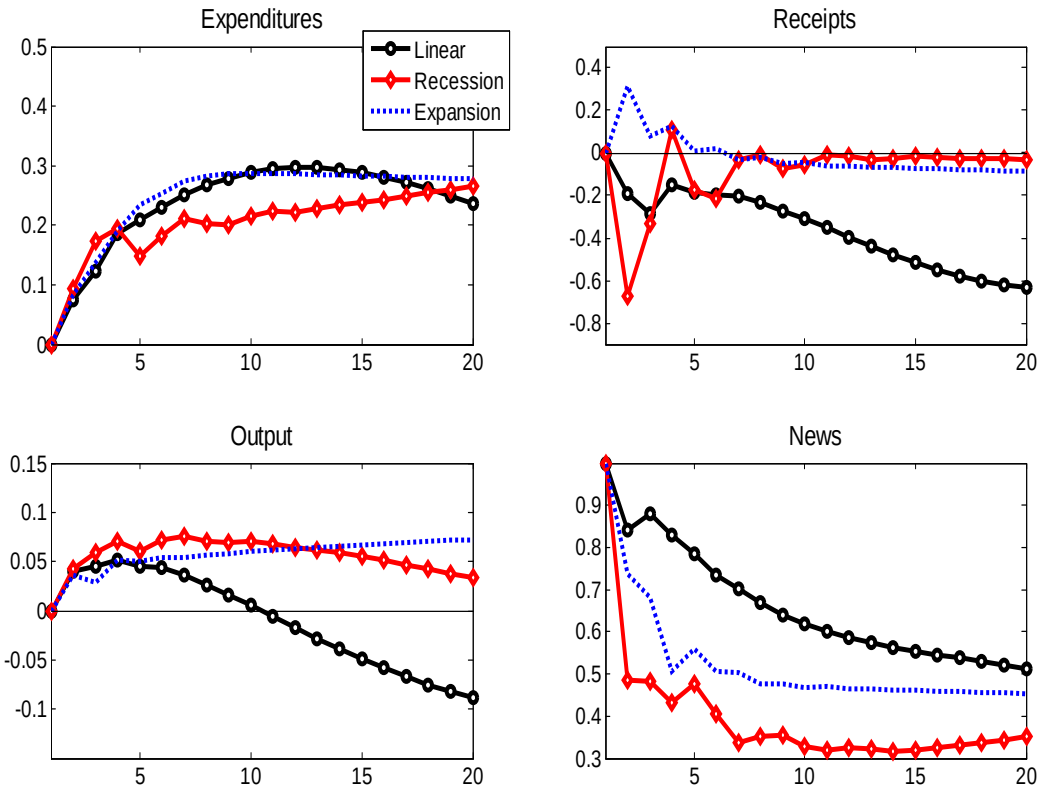

Figure 1: **Impulse responses to a fiscal news (anticipated) spending shock in linear vs. non-linear VARs**. Solid black lines with circles: Linear model. Solid red lines with diamonds: Recessions. Dotted blue lines: Expansions. News variable constructed as the integral of the revisions of the one, two, and three step-ahead expectation values over fiscal spending growth. Integral cumulated ex-post to induce the same integration order as the one of the log-real variables in the vector. Impulse responses to a news shock normalized to one. Sample 1981Q3-2013Q1. VAR models estimated with a constant and three lags.

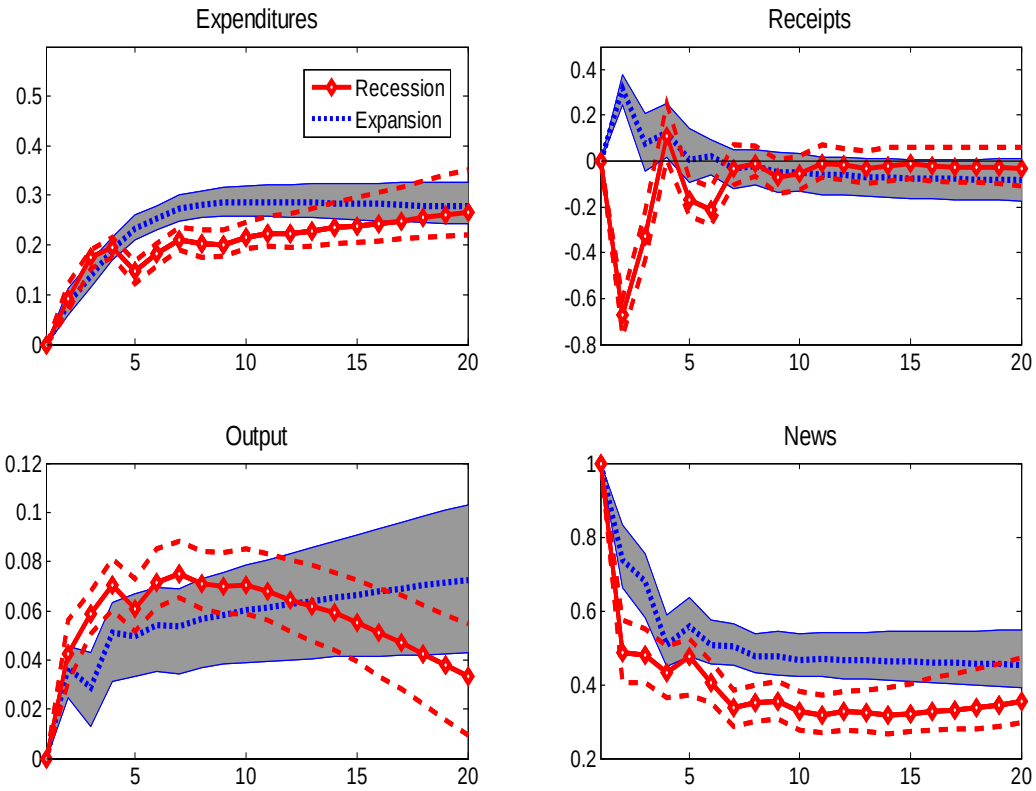

Figure 2: **Impulse responses to a fiscal news (anticipated) spending shock: Recession vs. expansion.** Solid red lines with diamonds: Recessions. Dotted blue lines: Expansions. 90 per-cent confidence intervals plotted along with point-estimates. News variable constructed as the integral of the revisions of the one, two, and three step-ahead expectation values over fiscal spending growth. Integral cumulated ex-post to induce the same integration order as the one of the log-real variables in the vector. Impulse responses to a news shock normalized to one. Sample 1981Q3-2013Q1. VAR models estimated with a constant and three lags.