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Published Version:
Caggiano, G., Castelnuovo, E., Colombo, V., Nodari, G. (2015). Estimating Fiscal Multipliers: News From A Non-linear World. ECONOMIC JOURNAL, 125(584), 746-776 [10.1111/ecoj.12263].

Availability:
This version is available at: https://hdl.handle.net/11585/611683 since: 2022-04-12

Published:
DOI: http://doi.org/10.1111/ecoj.12263

Estimating Fiscal Multipliers: News From a Nonlinear World*

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March 2015

Abstract

We estimate nonlinear VARs to assess to what extent fiscal spending multipliers are countercyclical in the United States. We deal with the issue of nonfundamentalness due to fiscal foresight by appealing to sums of revisions of expectations of fiscal expenditures. This measure of anticipated fiscal shocks is shown to carry valuable information about future dynamics of public spending. Results based on generalized impulse responses suggest that fiscal spending multipliers in recessions are greater than one, but not statistically larger than those in expansions. However, nonlinearities arise when focusing on "extreme" events, i.e., deep recessions vs. strong expansionary periods.

Keywords: Fiscal news, Fiscal foresight, Fiscal spending multiplier, Smooth Transition Vector-AutoRegressions, Extreme events.

JEL codes: C32, E32, E52.

* A shorted version of this paper has been accepted for publication in the *Economic Journal*. We thank Morten O. Ravn (Editor) and two anonymous referees for their insighful comments and suggestions. We also thank Fabio Canova, Fabrice Collard, Marco Del Negro, Filippo Ferroni, Patrick Fève, Luca Gambetti, Michal Horvath, James Morley, Giorgio Primiceri, Giovanni Ricco, Antti Ripatti, Barbara Rossi, Timo Teräsvirta, Tugrul Vehbi, Benjamin Wong, and participants at various seminars and conferences for their feedback. Part of this work was developed while Colombo was visiting the Aarhus University and Caggiano the University of Melbourne, whose hospitality is gratefully acknowledged. Caggiano acknowledges the financial support received by the Visiting Research Scholar program offered by the University of Melbourne. Corresponding author: Efrem Castelnuovo, efrem.castelnuovo@unimelb.edu.au .

1 Introduction

How large is the fiscal spending multiplier? Following the lead of Blanchard and Perotti (2002), several VAR models featuring fiscal aggregates have been estimated to answer this question (for a survey, see Ramey (2011a)). However, the quantification of fiscal multipliers with standard VARs is controversial for two reasons. First, as stressed by Parker (2011), the effects of fiscal policy shocks may very well be countercyclical. Fiscal multipliers may be larger in periods of slack because of a milder crowding out of private consumption and investment due to less responsive prices (see the textbook IS-LM-AD-AS model), a constrained reaction of nominal interest rates due to the zero-lower bound (Eggertsson (2010), Christiano, Eichenbaum, and Rebelo (2011), Woodford (2011), Leeper, Traum, and Walker (2011), and Fernández-Villaverde, Gordon, Guerrón-Quintana, and Rubio-Ramírez (2012)), higher returns from public spending due to countercyclical financial frictions and credit constraints (Canzoneri, Collard, Dellas, and Diba (2015)), and lower crowding out of private employment due to a milder increase in labor market tightness (Michaillat (2014), Roulleau-Pasdeloup (2014)). Empirical evidence in favor of state-dependent fiscal multipliers is provided by, among others, Tagkalakis (2008), Auerbach and Gorodnichenko (2012, 2013a, 2013b), Bachmann and Sims (2012), Batini, Callegari, and Melina (2012), Mittnik and Semmler (2012), Baum, Poplawski-Ribeiro, and Weber (2012), Fazzari, Morley, and Panovska (2014).[1] Second, anticipation effects are likely to be of great relevance in the transmission of fiscal policy shocks, a phenomenon often referred to as "fiscal foresight" (see, among others, Yang (2005), Fisher and Peters (2010), Mertens and Ravn (2011), Ramey (2011b), Gambetti (2012a, 2012b), Kriwoluzky (2012), Favero and Giavazzi (2012), Leeper, Walker, and Yang (2013), Ellahie and Ricco (2013)). Modeling a standard set of U.S. variables with a medium-scale structural model that allows for foresight up to eight quarters, Schmitt-Grohe and Uribe (2012) find that about sixty percent of the variance of government spending is due to anticipated shocks. Unfortunately, in presence of fiscal foresight, standard VARs - which rely on current and past shocks to

[1] Other forms of state-dependence have been identified in the literature. Corsetti, Meier, and Müller (2012) investigate the sensitivity of government spending multipliers to different economic scenarios. They find fiscal multipliers to be particularly high during times of financial crisis. Rossi and Zubairy (2011) and Canova and Pappa (2011) show that fiscal multipliers tend to be larger when positive spending shocks are accompanied by a decline in the real interest rate. Perotti (1999) shows that fiscal multipliers may depend on the debt-to-GDP ratio in place when fiscal shocks occur. For a DSGE-based quantification of fiscal multipliers in presence of normal vs. abnormal debt-to-GDP ratios, see Cantore, Levine, Melina, and Pearlman (2013).

interpret the dynamics of the modeled variables - are typically "non-fundamental", in that they do not embed the information related to "news shocks", i.e., future shocks anticipated by rational agents.[2] Leeper, Walker, and Yang (2013) work with a variety of fiscal models and show that the anticipation of tax policy shocks severely affects VAR exercises aiming at identifying fiscal shocks. Forni and Gambetti (2010) and Ramey (2011b) show that government spending shocks estimated with standard fiscal VARs are predictable, i.e., they are non-fundamental.

This paper estimates *state-dependent fiscal multipliers* by explicitly addressing the issue of *fiscal foresight*. We tackle the issue of non-fundamentalness by jointly modeling a measure of *anticipated ("news") fiscal spending shocks* along with a set of standard macro-fiscal variables. Such a measure of fiscal news is the *sum of revisions of expectations about future government spending* collected by the Survey of Professional Forecasters. As shown by Gambetti (2012a, 2012b) and Forni and Gambetti (2014), this measure of fiscal shocks is particularly powerful to capture the effects of fiscal spending shocks when the implementation lag of fiscal policy is larger than one quarter, a very plausible assumption as for U.S. fiscal policy decisions.[3] We include this measure of fiscal news in a nonlinear Smooth Transition Vector AutoRegressive (STVAR) model, which we use to discriminate dynamic responses to fiscal shocks in bad and good times (i.e., recessions vs. expansions). Our multipliers are computed as the integral of the impulse response of output (up to a chosen horizon) divided by the integral of the response of fiscal expenditure (up to the same horizon) and rescaled by the sample mean value of the output-public spending ratio.[4] To assess the effects of public spending shocks on output and estimate fiscal multipliers in recessions and expansions, we compute Generalized Impulse Response Functions (GIRFs), which model the endogeneity of the transition from a state to another after a fiscal shock. Importantly, as explained by Koop, Pesaran, and Potter (1996), GIRFs allow us to scrutinize the role played by different initial conditions. We then isolate *"extreme" events*, i.e., deep recessions and

[2]For a recent discussion on non-fundamentalness in the VAR context and a survey of the main contributions in this area, see Beaudry and Portier (2014).

[3]Yang (2005) shows that the average implementation lag for major postwar U.S. income tax legislation is about seven months. Mertens and Ravn (2011) find that the median implementation lag is six quarters. Leeper, Richter, and Walker (2012) calibrate tax foresight and government spending foresight to range between two and eight quarters (the former) and between three and four quarters (the latter).

[4]Our results are robust to to the employment of an alternative way of computing fiscal multipliers, i.e., the ratio of the "peak" value of the impulse responses of output and public spending rescaled by the sample mean ratio of the levels of ouput over public spending. Our Appendix (available upon request) documents the results obtained with this alternative way of computing fiscal multipliers.

strong expansions, with the aim of understanding if *fiscal multipliers are larger in very severe economic conditions*. To our knowledge, this key policy-relevant question has not been previously studied in the empirical literature on fiscal multipliers.

Our results are the following: i) anticipated fiscal expenditure shocks trigger a significant reaction of output; ii) such a reaction is not statistically different across different phases (recessions/expansions) of the U.S. business cycle; iii) the reaction becomes statistically different for extreme phases of the business cycle, i.e., deep recessions vs. strong expansions; iv) fiscal multipliers in recessions are statistically larger than one; v) spending shocks in recessions have a noticeable stabilization effect and substantially reduce the probability that the economy will remain slack. These results are robust to a wide battery of checks, including i) the employment of a "purged" measure of fiscal news, which is constructed using information available to survey respondents when they formulate their expectations over future public spending, to account for potential identification issues; ii) the use of the fiscal news constructed by Ramey (2011b), which allows us to extend our sample back to 1947, to control for small-sample biases that may affect our data-intensive estimator; iii) the role of debt, to account for the role played by fiscal strains in computing multipliers; iv) several different VAR specifications.

Our paper represents a novel contribution under several respects. First, our VAR jointly accounts for two relevant issues for the quantification of fiscal multipliers: fiscal foresight and state dependence. Second, we estimate the response of economic aggregates to fiscal shocks via GIRFs, which allow us to endogenize the possibly stabilizing effects of fiscal policy. Third, the use of GIRFs allows us to address a previously unexplored issue, i.e., the role played by business cycle conditions for the quantification of fiscal multipliers, which we investigate by distinguishing between "extreme" and "moderate" business cycle phases. As a result, we are able to establish some new stylized facts about government spending multipliers in the U.S., in particular the fact that firm evidence of state dependence arises only when looking at extreme phases of the business cycle.

The closest papers to ours are Auerbach and Gorodnichenko (2012, 2013a), Owyang, Ramey, and Zubairy (2013), and Ramey and Zubairy (2014). Auerbach and Gorodnichenko (2012, 2013a) employ a STVAR model and find evidence of countercyclical fiscal multipliers.[5] There are substantial differences between Auerbach and Gorodnichenko's contributions and ours. First, they investigate the role of unanticipated fiscal spending shocks. Differently, we focus on anticipated changes in fiscal spending.

[5] For a similar exercise focusing on the role of business confidence, see Bachmann and Sims (2012).

Second, their impulse responses are conditionally linear, i.e., expansionary fiscal spending shocks are, by construction, not allowed to drive the economy out of a recession. As pointed out by the same authors, this assumption provides an "upper bound" for their estimates of the fiscal multiplier in recessions, because it does not allow the returns from fiscal spending to be decreasing as the economy exits a recession. Our approach links the evolution of the variables in our STVAR to the probability of being in a recession, which is then endogenously modeled. Third, our focus is on "extreme" events, i.e., realizations on the tails of the distribution of our business cycle indicator (like the 2007-09 crisis). Our main result is that, while fiscal multipliers may be acyclical when recessions and expansions are considered all alike (i.e., they may be similar when considering the average effect in recessions vs. expansions), they are likely to be large in presence of particularly severe economic conditions. Owyang, Ramey, and Zubairy (2013) and Ramey and Zubairy (2014) employ local-projection methods à la Jordà (2005) to investigate the nonlinearity of fiscal multipliers. They find no evidence of larger fiscal multipliers during downturns as for the United States. The comparability between our exercises and theirs is not immediate due to a number of different modeling choices (construction of the news shocks, length of the sample, construction of the impulse responses, among others). We notice that our results are similar to theirs in that we also do not find larger fiscal multipliers in recessions on average. However, when it comes to deep recessions vs. strong expansions, we find such larger multipliers to arise.

Other strands of the literature have dealt with fiscal foresight and anticipated fiscal spending shocks in VARs. Mertens and Ravn (2010) recover the non-fundamental responses to an anticipated fiscal policy shock via economic theory-driven restrictions to gauge information about economic agents' anticipation rate. Such a rate is then used as an input in Blaschke matrices to flip the roots that cause the non-invertibility of the VMA representation of fiscal spending and output. Kriwoluzky (2012) recovers reduced-form innovations by estimating a VARMA model using the Kalman filter. Then, he identifies anticipated fiscal shocks via theoretically-supported sign restrictions. Ramey and Shapiro (1998) follow a narrative approach to identify exogenous changes in military spending related to wars. Ramey (2011b) constructs a measure of changes in the expected present value of government spending. Fisher and Peters (2010) construct a measure of excess returns of large U.S. military contractors which is shown to anticipate future military spending shocks. Ben Zeev and Pappa (2014) identify U.S. defense news shocks as the shocks that best explain future movements in defense spending over a five year horizon and are orthogonal to current defense spending. All these contributions show that, at least qualitatively, anticipated positive fiscal shocks induce a significant increase in output.[6] Perotti (2007, 2011), Ramey (2011b), Gambetti (2012a, 2012b), Blanchard and Leigh (2013), Alesina, Favero, and Giavazzi (2014), Forni and Gambetti (2014a), and Ricco (2014) work with expectations revisions in different modeling frameworks. Our paper complements these contributions, in that it quantifies the effects of anticipated fiscal spending shocks with a nonlinear model focusing on extreme events.[7]

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 sums of revisions of fiscal expectations variable employed in our analysis helps solving the issue. Section 3 offers statistical support to the role of nonlinearities in this context and presents the Smooth Transition VAR model employed in our analysis. Our main results are shown in Section 4, which deals with the computation of fiscal multipliers in recessions and expansions, and Section 5, which focuses on extreme events. Section 6 documents a battery of robustness checks. Concluding remarks are provided in Section 7.

2 Non-fundamentalness and expectations revisions

The role of expectations revisions. As anticipated in our Introduction, standard fiscal VARs may return severely biased impulse responses in presence of news shocks. Consider the model

$$y_t = \delta E_t y_{t+1} + g_t + \omega_t \tag{1}$$

$$g_t = \varepsilon_{t-h} + \phi_1 \varepsilon_{t-h-1} + \ldots + \phi_{q-h-1} \varepsilon_{t-(q-1)} + \phi_{q-h} \varepsilon_{t-q} = \Phi(L)\boldsymbol{\varepsilon}_t \tag{2}$$

[6] Another interesting approach to account for fiscal foresight rests on the use of municipal bond spreads. This bond spread is well-known to have predictive power for tax changes and can therefore be used to control for anticipated tax changes (see, among others, Poterba (1989), Fortune (1996), and Kueng (2014)). Leeper, Richter, and Walker (2012) show that spreads with maturity lengths of 1 and 5 years are very informative about future tax events. Our paper deals with anticipated fiscal spending shocks. We leave the analysis of anticipated tax shocks to future research.

[7] Admittedly, the theoretical papers modeling nonlinearities cited in this Introduction mainly consider models in which government spending is implemented without lags. As for the zero lower bound, however, Christiano, Eichenbaum, and Rebelo (2011) conduct an exercise in which they model implementation lags in their framework featuring the zero lower bound. They find that a key determinant of the size of the multiplier is indeed the state of the world in which new government spending comes on line. Our conjecture is that such asymmetric effects may be present also when anticipated fiscal shocks hit economic systems characterized by state-dependent financial constraints and labor market downward rigidities.

where $|\delta| < 1, \phi_i > 0 \ \forall i, h \geq 0, q \geq h$, and $\phi_0 = 0$. The forward-looking process y_t - say, output measured as log-deviations from its trend - is affected by the exogenous stationary process g_t - say, a fiscal process - plus a random shock ω_t, which is assumed to capture non-fiscal spending shocks affecting output and which is assumed to be *i.i.d.* with zero mean and unit variance. The process (2) features $q - h + 1$ moving average terms. If $h = 0$ and $q > 0$, the process (2) features an unanticipated, ε_t, as well as anticipated shocks ε_{t-q} for $q > 0$. For $h > 0$, the process (2) would feature only anticipated shocks, where h is the number of periods of foresights. The process g_t is a news-rich process if $|\phi_i| > 1$ for at least one $i > 0$ (Beaudry and Portier (2014)). In all cases, $\{\varepsilon_{t-j}\}_{j=h}^{q}$ is said to be fundamental for g_t if the roots of the polynomial $\Phi(L)$ lie outside the unit circle (Hansen and Sargent (1991)). Importantly, if the g_t process is non-fundamental, its structural shock is not recoverable by employing current and past realizations of g_t only. Consequently, its impulse response to an anticipated shock as well as the dynamic responses of other variables – in this example, y_t – will not be correctly recovered by estimating a VAR in y_t and g_t.

We assume that agents have rational expectations and observe news shocks without noise.[8] It can be shown that, if the period of foresight $h \geqslant 1$ is known, the problem of non-fundamentalness in model (1)-(2) can be solved by alternatively including: i) the h-step-ahead expectation, $E_t g_{t+h}$, if $h = q$; ii) the h-step-ahead expectation revision, $E_t g_{t+h} - E_{t-1} g_{t+h}$, if $h < q$. However, if $h > 1$ is unknown, expectation revisions are not of help. To solve this issue, Gambetti (2012a) proposes to use a news variable defined as

$$\eta_{1J}^{g} = \sum\nolimits_{j=1}^{J} \left(E_t g_{t+j} - E_{t-1} g_{t+j} \right) = \begin{cases} \left(1 + \phi_1 + ... + \phi_{J-h}\right) \varepsilon_t \text{ if } J < q \\ \left(1 + \phi_1 + ... + \phi_{q-h}\right) \varepsilon_t \text{ if } J \geqslant q \end{cases}, \tag{3}$$

which correctly identifies the news shock if $J \geqslant h$.[9] Our Appendix provides further discussions and derivations as regards this news variable.

[8] Forni, Gambetti, Lippi, and Sala (2013) investigate the case in which economic agents deal with noisy news. Agents are assumed to receive signals regarding the future realization of TFP shocks. Since such signals are noisy, agents react not only to genuinely informative news, but also to noise shocks that are unrelated to economic fundamentals. They find that such noise shocks explain about a third of the variance of output, consumption, and investment. We leave the quantification of the role of noise shocks in the fiscal context to future research.

[9] If $J < h$, the news variable would have no predictive content about fiscal shocks, and it would be equal to zero. In our sample, however, this never happens. This is consistent with the evidence in Leeper, Richter, and Walker (2012), who report an average implementation lag of about three quarters. In our example above, h should be interpreted as the minimum temporal gap between the announcement of the implementation of future fiscal spending and the realization of the spending itself (which may take more than one quarter), rather than the mean value. Hence, also the effects of the announcement of future spending whose full implementation would take more than J quarters would be captured by our news, as long as the minimum lag h is less than J.

The News13 variable. We will then consider a fiscal VAR augmented with a measure of news constructed by summing up revisions of expectations as follows:

$$\eta_{13}^{g} = \sum\nolimits_{j=1}^{3} (E_t g_{t+j} - E_{t-1} g_{t+j}) \tag{4}$$

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 "news" that becomes available to private agents between time $t-1$ and t about the growth rate of government spending j periods ahead. We use data coming from the Survey of Professional Forecasters (SPF), which collects forecasts conditional on time $t-1$ of variables up to time $t+3$. This is the reason why our baseline analysis will be conducted by considering the variable η_{13}^{g}.[10]

Information content of expectations revisions. To assess the statistical relevance of our news variable for the dynamics of public expenditure, we regress public spending on a constant and three lags of the dependent variable, public receipts, real GDP, and one lag of the measure of news η_{13}^{g} (a detailed description of the data is provided in Section 3). This regression augments the public spending equation of a trivariate VAR system modeling the "usual suspects" (public spending, tax receipts, output) with our news variable lagged one period.[11] Public spending shocks are often identified with a Cholesky decomposition of the covariance matrix of the VAR residuals. Hence, the (orthogonalized) residuals of the public spending equation are interpreted as public spending shocks. As shown in Table 1 - which collects the p-values for our η_{13}^{g} variable in the equation described above - news shocks are found to carry significant information about the future evolution of public spending. This implies that the trivariate fiscal VAR without news is non-fundamental. Digging deeper, we find that all the three components (forecast revisions) included in η_{13}^{g} have some predictive power. Overall, this empirical exercise highlights the significant contribution of news revisions regarding *future* realizations of public expenditure. Differently, revisions of expectations based on nowcasting, i.e., $E_t g_t - E_{t-1} g_t$, turn out to be insignificant at the 90% confidence level (see Table 1, last column). In line with Ricco (2014), this result suggests that revisions based on "nowcasts" (revision of expectations at time t of contemporaneous public ex-

[10] SPF data are affected by frequent changes in the base years. Forecast errors on the growth rates are not affected by these changes. Hence, they are preferable to forecast errors computed with SPF levels. About this point, see also Perotti (2011).

[11] The regression includes variables in (log-)levels and the news η_{13}^{g} variable in cumulated sums to preserve the same order of integration. This is consistent with the modeling choices of our baseline VAR analysis (specified in the next Section).

penditures) are possibly of help in identifying truly *unanticipated* fiscal shocks, rather than *anticipated, news* shocks.[12]

Overall, our results i) show that, from a statistical standpoint, residuals typically employed in a standard trivariate fiscal VAR cannot be interpreted as fiscal shocks; ii) suggest that the components of the variable η_{13}^g, which we interpret as a measure of anticipated fiscal shocks, can augment the information content of our VAR system. These results are consistent with the outcome of the Granger-causality tests conducted by Gambetti (2012b), who shows that η_{13}^g Granger-causes fiscal spending at different horizons.[13]

Extreme realizations of the news spending variable: An interpretation. Figure 1 plots our news variable (an updated version of Gambetti's 2012b). The standardized variable η_{13}^g conveys useful information about fiscal policy shocks in the United States. To see this, we isolate the seven realizations which exceed two in absolute value, and provide an interpretation based on the recent U.S. fiscal history. The 1983Q1 positive realization is associated to Ronald Reagan's "Evil Empire" and "Star Wars" speeches, with which the U.S. President announced a forthcoming increase in military spending. The 1986Q1 negative spike reflects the speech given in January 1986 by Mikhail Gorbachev, who proposed decommissioning all nuclear weapons by 2000 in the early stage of the "Perestrojka" period. The 1987Q1 positive forecast revisions might be due to the mid-term Senate elections won by the Democrats in November 1986 plus the questioned constitutionality of the Gramm-Rudman-Hollings Balanced-Budget Act. The 1987Q4 forecast revisions are due to announcements about spending cuts for the Pentagon. The fall of the Berlin Wall in November 1989 is behind the negative spike in 1989Q4. The war in Afghanistan rationalizes the positive peak in 2001Q4. Finally, the upward spike in 2009Q1 can be associated to Obama's stimulus package.

Comparison with Ramey's (2011b) news variable. Figure 1 also plots the military spending news variable constructed by Ramey (2011b), and extended up to

[12]These results are conditional on news variables constructed as revisions of the mean predicted values of the levels of future government spending as collected by the Survey of Professional Forecasters. Similar results were obtained by employing median values of such forecasts, as well as variables expressed in growth rates.

[13]In a recent paper, Perotti (2011) questions the use of the SPF forecast errors employed by Ramey (2011) to isolate fiscal spending anticipated shocks. In particular, he shows that the one-step-ahead predictive power of the forecast revisions as for federal spending is quite modest, since such revisions are shown to be noisy. Our results are fully consistent with Perotti's (2011) analysis, in that we also reject the relevance of very short-term SPF forecast revisions on future fiscal spending. This evidence suggests the need of searching for anticipation effects beyond one-quarter relative to the moment in which predictions are formulated, and supports the employment of a variable like η_{13}^g.

2010Q4 by Owyang, Ramey, and Zubairy (2013).[14] It appears that the η^g_{13} variable anticipates changes in Ramey's, or at least it is not anticipated by the latter. To corroborate this statement, we run Granger-causality tests based on an estimated bivariate VAR with one lag involving the military spending news proposed by Ramey (2011b) (as well as its updated version by Owyang, Ramey, and Zubairy, 2013) and the η^g_{13} variable. Table 2 collects the outcome (p-values associated to testing the null hypothesis that the column variable does not Granger-cause the alternative news measure) of this exercise for our benchmark sample and a shorter sample to account for the fact that, for the first five years in the benchmark sample, Ramey's (2011b) variable is equal to zero. While the contribution of our news shock variable finds large statistical support, Granger-causality running from Ramey's shock to ours is clearly rejected by the data. The same evidence emerges when employing the news variable by Owyang, Ramey, and Zubairy (2013), which includes observations related to the 2007-2009 recession. Again, these results are in line with those reported in Gambetti (2012b), who also finds Ramey's news shock to be predicted by forecast revisions over one quarter.

3 Econometric approach: A STVAR macro-fiscal model

Modeling choices. We assess the state-dependence of fiscal spending multipliers to news shocks by estimating a Smooth-Transition VAR model (for an extensive presentation, see Teräsvirta, Tjøstheim, and Granger (2010)). Our STVAR framework reads as follows:

$$
\begin{aligned}
\boldsymbol{X}_t &= F(z_{t-1})\boldsymbol{\Pi}_R(L)\boldsymbol{X}_t + (1 - F(z_{t-1}))\boldsymbol{\Pi}_E(L)\boldsymbol{X}_t + \boldsymbol{\varepsilon}_t, && (5)\\
\boldsymbol{\varepsilon}_t &\sim N(0, \boldsymbol{\Omega}_t), && (6)\\
\boldsymbol{\Omega}_t &= F(z_{t-1})\boldsymbol{\Omega}_R + (1 - F(z_{t-1}))\boldsymbol{\Omega}_E, && (7)\\
F(z_t) &= \exp(-\gamma z_t)/(1 + \exp(-\gamma z_t)), \gamma > 0, z_t \sim N(0, 1). && (8)
\end{aligned}
$$

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 $\boldsymbol{\Pi}_E$

[14] Ramey (2011b) employs *Business Week* and other newspaper sources to construct an estimate of changes in the expected present value of goverment spending (nominal spending divided by nominal GDP one period before).

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 $\boldsymbol{\Omega}_E$ stand for the covariance structure of the residuals in recessions and expansions, respectively. The modeling assumption is that the variables can be described with a combination of two linear VARs, one suited to describe the economy during recessions and the other during expansions. The transition from a state to another is regulated by the standardized transition variable z_t. The smoothness parameter γ affects the probability 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 (5)-(8) allows for nonlinearities to arise from both the contemporaneous and the dynamic relationships of the economic system.

Our baseline analysis refers to the vector $\boldsymbol{X}_t = [G_t, T_t, Y_t, \eta^g_{13,t}]'$, 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, and Y is the log of real GDP.[15] The construction of G and T closely follows Auerbach and Gorodnichenko (2013a).[16] The variable η^g_{13} is the public expenditure news variable (4). The variables are expressed in levels because of possible cointegration relationships. Consistently, the variable η^g_{13} is considered in cumulated sums to preserve the same order of integration as the other variables included in the vector. Our sample of U.S. data spans the period 1981Q3-2013Q1, 1981Q3 being the first available quarter to construct the news variable.[17]

The choice of the transition variable z_t and the calibration of the smoothing parameter γ are justified as follows. As in Auerbach and Gorodnichenko (2012), Bachmann and Sims (2012), Caggiano, Castelnuovo, and Groshenny (2014), and Berger and Vavra (2014), we employ a standardized moving average of the real GDP quarter-on-quarter

[15] Our fiscal aggregates are constructed using 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 expenditure is the sum of consumption expenditure and gross government investment from which we subtract the consumption of fixed capital. Data on real GDP and the implicit GDP deflator (which we use to deflate all nominal series) are provided by the Federal Reserve Bank of St. Louis.

[16] Auerbach and Gorodnichenko (2013a) 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.

[17] Our interpretation of the news variable here is that of an instrument to gauge the real effects of anticipated changes in fiscal spending. We recall that different identification approaches may very well lead to the construction of different, but in principle equally valid, instruments. For an elaboration of this point, see Favero and Giavazzi (2012).

percentage growth rate.[18] We calibrate the smoothness parameter γ to match the observed frequencies of the U.S. recessions as identified by the NBER business cycle dates, i.e. 15% in our sample. Then, we define as "recession" a period in which $F(z_t) \geqslant 0.85$, and calibrate γ to obtain $\Pr(F(z_t) \geqslant 0.85) \approx 15\%$. This metric implies a calibration $\gamma = 2.3$. The choice is consistent with the threshold value $\overline{z} = -0.75\%$ discriminating recessions and expansions, i.e., realizations of the standardized transition variable z lower (higher) than the threshold will be associated to recessions (expansions).[19] Figure 2 plots the transition function $F(z_t)$. Clearly, high realizations of $F(z_t)$ tend to be associated with NBER recessions. Importantly, our results are robust to the employment of alternative calibrations of the slope parameter γ that imply a number of recessions in our sample ranging from 10% to 20%, where the lower bound is determined by the minimum amount of observations each regime should contain according to Hansen (1999) (checks not shown here for the sake of brevity, but available upon request).

Identification of the anticipated fiscal shock. Following Fisher and Peters (2010), we order the news variable η_{13}^{g} last in our vector and orthogonalize the reduced-form residuals of the VAR via a Cholesky-decomposition of the variance-covariance matrix. We analyze the implications of this versus alternative strategies to identify fiscal news shocks in Section 5.

Statistical evidence in favor of nonlinearity. For our vector of endogenous variables $\mathbf{X}_t$, we test and clearly reject the null hypothesis of linearity in favor of the (Logistic) Smooth Transition Vector AutoRegression via the multivariate test proposed by Teräsvirta and Yang (2013) in presence of a single transition variable. Details on this test and its implementation are presented in our Appendix.

Model estimation. Given the high nonlinearity of the model, we estimate it via the Monte-Carlo Markov-Chain algorithm developed by Chernozhukov and Hong (2003). The (linear/nonlinear) VARs include three lags. This choice is based on the Akaike criterion applied to a linear model estimated on the full-sample 1981Q3-2013Q1.

[18] The transition variable z_t is standardized to render our calibration of γ comparable to those employed in the literature. We employ a backward-looking moving average involving four realizations of the real GDP growth rate.

[19] The corresponding threshold value for the non-standardized moving average real GDP growth rate is equal to 0.34%. The sample mean of the non-standardized real GDP growth rate in moving average terms is equal to 0.71, while its standard deviation is 0.50. Then, its corresponding threshold value is obtained by "inverting" the formula we employed to obtain the standardized transition indicator z, i.e., $\overline{z}^{nonstd} = -0.75 \times 0.50 + 0.71 = 0.34$.

4 Generalized impulse responses and fiscal multipliers

This Section reports the estimated impulse responses to an anticipated fiscal spending shock. Following Koop, Pesaran, and Potter (1996), we compute generalized impulse responses to take into account the interaction between the evolution of the variables in the vector $\mathbf{X}_t$ and the transition variable, the latter being directly influenced by the evolution of output. In other words, we model the feedback from the evolution of output in the vector $\mathbf{X}_t$ to the transition indicator z_t and, consequently, the probability $F(z_{t-1})$. Hence, in computing our GIRFs, the probability $F(z)$ is endogenized.[20] Koop, Pesaran, and Potter (1996) and Ehrmann, Ellison, and Valla (2003) show that initial conditions affect the computation of the GIRFs. In our benchmark exercise, we randomize over all possible histories within each state, so to control for the role of initial conditions.[21] We compute the GIRFs by normalizing the news shocks to one.[22]

GIRFs. Figure 3 reports the impact of a government spending news shock computed with our linear and nonlinear VARs. The responses obtained with our linear model point to a delayed short-run increase in government expenditure and output, and a decrease in government receipts. 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.

[20] Recall that our transition indicator $z_t \equiv \frac{1}{4}(\Delta Y_t + \Delta Y_{t-1} + \Delta Y_{t-2} + \Delta Y_{t-3})$, i.e., the relationship between z_t and $\Delta Y_{t-i}, i = 0, 1, 2, 3$ features no stochastic elements. Hence, stochastic singularity prevents us from estimating our model jointly with the evolution of z_t. Following Koop, Pesaran, and Potter (1996), our GIRFs are based on simulations that take into account the link between $\mathbf{X}_t$ and z_t after the estimation of our econometric framework.

[21] Following Koop, Pesaran, and Potter (1996), our GIRFs are computed as follows. First, we draw an initial condition, i.e., starting values for the lags of our VARs as well as the transition indicator z, which - given the logistic function (8) - gives us the value for $F(z)$. Then, we simulate two scenarios, one with all the shocks identified with the Cholesky decomposition of the VCV matrix (7), and another one with the same shocks plus a $\delta > 0$ corresponding to the first realization of the news shock. The difference between these two scenarios (each of which accounts for the evolution of $F(z)$ by keeping track of the evolution of output and, therefore, z) gives us the GIRFs to a fiscal news shock δ. Per each given initial condition z, we compute 500 different stochastic realizations of our GIRFs, then store the median realization. We repeat these steps until 500 initial conditions (drawn by allowing for repetitions) associated to recessions (expansions) are considered. Then, we construct the distribution of our GIRFs by considering these 500 median realizations. Our Appendix provides details on the algorithm we employed to compute the GIRFs.

[22] The standard deviation of the news variable employed in the sample is 0.19 according to our linear model, 0.21 conditional on our framework under recessions, and 0.18 under expansions. While being theoretically size-dependent, we verified that the sensitivity of our impulse responses to reasonable changes in the size of the shock is negligible.

Next, we look at the evidence coming from the nonlinear VAR. Interestingly, the estimated response of output is persistently stronger under recessions. Output increases in expansions in the short-run, but the increase is much milder compared to recessions, and vanishes after about four quarters. Another difference between the two states is the reaction of government spending itself, which is always positive but stronger in recessions. Tax receipts react asymmetrically in the short run, then their patterns become more similar.

Are the reactions of output in recessions and expansions different from a statistical standpoint? Figure 4 plots the GIRFs and the associated 90% confidence intervals estimated for both states. Focusing on output, we see that the confidence bands overlap substantially. This result suggests that the reaction of output to a fiscal shock is not necessarily stronger if the economy is slack. This finding is in line with some recent results put forth by Valerie Ramey and coauthors (see Ramey (2011b), Owyang, Ramey, and Zubairy (2013) and Ramey and Zubairy (2014)), which are obtained with a different identification strategy (fiscal spending news shocks constructed following Ramey's (2011b) approach) and methodology (local projections à la Jordà (2005)). At a first glance, the evidence seems to be at odds with the impulse response analysis proposed by Auerbach and Gorodnichenko (2012, 2013a), who find a statistically significant difference between the response of output conditional on different states. However, a subtle difference in the construction of the dynamic responses must be considered. Auerbach and Gorodnichenko (2012, 2013a) assume the economy hit by the fiscal shock to start and remain in a recession/expansion for twenty quarters. Differently, here we allow the economic system to switch from a state to another according to the endogenous evolution of the transition indicator. Moreover, the GIRFs plotted in Figure 4 are constructed by integrating over all histories belonging to a given state (recessions, expansions). We elaborate on the role played by initial conditions in Section 5.

Quantifying the multipliers. We now turn to the key issue of computing the multipliers and the associated 90% confidence intervals. We compute the "sum" (cumulative) multiplier as the integral of the response of output divided by the integral of the response of fiscal expenditure, i.e., $\sum_{h=1}^{H} Y_h / \sum_{h=1}^{H} G_h$, where H is a chosen horizon. Percent changes are then converted into dollars by rescaling such a ratio by the sample mean ratio of the levels of output over public spending.[23] This measure is designed to

[23] Ramey and Zubairy (2014) warn against this practice by noticing that, in a long U.S. data sample spanning the 1889-2011 period, the output-over-public spending ratio varies from 2 to 24 with a mean of 8. Hence, the choice of a constant value for such ratio may importantly bias the estimation of the multipliers. In our sample, the mean value of such a ratio is 6, and it varies from 5.39 to 6.76. Hence,

account for the persistence of fiscal shocks (Woodford (2011)).

Our results are reported in Table 3, where multipliers have been computed considering horizons from one to five years. The evidence clearly speaks in favor of larger (short-run) fiscal spending multipliers in recessions, with values between 3.05 after 8 quarters and 1.00 after 20 quarters. The point-estimates of our multipliers in expansions are substantially lower (from 0.33 to -2.27 after 8 and 20 quarters, respectively). The multipliers under recession are statistically larger than one in the short run (i.e., for the first four quarters).

Are multipliers statistically bigger in recessions? We answer this question by constructing a test based on the difference between the multiplier estimated under recessions and expansions. Such a test is constructed to account for the correlation between the estimated state-dependent multipliers.[24] Figure 5 plots the distribution of the difference of our multipliers for a range of horizons of our impulse responses along with 90% confidence bands. Evidence in favor of state-dependent multipliers would be gained if zero were not included in the confidence bands. In all cases, although marginally, the difference turns out to be not different from a statistical standpoint.[25]

The stabilizing effects of anticipated fiscal shocks. Our STVAR allows also to estimate the impact of government spending shocks on the probability of being in a recession for each given horizon of interest after the shock. Figure 6 plots the estimated transition function implied by our model, $\widehat{F(z)}$, along with the 90% confidence bands. The Figure gives interesting information about the estimated impact of a positive government spending shock on the likelihood of remaining in the same phase of the business cycle. Looking at the behavior of the $\widehat{F(z)}$ under recession, we notice that the fiscal shock leads to a clear drop in the probability of remaining in recession. Given the large

the commonly adopted *ex-post* conversion from the estimated elasticities to dollar increases does not appear to be an issue for our exercise. The average value of the output-public spending ratio in our sample in 5.81 in NBER recessions, and 6.02 in NBER expansions. Our results are robust to the employment of state-dependent output-public spending ratios.

[24]In short, we compute differences of our multipliers in recessions vs. expansions conditional on the same set of draws of the stochastic elements of our model as well as the same realizations of the coefficients of the vector. The empirical density of the difference between our multipliers is based on 500 realizations of such differences for each horizon of interest.

[25]Importantly, our results are not driven by the systematic component of our STVAR *per se*. In other words, in absence of fiscal interventions, our model economy does not deliver large negative accumulated multipliers at longer forecast horizons when starting in expansions. This was verified by simulating a deterministic version of the STVAR, in which only initial conditions are responsible for the different evolution of the variables in recessions and expansions. Our simulations confirm that our cumulated multipliers are indeed driven by the interaction between fiscal shocks and the systematic component of our STVARs.

uncertainty surrounding the response of output to a fiscal shock, different paths of $\widehat{F(z)}$ are admittedly possible. However, the median indication clearly suggests a quick fall of such a probability under the threshold value $\overline{F} = 0.85$ just after five quarters, which is exactly the average duration of a NBER recession in the sample. In terms of the econometric methodology employed to estimate the state-dependent effect of government spending shocks on output, this evidence shows the importance of allowing for the possibility of switching from one phase of the business cycle to another. Unsurprisingly, given its expansionary effect, the probability of falling into a recession after the news shock when starting from an expansions is basically zero, though such a probability is quite imprecisely estimated.

5 Fiscal multipliers in presence of "extreme" events

Extreme events analysis. So far, our analysis has focused on the possible state-dependence of output reactions to fiscal news shocks and fiscal multipliers, finding weak evidence in favor of countercyclical spending multipliers. The next question we address is whether evidence of nonlinearities might arise when recessions and expansions are "extreme" events. We then re-compute the GIRFs by randomizing over different subsets of histories associated to recessions and expansions. We label "deep" recessions/"strong" expansions the histories associated to realizations of the transition variable which are below/above two standard deviations. Given that our transition variable is standardized, this amounts to saying that all historical realizations of z above two are associated to a strong expansion, while all realizations below minus two are associated to a deep recession. This criterion leads us to isolate four realizations in deep recessions corresponding to the recent great recession (2008Q4-2009Q3) and three realizations which belong to the "strong" expansions category (1983Q4-1984Q2). In a complementary fashion, mild recessions/weak expansions are associated to histories consistent with realizations of the transition variable below/above the threshold value $\overline{z} = -0.75$ but within the range $[-2, 2]$. We then re-compute the GIRFs by randomizing over histories within each of these four sub-categories.

Figure 7 shows the GIRFs obtained by distinguishing between "deep" and "mild" recessions and "strong" and "weak" expansions. The estimated GIRFs show that the response of output is roughly proportional to the strength of the recession (expansion). Although in the short-run the response of output in the case of a "mild" recession is very similar to the response of output in a "deep" recession, the response of output is much more persistent at longer horizons when conditioning on the latter case. This, however, cannot be immediately turned into evidence about multipliers, since the persistence in output response might be driven by the persistence of government spending.

Table 4 reports the fiscal multipliers estimated in the four different cases under scrutiny. Interestingly, multipliers are still larger in recessions relative to expansions, regardless of the strength of the recession (expansion). When the economy is in a deep recession, we find the 4-year horizon multiplier to be 1.6. A similar figure can be gauged for mild recessions, where government spending is found to be expansionary after up to four years. In strong expansions, short-run (one-year) multipliers are slightly above one, but they take negative values at longer horizons. Interestingly, while the difference between mild recessions and weak expansions might seem minimal, the impact of fiscal policy in these two states is much more dramatic. Such a difference may be interpreted in light of the different response of fiscal revenues in the two states (at least in the short-run). In good times, government receipts are found to increase after the shock, while in bad times they are found to decrease. In other words, our VAR suggests that recessions are associated to deficit-financed increases in public spending, while expansions are associated to increases in fiscal spending which are readily financed via an increase in revenues. Hence, recessions are associated with a higher net present value of the fiscal deficit relative to expansions. This can justify the large and positive real effects of fiscal news on the output multiplier if, during recessions, the Ricardian equivalence does not hold because of, say, binding liquidity constraints during recessions, of rule-of-thumb consumers. It can also offer a rationale for the negative multipliers in strong expansions, which is a state associated with a clearly positive response of revenues to fiscal spending shocks.[26]

Turning to multipliers in expansions, while our point estimates suggest values above one in the short-run, 90% confidence bands imply that we cannot reject values lower than unity. A possible interpretation of large short-run multipliers in expansions relates to the zero lower bound, which has been in place even after the end of the 2007-09 recession, hence in a period classified as ("weak") expansion in our sample. As shown by Leeper, Traum, and Walker (2011), multipliers may be larger than one when an active fiscal policy is accompanied by a passive monetary policy.[27]

[26] See Barro and Redlick (2011) for a discussion of deficit-financed versus balanced-budget fiscal multipliers.

[27] In our sample, the number of quarters associated to expansions by the NBER in which the zero lower bound is in place is 15, i.e., some 14% of all the quarters in expansions according to the NBER, which is a non-negligible share. For an analysis pointing to lower fiscal spending multipliers in a

When we turn to statistical difference, a comparison between the multipliers in the case of "deep" recessions and those conditional on "strong" expansions suggests that the confidence bands do not overlap, and point to a strong evidence in terms of nonlinear responses of the economy to an expansionary fiscal shock. Our results are confirmed also by looking at the distribution of the difference between the estimated state-dependent multipliers. As shown in Figure 8, the countercyclicality of fiscal multipliers conditional on extreme realizations of the business cycle is supported regardless of the horizon.

In our context, it might be more appropriate to test for the null hypothesis of equal multipliers versus the one-sided alternative of multipliers larger in recessions relative to expansions. Table 5 collects the fraction of multipliers that are larger in recessions for both "Normal" (recessions/expansions) and "Extreme" (deep recessions/strong expansions) phases of the business cycle. As before, these numbers are estimated by referring to different initial conditions, all else being equal. Hence, any entry greater than or equal to 90 might be interpreted as evidence in favor of larger multipliers in recessions at a 90% confidence level in the context of a one-sided test. The figures corresponding to the exercises conducted so far refer to the "Baseline" scenario. Under the "Normal" (i.e. all recessions vs. all expansions) case, evidence in favor of countercyclical multipliers is not present for all horizons. Differently, the analysis of extreme events robustly points towards larger multipliers during recessions. We postpone the analysis of the robustness of this result to a number of perturbations of the baseline framework to the next Section.

How does the economic system evolve after a fiscal shock hitting during an extreme phase of the business cycle? Figure 9 plots the estimated value of the $\widehat{F(z)}$ conditional on the four scenarios. For deep recessions, a sizeable decrease of the probability of remaining in such a state occurs as a consequence of the government spending shock: after about five quarters, the value of $\widehat{F(z)}$ decreases from 1 (the economy is in a recession with probability one) to about 0.5 (the economy is unlikely to be in a recession). This drop is quicker and more substantial than the one estimated in presence of mild recessions, and it is also more precisely estimated. Importantly, this suggests that government spending can be effective in lifting the U.S. economy from a deep recession to an expansionary path. The probability of moving away from a strong expansion is low, and more precisely estimated than the one of drifting away from a weak expansion. However, none of the two suggests a high likelihood of falling into a recession.

liquidity trap caused by a self-fulfilling state of low confidence in a model with nominal rigidies and a Taylor-type interest rate rule, see Mertens and Ravn (2014).

Estimated multipliers: Comparison with the literature. Our evidence points to larger multipliers in recessions (around 1.6 for the 4-year horizon), and smaller ones, but still somewhat high in the short-run (slightly larger than 1 after one year), in expansions. Are these multipliers in line with what suggested by the literature? A close look at some recent contributions suggests a positive answer. Auerbach and Gorodnichenko (2012, 2013a) deal with unexpected fiscal shocks in a nonlinear VAR framework and find multipliers in recessions of about 2.5. Bachmann and Sims (2012) control for the effects of business confidence and find the sum and peak multipliers in recessions to be 2.7 and 3.3, respectively. Corsetti, Meier, and Müller (2012) work with a flexible panel of OECD countries that allow them to study the effects of fiscal spending shocks under different scenarios. Conditional on periods of financial strains, they find fiscal spending multipliers to be 2.3 on impact, 2.9 at the peak, and larger than 2 in the medium run.[28] Christiano, Eichenbaum, and Rebelo (2011) work with a medium-scale DSGE model and find a multiplier of 2.3 conditional on the zero-lower bound being in place for one year. Evidence of large multipliers can be found also in linear frameworks which deal with the issue of fiscal foresight. Using Bayesian prior predictive analysis for a battery of closed- and open-economy DSGE models featuring different frictions and policy conducts, Leeper, Traum, and Walker (2011) rationalize fiscal spending multipliers of two or larger. Ben Zeev and Pappa (2014) find a peak multiplier larger than 4. Fisher and Peters (2010), using their measure of excess returns of large U.S. military contractors, find a multiplier of 1.5. The same figure is found by Ricco (2014), who employes a measure of news which accounts for the changes in the composition of the pool of forecasters compiling the SPF questionnaires. Depending on the set of restrictions imposed in their sign restriction-VAR analysis, Canova and Pappa (2011) find the U.S. fiscal multipliers to range between 2 and 4.

Our findings qualify those by Auerbach and Gorodnichenko (2012, 2013a), who suggest that recessions are associated with larger fiscal spending multipliers. As already pointed out, their general conclusion might be driven by the implicit assumption that all recessions are treated like "extreme events" when conducting their impulse response analysis. Our analysis suggests that this may very well be the case. This finding has important implications from a policy perspective too, given that a fiscal stimulus may be needed exactly in correspondence to deep recessions.

[28] As reported in the minutes of the *Economic Policy* Panel Discussion, Giancarlo Corsetti pointed out that financial crises, in their study, are not meant to represent recessions. However, he also added that the multipliers are even larger when one uses macro crisis episodes alone in their panel approach. See *Economic Policy*, 2012, 27(72), p. 562.

Overall, our analysis based on "disaggregated" recessions and expansions shows that nonlinearities are likely to arise when we look *within* each of the two states typically investigated in a business cycle context, i.e., recessions and expansions. In particular, we find support in favor of a larger fiscal multiplier when deep recessions are considered.

6 Further investigations

Our baseline analysis suggests that evidence in favor of countercyclical fiscal multipliers is borderline when we condition upon recessions vs. expansions, while it becomes much clearer and solid when conditioning upon extreme events. This Section discusses the solidity of our results to the employment of i) alternative identification strategies; ii) a longer sample; iii) debt; iv) several different VAR specifications.

6.1 Identification

Exogeneity of the change in government spending expectations. Our baseline analysis rests on revisions of government spending expectations. Such revisions may in principle be due to shocks other than merely fiscal ones. Suppose that $g_t = \boldsymbol{\delta} \boldsymbol{z}_t + \xi_t$, where $\boldsymbol{z}_t$ is a vector of m indicators of the business cycle (say, output, unemployment, inflation, interest rates), $\boldsymbol{\delta}$ is the vector of loadings relating $\boldsymbol{z}_t$ to g_t, and $\xi_t = \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + ... + \phi_n \varepsilon_{t-n}$ is a moving average process modeling the unexpected fiscal shock ε_t as well as the expected ones $\varepsilon_{t-j}, j = 1, ..., n$. Then, $\eta_{13}^g = \sum_{j=1}^{3} (E_t g_{t+j} - E_{t-1} g_{t+j}) = \boldsymbol{\delta} \sum_{j=1}^{3} (E_t \boldsymbol{z}_{t+j} - E_{t-1} \boldsymbol{z}_{t+j}) + \widetilde{\eta}_{13}^g$, where $\widetilde{\eta}_{13}^g = \sum_{j=1}^{3} \phi_j \varepsilon_{t-j}$. In words, systematic revisions of fiscal spending forecasts might be due not only to anticipated fiscal shocks, but also to revisions of other variables' forecasts possibly due to other shocks (technology, financial). We deal with this issue by regressing our measure of fiscal news η_{13}^g on a number of macroeconomic indicators available to professional forecasters when they are asked to form expectations about G: (the sums of forecasts revisions of) real GDP growth, unemployment, GDP deflator inflation, the 3-month Treasury bill rate, and the 10-year Treasury bond rate.[29] Figure 10 displays the raw and purged

[29] Forecasts of the debt-to-GDP ratio are not included in the SPF survey. We run further regressions by adding lagged realizations of debt-to-GDP ratio to the regression described in the text. Such measures turn out to be insignificant. The choice of not including the contemporaneous realizations of the debt-to-GDP ratio on the right-hand side of the regression is due to the timing of the Survey of Professional Forecasters (SPF). The questionnaire of such survey is sent to the pool of respondents after the advance report of the national income and product accounts by the Bureau of Economic Analysis (BEA) is released to the public. Hence, the questionnaire contains the first estimate of GDP

versions of the news variable, denoted by η_{13}^{g} and $\widetilde{\eta}_{13}^{g}$ respectively. Two considerations are in order. First, the correlation between these two variables is quite high (0.95). Second, the most extreme realizations, documented in Figure 1 and reproposed here, are clearly captured by both variables. Hence, most of the information content of the (unpurged version of the) η_{13}^{g} variable is likely to come from its genuinely exogenous component. To corroborate this statement, we replace the η_{13}^{g} variable with its purged version $\widetilde{\eta}_{13}^{g}$ in our VAR, and re-run our estimations and simulations. Table 6 ("$\widetilde{\eta}_{13}^{g}$ last") collects the results of this exercise for our extreme events analysis.[30] These results, as well as those in Table 5 on the difference of the multipliers in extreme business cycle phases, confirm our baseline findings

Contemporaneous effects of fiscal spending shocks. Another issue affecting our baseline analysis regards the timing of the impact of the news shocks. The baseline vector features a recursive identification scheme in which the news variable is ordered last. This choice aims at purging the movements of the η_{13}^{g} fiscal variable by accounting for its systematic response to government spending, tax revenues, and output. However, such a choice has an obvious limitation, i.e., output is not allowed to move immediately after the realization of the news shock. We then perform a robustness check by focusing on the four-variate VAR $\boldsymbol{X}_t^{\widetilde{\eta}^g} = [\widetilde{\eta}_{13,t}^{g}, G_t, T_t, Y_t]'$, which enables fiscal news shocks to affect output on impact.[31] We run this exercise with our purged measure of anticipated fiscal shocks to control for the systematic movements of fiscal news due to news hitting other macroeconomic indicators, as explained above. Table 6 ("$\widetilde{\eta}_{13}^{g}$ first") documents slightly different, but statistically equivalent, multipliers relative to the baseline. Most importantly, as also documented by Table 5, we find again larger multipliers in deep recessions than in strong expansions.

and its components for the *previous* quarter. Thus, in formulating and submitting their projections, the information sets of the SPF panelists include the data reported in the advance report and related to quarter $t-1$ but not data regarding quarter t. For information on the variables included in the survey and the information set possessed by respondents, see http://www.philadelphiafed.org/research-and-data/real-time-center/survey .

[30] Multipliers computed by considering a four-year time span. Similar results are obtained when considering a two-year time span.

[31] An alternative, not pursued here, would be to work with sign restrictions. For an analysis of sign restrictions in fiscal VARs and their implications for the implied fiscal elasticities, see Caldara and Kamps (2012).

6.2 Longer sample

The nonlinear estimator we employ is data intensive. Because of limited data availability for the SPF forecast revisions, our baseline analysis rests on a relatively short sample, i.e., 1981Q3-2013Q1. Hence, small-sample issues may lead to distortions of our estimated coefficients, which could then lead us to obtain biased multipliers. We then conduct a robustness check by employing a much longer sample, i.e., 1947Q1-2013Q1. To do so, we use an updated version of Ramey's (2011b) widely known fiscal news variable (available at Valerie Ramey's website), and put it first in a VAR including fiscal spending, fiscal revenues, and output. Following Ramey (2011b), we estimate a VAR with four lags and a quadratic trend. Table 6 ("Long sample, Ramey's news") collects the outcome of our estimations. Reassuringly, this exercise produces multipliers very much in line with our baseline ones, and it offers support to the importance of looking at extreme events to find nonlinearities in the fiscal multipliers even in long samples.

6.3 The role of debt

Our baseline VAR does not feature debt. However, controlling for debt fluctuations in our regressions is important to better understand the drivers of our countercyclical multipliers. The reason is simple. Recent panel-data studies have shown that countries with "high" levels of debt have smaller multipliers than countries with lower levels of debt (see, e.g., Corsetti, Meier, and Müller (2012), Ilzetzki, Mendoza, and Végh (2013)). Hence, it could in principle be possible that the nonlinearities we have found are driven by different levels of debt rather than different phases of the business cycle. It is then of interest to check if the relevant initial conditions could be related to different degrees of fiscal distress. To this aim, we modify our baseline vector along two dimensions. First, we include the debt/GDP ratio in our VAR. Following a common modeling choice in the literature (see, among others, Leeper, Traum, and Walker (2011), Leeper, Richter, and Walker (2012), Corsetti, Meier, and Müller (2012), and Leeper, Walker, and Yang (2013)), we assume the debt/GDP ratio to affect the fiscal instruments with a lag, and put it last in the vector. Second, we employ our debt/GDP ratio as the variable which dictates the switch from a regime to another. This second modification is exactly aimed at capturing the idea of different "debt-contingent" regimes. To discriminate between "high" vs. "low" realizations of debt, we focus on the cyclical component of the debt/GDP ratio, which is extracted from the raw series (in log) by applying a standard Hodrick-Prescott filter with smoothing weight equal to 1,600. Realizations of the debt/GDP ratio one standard deviation above (below) the HP-trend are interpreted as phases of "high" ("low") debt. Positive (negative) realizations within one standard deviation are classified as "moderately high" ("moderately low"). A possible interpretation of this series is that of a "debt/GDP gap" computed by considering a time-varying debt/GDP target, which may be consistent with the clear upward-trending behavior displayed by this ratio in our sample.

Table 6 ("Debt/GDP ratio") collects the multipliers produced by this exercise. We distinguish between extreme phases of "high" and "low" fiscal distress, as well as intermediate ones, i.e. "moderately high" and "moderately low", which we indicate with "$Mod.^{+}$ *debt*" and "$Mod.^{-}$ *debt*", respectively. Our results point to fairly similar fiscal multipliers when computed conditional on "high" vs. "low" debt levels. Hence, countercyclical fiscal multipliers do not seem to be guided by the "fiscal cycle".[32] Our results echo those by Favero and Giavazzi (2012), who also find no major empirical differences in a fiscal model for the U.S. when adding debt. It is important to stress, however, that this conclusion is not inconsistent with cross-country studies which point to relevant nonlinearities of fiscal policy effects due to different levels of debt, in particular for developing countries.

6.4 Further robustness checks

Our results are robust to a variety of further perturbations of our baseline model, which include: i) a "FAST-VAR" (Factor Augmented Smooth Transition-VAR) version of our VAR model, which we estimate to further control for non-fundamentalness as suggested by Forni and Gambetti (2014b); ii) the estimation of a five-variate VAR featuring the sum of forecast revisions regarding future real GDP as first variable in the vector, again to control for revisions of real GDP forecasts; iii) the employment of revisions over total spending forecasts (as opposed to Federal spending only); iv) a measure of news which accounts for the changes in the composition of the pool of forecasters compiling the SPF questionnaires as in Ricco (2014).[33] The solidity of our baseline results is confirmed also by this battery of robustness checks, which is available upon request.

[32] An analysis conducted by adding the debt-to-GDP ratio to our otherwise baseline framework while keeping the moving average of real GDP as our transition indicator returned multipliers very similar to our baseline ones.

[33] We thank Giovanni Ricco for providing us with his measure of fiscal news.

7 Conclusions

This paper quantifies the fiscal spending multiplier in the U.S. and tests the theoretical prediction of a larger reaction of output to fiscal shocks in economic downturns. Following Gambetti (2012a,b) and Forni and Gambetti (2014), we tackle the issue of non-fundamentalness due to fiscal foresight by identifying anticipated government spending shocks via sums of forecasts revisions collected by the Survey of Professional Forecasters. We show that such a measure of fiscal spending news carries relevant information to predict the future evolution of fiscal expenditures and Granger-causes other measures of fiscal news recently proposed in the literature. Then, we augment a macro-fiscal nonlinear VAR with this measure of fiscal news and estimate the size of fiscal spending multipliers across different phases of the business cycle.

Our empirical investigation points to fiscal multipliers larger than one in recessionary periods. However, conditional on a standard "recessions vs. expansions" classification of the phases of the U.S. business cycle, our results do not support the idea of a countercylical fiscal multiplier. Differently, when we condition the estimates of the fiscal multipliers on the *strength* of the business cycle (namely, when we distinguish between deep and mild recessions, and weak and strong expansions), we find that fiscal multipliers are statistically larger in deep recessions relative to strong expansionary periods.

The results of our paper highlight the relevance of the different initial economic conditions *within* each of the two states typically considered for classifying the U.S. business cycle. Fiscal multipliers may very well be larger when a fiscal shock occurs in presence of a deep recession like that of 2007-09 than when it occurs in presence of milder economic downturns. Our results imply that a correct measurement of the fiscal multipliers can be performed just if flexible-enough econometric models are put at work.

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$News$	$(1,3)$	$(1,1)$	$(2,2)$	$(3,3)$	$(0,0)$
$p-value$	**0.00**	**0.00**	**0.00**	**0.00**	0.11

Table 1: **Anticipated fiscal spending shocks: Statistical relevance.** P-values related to the exclusion Wald-test of one period-lagged News variables entering (one at a time) a regression involving government spending (dependent variable), a constant, three lags of government spending, three lags of fiscal receipts, and three lags of real GDP. Figures in bold are associated to a predictive power of news found to be significant at a 10 percent confidence level. News are expressed in cumulated terms to have an order of integration comparable to that of the other variables. Estimation conducted by considering Newey-West standard errors robust to heteroskedasticity and serial correlation.

$Sample$	$Ramey$	η_{13}^{g}	ORZ	η_{13}^{g}
1981:III-2008:IV	0.44	**0.06**		
1986:IV-2008:IV	0.28	**0.02**		
1981:III-2010:IV			0.71	**0.06**
1986:IV-2010:IV			0.59	**0.02**

Table 2: **News à la Ramey vs. forecast revisions: Granger-causality tests.** 'Ramey' stands for the news variable employed by Ramey (2011), 'ORZ' stands for its updated version employed by Owyang, Ramey, and Zubairy (2013). P-values related to the exclusion Wald-test of one period-lagged covariate of interest. Figures in bold are associated to a predictive power of news found to be significant at a 10 percent confidence level. Results based on a bivariate VAR with one lag. Null hypothesis: Column variable does not Granger cause the alternative news measure.

$Horizon/State$	$Expansion$	$Recession$
4	1.73 [0.52,3.50]	3.15 [1.71,4.27]
8	0.33 [−1.05,2.77]	3.05 [0.68,4.70]
12	−0.57 [−2.24,1.54]	2.13 [0.13,3.82]
16	−1.41 [−3.96,0.74]	1.54 [−0.42,2.95]
20	−2.27 [−6.23,−0.01]	1.00 [−0.94,2.47]

Table 3: **Fiscal spending multipliers.** Figures conditional on our baseline VAR analysis. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

Hor./State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
4	1.03 [−0.51,2.03]	3.42 [2.05,4.35]	1.69 [0.64,3.40]	3.09 [1.71,4.14]
8	−0.26 [−2.01,0.84]	3.42 [1.22,5.14]	0.30 [−0.87,2.83]	2.94 [0.56,4.46]
12	−1.32 [−3.68,−0.03]	2.21 [0.61,3.54]	−0.62 [−2.15,1.48]	2.06 [0.03,3.78]
16	−2.26 [−5.63,−0.78]	1.60 [0.18,2.63]	−1.40 [−3.91,0.65]	1.38 [−0.48,3.02]
20	−3.28 [−7.00,−1.56]	1.09 [−0.31,2.07]	−2.37 [−6.08,0.01]	0.83 [−0.97,2.54]

Table 4: **Fiscal spending multipliers: Extreme events.** Figures conditional on our VAR analysis with GIRFs conditional on four different sets of initial conditions. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

Scenario/Horizon	*Cycle*	h=4	h=8	h=12	h=16	h=20
Baseline	*Normal*	84.8	91.6	93.6	95.4	96.6
	Extreme	100	100	100	100	100
$\tilde{\eta}_{13}^{g}$ *last*	*Normal*	78.2	86.4	89.4	90.6	92.6
	Extreme	100	100	100	100	100
$\tilde{\eta}_{13}^{g}$ *first*	*Normal*	58.2	76.2	82.2	89.8	92.0
	Extreme	71.6	93.0	97.8	98.8	99.2
Long sample (Ramey's news)	*Normal*	82.8	89.6	87.6	86.4	86.6
	Extreme	90.2	92.8	92.8	93.0	93.6

Table 5: **Fiscal spending multipliers: Shares of multipliers larger in recessions.** Normal scenarios: Fraction of multipliers which are larger in recessions than expansions out of 500 draws from their empirical distributions. Extreme scenarios: Fraction of multipliers which are larger in deep recessions than strong expansions out of 500 draws from their empirical distributions. 'h' identifies the number of quarters after the shock.

Scenario/State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
Baseline	-2.26 $[-5.63,-0.78]$	1.60 $[0.18,2.63]$	-1.40 $[-3.91,0.65]$	1.38 $[-0.48,3.02]$
$\widetilde{\eta}^g_{13}$ *last*	-1.57 $[-2.92,-0.91]$	2.28 $[1.23,3.10]$	-0.44 $[-1.97,2.29]$	2.16 $[0.22,3.00]$
$\widetilde{\eta}^g_{13}$ *first*	-0.70 $[-2.50,0.43]$	2.36 $[0.99,4.29]$	0.66 $[-1.04,2.90]$	2.50 $[0.59,4.39]$
Long sample (Ramey's news)	0.15 $[-0.24,0.53]$	1.74 $[0.08,3.92]$	0.07 $[-1.23,0.96]$	1.52 $[0.60,4.62]$
	High debt	*Mod.$^+$ debt*	*Mod.$^-$ debt*	*Low debt*
Debt/GDP ratio	0.68 $[0.15,1.37]$	0.74 $[-1.02,1.15]$	1.33 $[0.95,1.66]$	1.33 $[0.81,1.97]$

Table 6: **Fiscal spending multipliers: Extreme events. Different Scenarios.** Four-year integral multipliers. Figures conditional on our VAR analysis with GIRFs conditional on four different sets of initial conditions. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

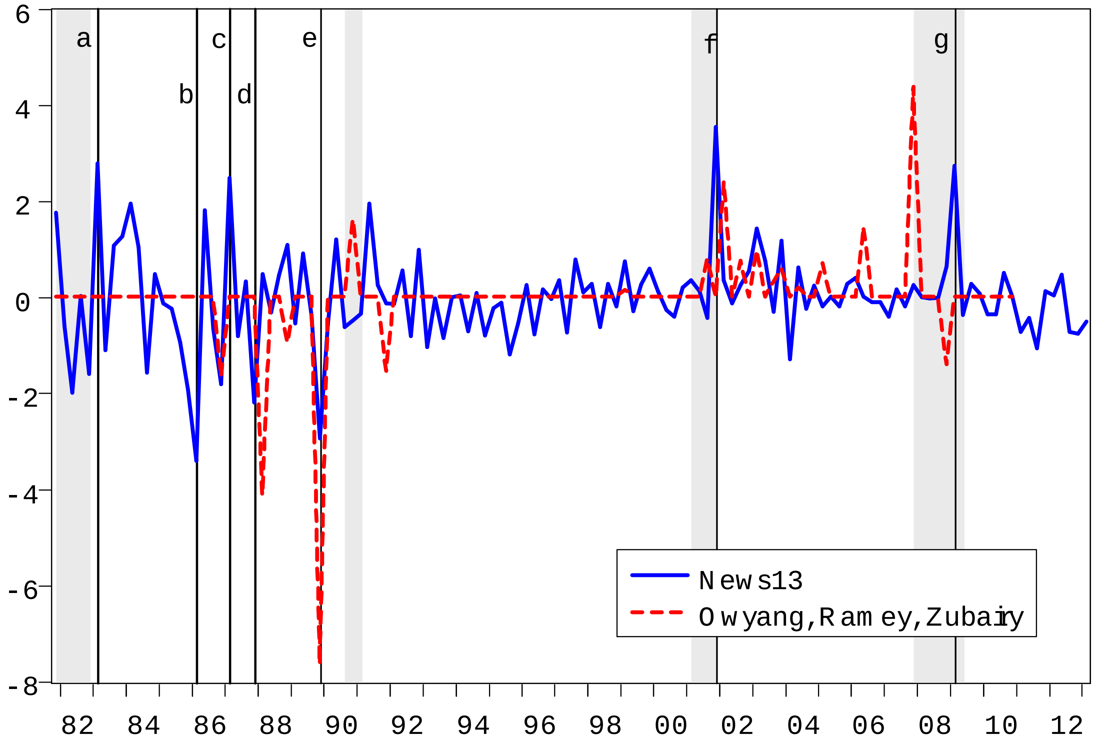

Figure 1: **News13 (this paper) vs. Owyang, Ramey, and Zubairy's (2013) news variable**. Blue, solid line: News variable constructed by considering the sum of Survey of Professional Forecasters' forecast revisions regarding future public spending from one-to-three quarter-ahead. Extreme values, interpretation: (a) 1983Q1: Reagan's "Evil Empire" and "Star Wars" speeches; (b) 1986Q1: Perestrojka; (c) 1987Q1: Senate elections won by the Democrats a quarter before; (d) 1987Q4: Spending cuts as for the Pentagon; (e) 1989Q4: Berlin wall; (f) 2001Q4: War in Afghanistan; (g) 2009Q1: Obama's stimulus package. Red, dashed line: News variable constructed by Owyang, Ramey, and Zubairy (2013), who extended Ramey's (2011) news variable up to 2010Q4. Ramey's (2011) variable is constructed by considering the present discounted value of expected changes in defense spending (nominal spending divided by nominal GDP one period before). Both news measures in this Figure are standardized.

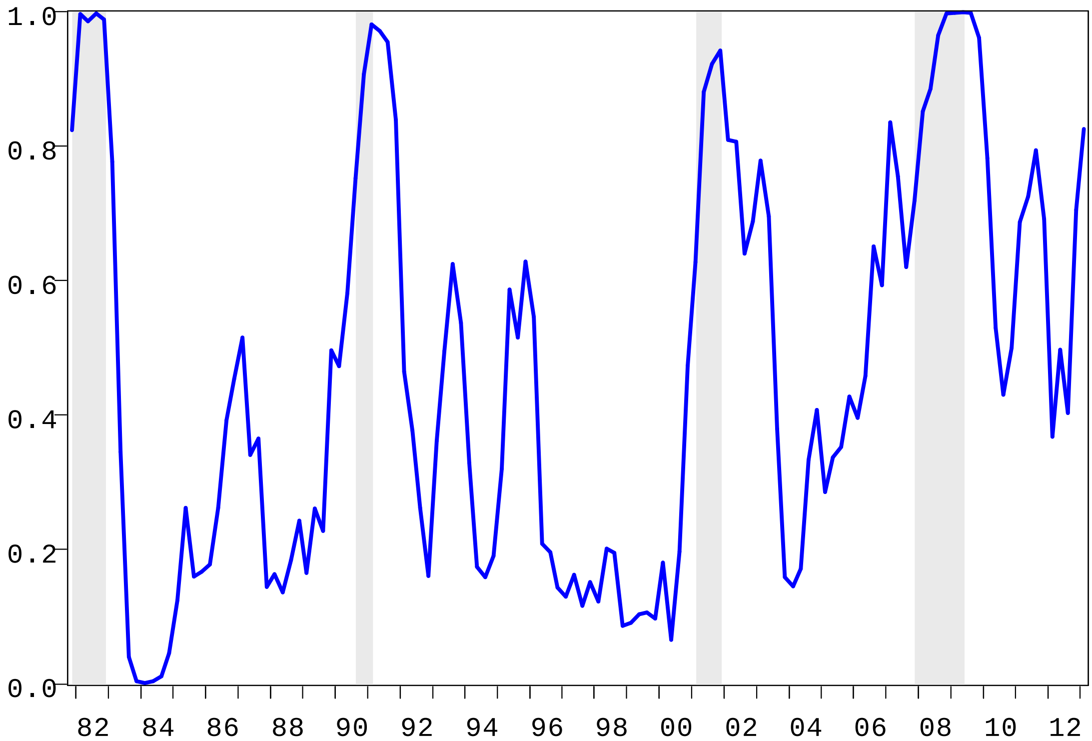

Figure 2: **Probability of being in a recessionary phase.** $F(z)$ computed according to the logistic function presented in the text. Transition variable: Standardized backward-looking moving average constructed with four realizations of the quarter-on-quarter real GDP growth rate. Value of the slope parameter: 2.3.

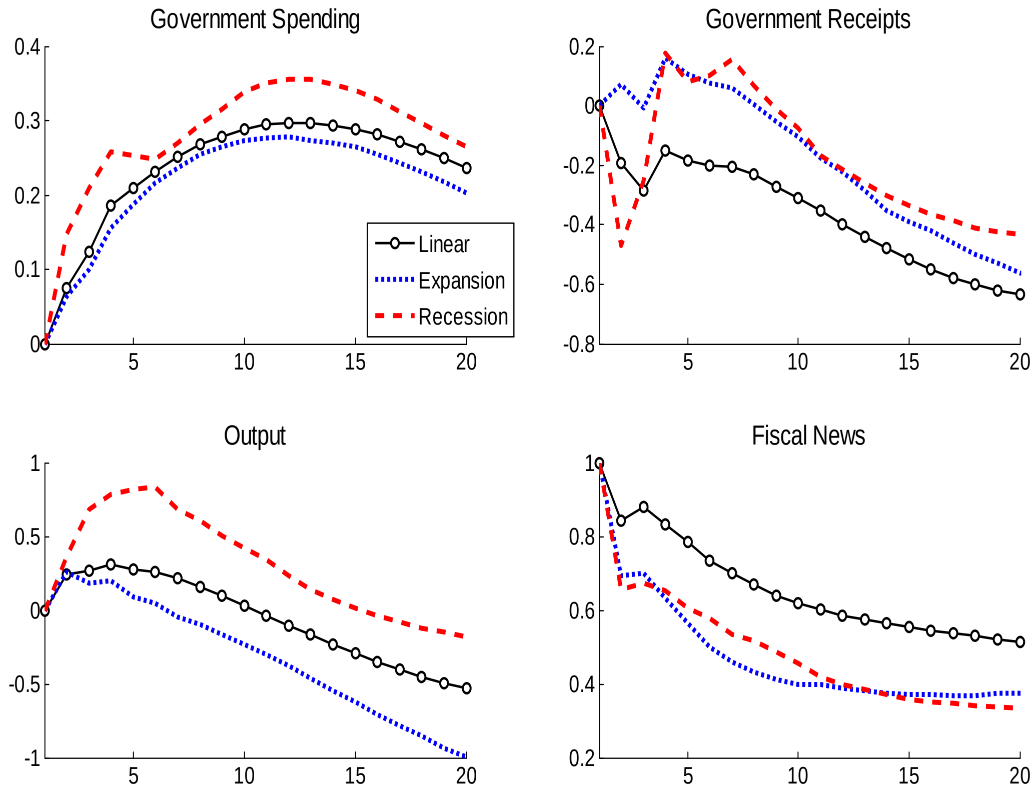

Figure 3: **Generalized impulse responses to a fiscal news (anticipated) spending shock: Linear model, recessions, expansions.** Median responses to a fiscal news shock normalized to one. News variable constructed as the sum of the revisions of the one, two, and three step-ahead expectation values over future fiscal spending growth. News variable expressed in cumulated terms to have the same order of integration as the one of the log-real variables in the vector. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

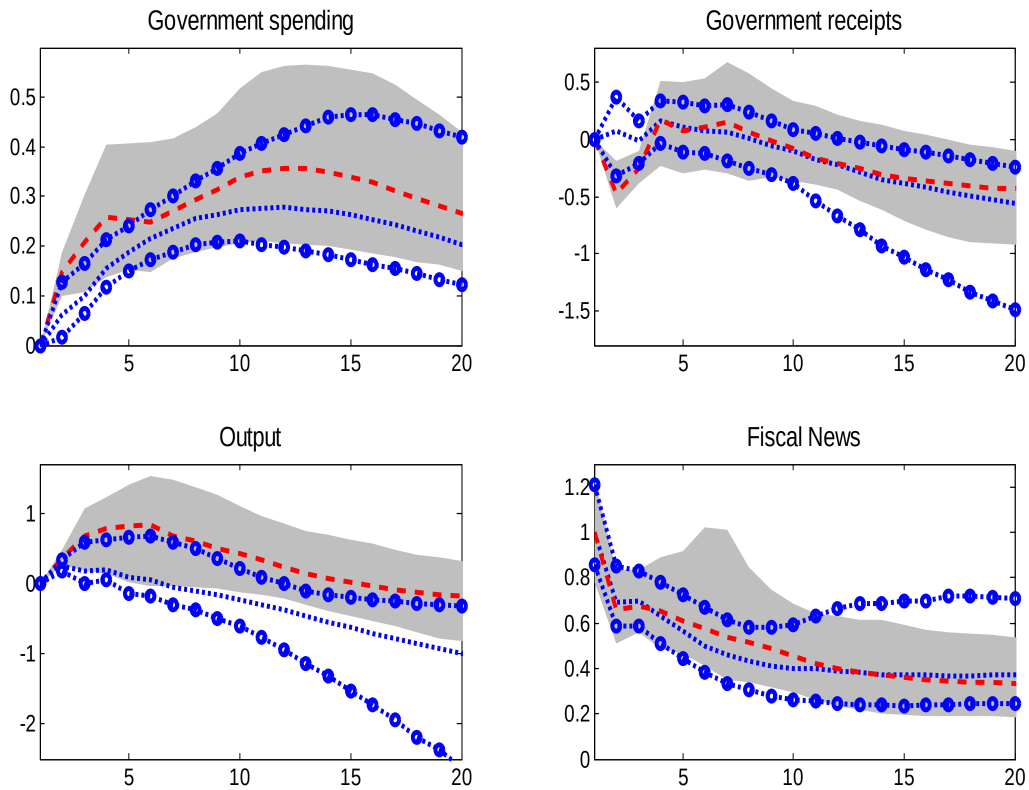

Figure 4: **Generalized impulse responses to a fiscal news (anticipated) spending shock: Recessions vs. expansions.** Median responses to a fiscal news shock normalized to one. 90 percent confidence intervals identified with gray areas (recessions) and circled lines (expansions). Red dashed lines: Recessions. Dotted blue lines: Expansions. News variable constructed as the sum of the revisions of the one, two, and three step-ahead expectation values over future fiscal spending growth. News variable expressed in cumulated terms to have the same order of integration as the one of the log-real variables in the vector. Sample 1981Q3-2013Q1. VAR models estimated with a constant and three lags. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

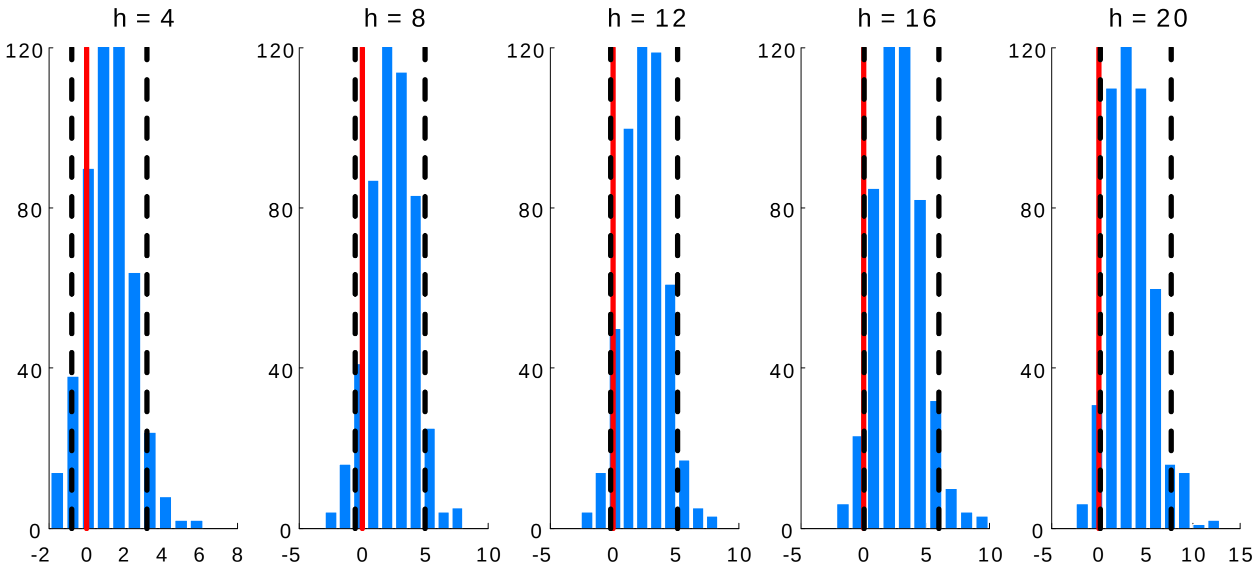

Figure 5: **Difference in multipliers between recessions and expansions: All histories.** Empirical densities of the differences computed as multipliers in recessions minus multipliers in expansions. Densities constructed by considering all recessions and expansions (initial conditions) present in the sample. Multipliers conditional on the same set of draws of the stochastic elements of our STVAR model as well as the same realizations of the coefficients of the vector. Densities based on 500 realizations of such differences per each horizon of interest. 'h' identifies the number of quarters after the shock.

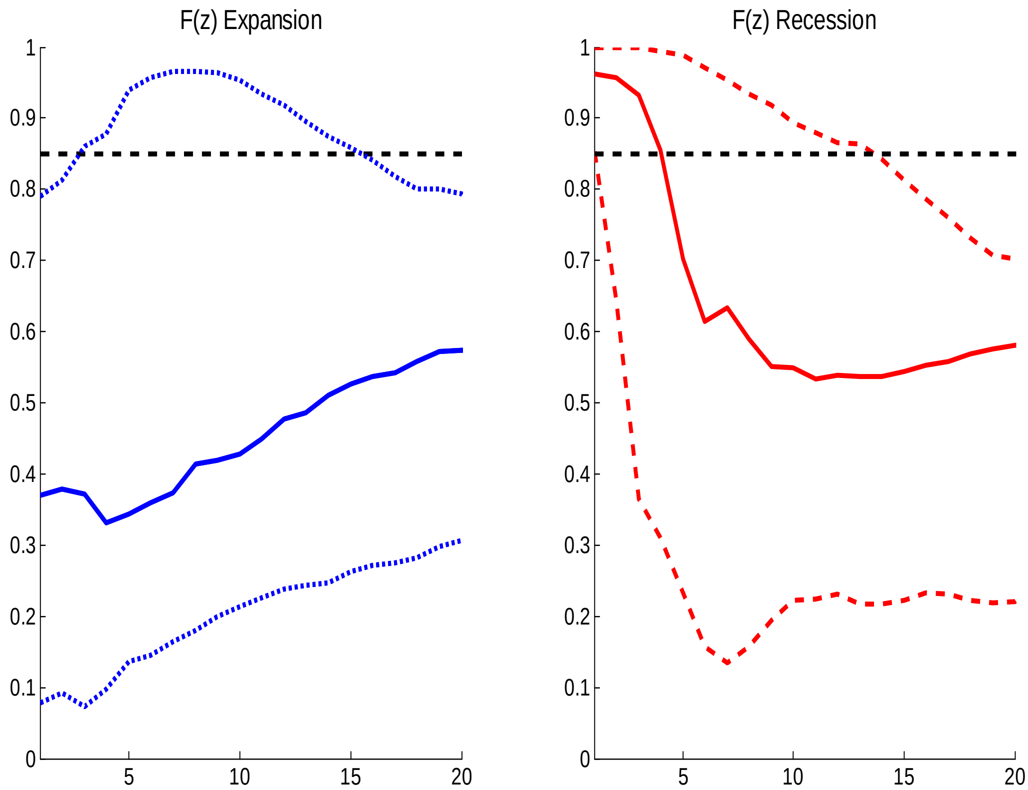

Figure 6: **Evolution of the probability of being in a recessionary phase F(z) consistent with our GIRFs.** Solid lines: Median reactions. Blue dotted/red dashed lines: 90 percent confidence intervals. Black dashed horizontal line: Threshold value to switch from a regime to another. Probability computed according to the logistic function presented in the text and the evolution of output conditional on a fiscal news shock. Transition variable: Standardized backward-looking moving average constructed with four realizations of the quarter-on-quarter real GDP growth rate. Value of the slope parameter: 2.3.

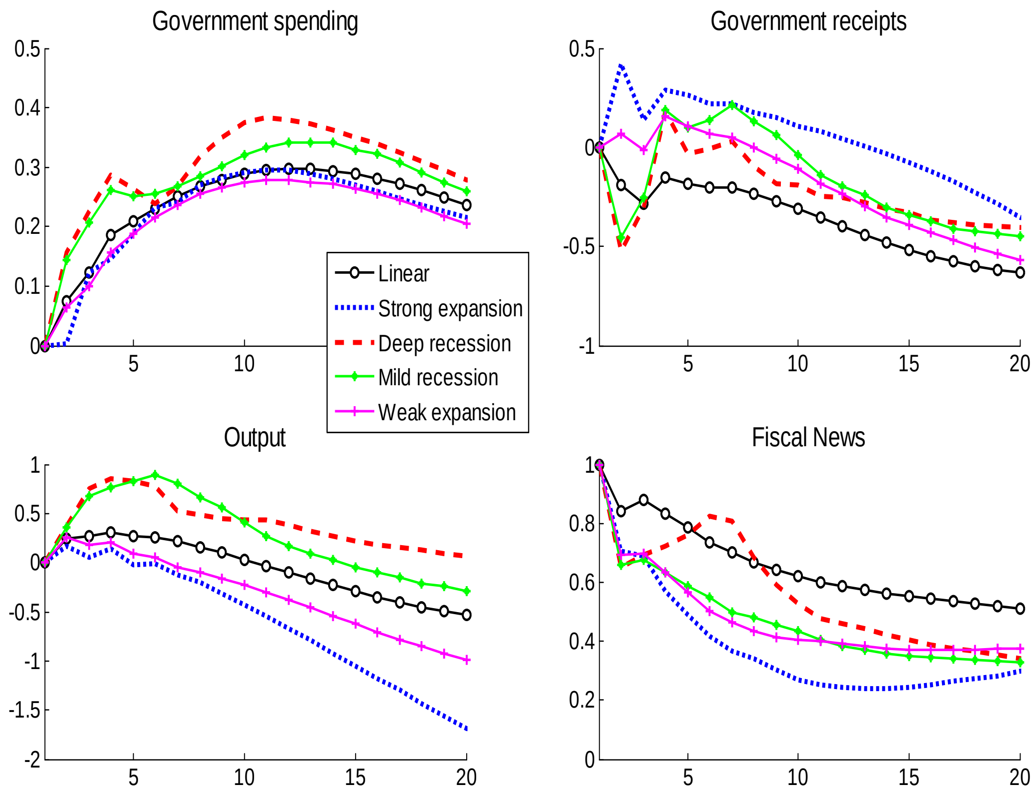

Figure 7: **Generalized impulse responses to a fiscal news (anticipated) spending shock: Linear model, deep vs. mild recessions, strong vs. weak expansions.** Deep recessions/strong expansions associated to histories consistent with realizations of our transition variable which are below/above two standard deviations. Mild recessions/weak expansions associated to histories consistent with realizations of our transition variable below/above -0.75 but within the range [-2,2]. Median responses to a fiscal news shock normalized to one. News variable constructed as the sum of the revisions of the one, two, and three step-ahead expectation values over future fiscal spending growth. News variable expressed in cumulated terms to have the same order of integration as the one of the log-real variables in the vector. VAR models estimated with a constant and three lags. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

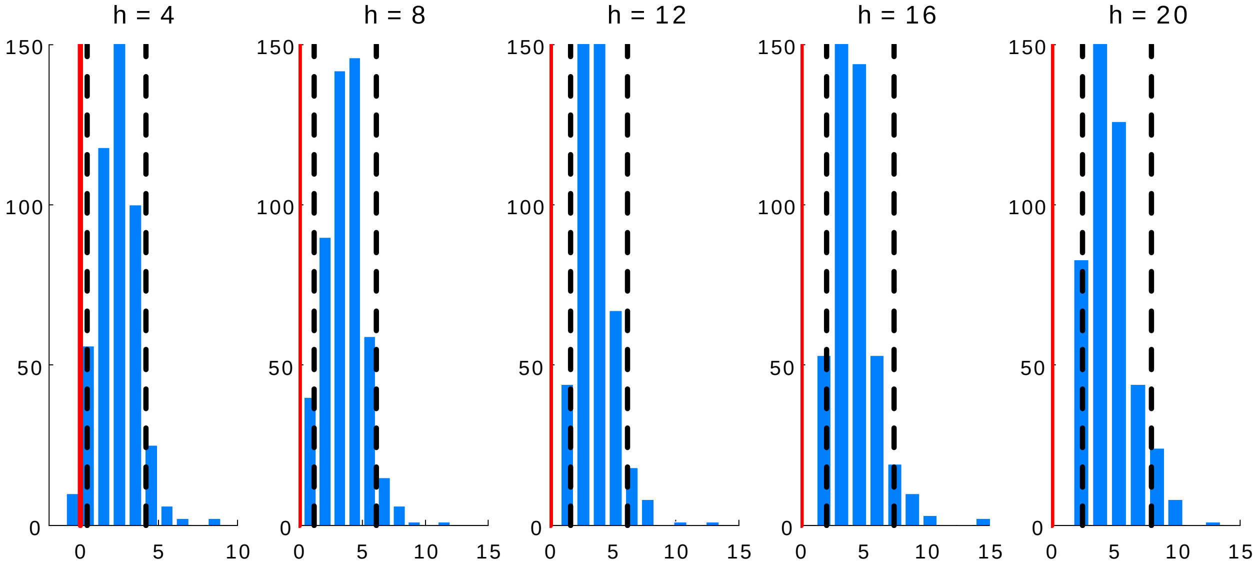

Figure 8: **Difference in multipliers between recessions and expansions: Extreme events.** Empirical densities of the differences computed as multipliers in recessions minus multipliers in expansions. Densities constructed by considering just extreme realizations of recessions and expansions (initial conditions) present in the sample. Multipliers conditional on the same set of draws of the stochastic elements of our STVAR model as well as the same realizations of the coefficients of the vector. Densities based on 500 realizations of such differences per each horizon of interest. 'h' identifies the number of quarters after the shock.

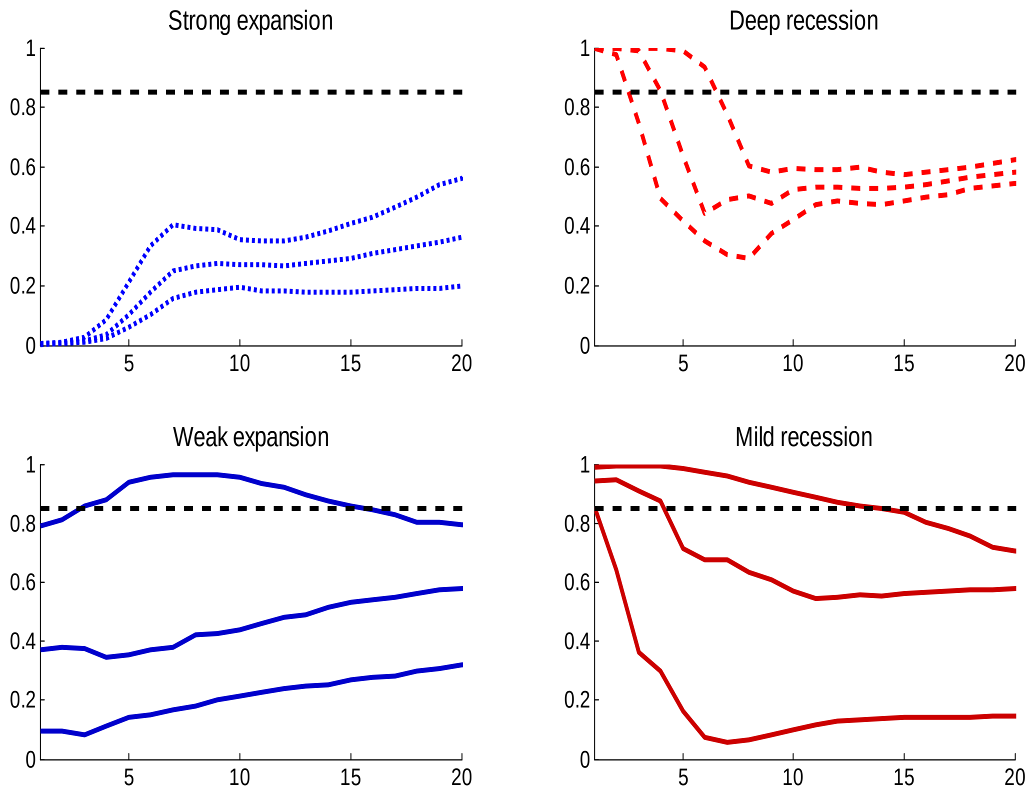

Figure 9: **Evolution of the probability of being in a recessionary phase F(z) consistent with our GIRFs: Extreme events.** Median reactions and 90 percent confidence intervals. Black dashed horizontal line: Threshold value to switch from a regime to another. Deep recessions/strong expansions associated to histories consistent with realizations of our transition variable which are below/above two standard deviations. Mild recessions/weak expansions associated to histories consistent with realizations of our transition variable below/above -0.75 but within the range [-2,2]. Probability computed according to the logistic function presented in the text and the evolution of output conditional on a fiscal news shock. Transition variable: Standardized backward-looking moving average constructed with four realizations of the quarter-on-quarter real GDP growth rate. Value of the slope parameter: 2.3.

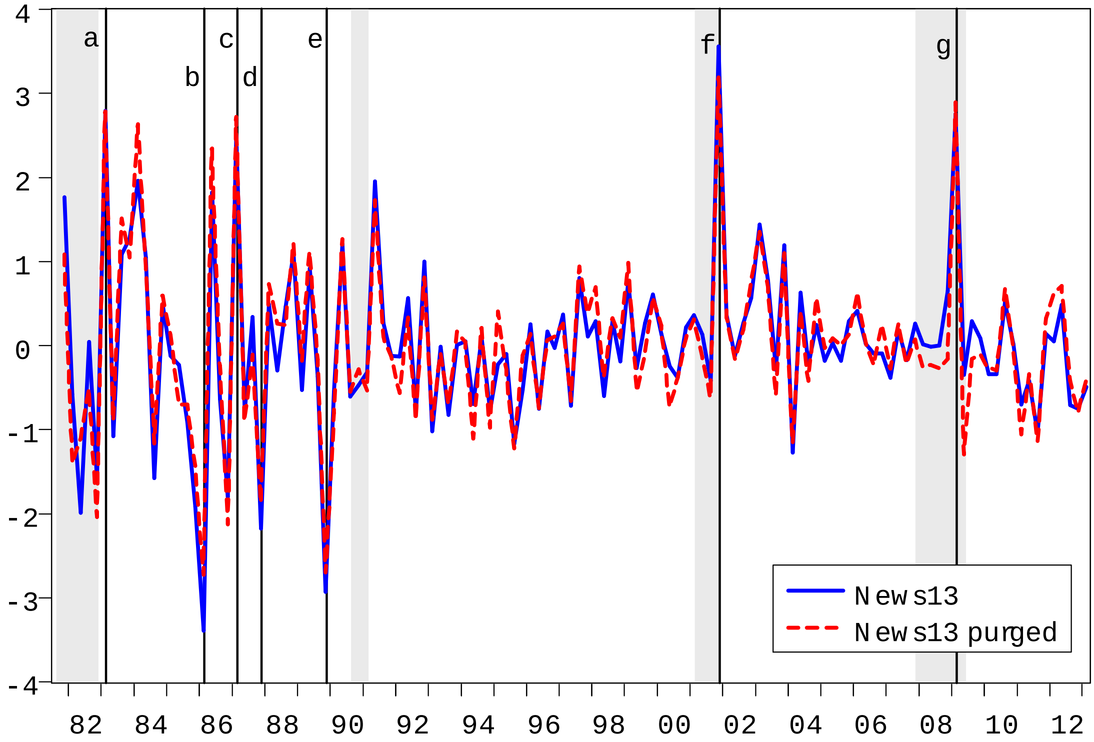

Figure 10: **News13 vs. News13 purged**. Blue, solid line: News variable constructed by considering the sum of Survey of Professional Forecasters' forecast revisions regarding future public spending from one to three period-ahead. Red, dashed line: News variable constructed by regressing News13 over a constant and the sums of the forecasts revisions of real GDP growth, unemployment, GDP deflator inflation, the three-month Treasury bill rate, and the 10-year Treasury bond rate. Extreme values, interpretation: (a) 1983Q1: Reagan's "Evil Empire" and "Star Wars" speeches; (b) 1986Q1: Perestrojka; (c) 1987Q1: Senate elections won by the Democrats a quarter before; (d) 1987Q4: Spending cuts as for the Pentagon; (e) 1989Q4: Berlin wall; (f) 2001Q4: War in Afghanistan; (g) 2009Q1: Obama's stimulus package. Both news measures in this Figure are standardized.

Appendix of "Estimating Fiscal Multipliers: News From a Nonlinear World" by Giovanni Caggiano, Efrem Castelnuovo, Valentina Colombo, Gabriela Nodari

This Appendix reports further details on non-fundamentalness in fiscal SVARs and the role of expectations revisions, the estimation of our nonlinear VARs, the computation of the Generalized Impulse Responses, a number of robustness checks not included in the paper and the computation of the factors employed in one of our robustness checks. Finally, it includes some results based on the computation of the fiscal "peak" multipliers, which are compared to our baseline "sum" multipliers.

Non-fundamentalness and the role of expectations revisions

Structural VARs have been extensively employed to recover the impulse responses of key macroeconomic variables to fiscal shocks. The implicit assumption when working with SVARs is that their VMA representations are invertible in the past, or in other words that they are fundamental Wold representations of the vector of interest. When such conditions are met, the econometrician has the same information set as the economic agents and can recover the structural shocks by conditioning the VAR estimates on past and current observables.

Fiscal foresight and non-fundamentalness. It is well known, however, that in presence of fiscal foresight (and news shocks in general), this assumption may not hold and fundamental shocks to fiscal policy cannot be recovered from past and current observations. The non-fundamentalness is due to the different discount patterns employed by agents and the econometrician: while the agents attach a larger weight to realizations of the shock occurring in the past, the econometrician discounts in the usual way, and attach lower weights to past observations compared to more recent ones, the reason being that the econometrician's information set lags that of the agents (Leeper, Walker, and Yang (2013)). Hence, in presence of a non-fundamental process, an econometrician not endowed with a large enough information set will not be able to correctly recover the impulse response function of a variable of interest to the structural shock.

How severe is the non-fundamentalness problem? As pointed out by Sims (2012) and Beaudry and Portier (2014), the answer to this question depends on the very same process(es) one wants to model. In terms of fiscal shocks, Leeper, Walker, and Yang (2013) convincingly show that when non-fundamentalness holds the magnitude of the error is quite severe. They employ two DSGE models of the business cycle - a calibrated RBC model and an estimated DSGE model with a number of nominal and real frictions à la Smets and Wouters (2007) - to quantify the mistake an econometrician makes when failing to model fiscal foresight. They show that fiscal multipliers may turn out to be off by hundreds of percent, and can even get the wrong sign.[1] Moreover, Forni and Gambetti (2010) and Ramey (2011) show that government spending shocks estimated with standard fiscal VARs can be predicted, evidence supporting the case for non-fundamentalness.

VAR analysis in presence of anticipated shocks. In this section, we propose a framework to fix ideas about the relationship between fiscal foresight and non-fundamentalness and to discuss how the problem can be tackled. To this aim, consider the model

$$y_t = \delta E_t y_{t+1} + g_t + \omega_t \tag{1}$$

$$g_t = \varepsilon_{t-h} + \phi_1 \varepsilon_{t-h-1} + \ldots + \phi_{q-h} \varepsilon_{t-q} = \Phi(L)\boldsymbol{\varepsilon}_t \tag{2}$$

where $|\delta| < 1, \phi_i > 0 \; \forall i, h \geq 0, q \geq h$. The forward-looking process y_t - say, output measured as log-deviations from its trend - is affected by the exogenous stationary process g_t - say, a fiscal process - plus a random shock ω_t, which is assumed to capture non-fiscal spending shocks affecting output and which is assumed to be *i.i.d.* with zero mean and unit variance. The process (2) features an unanticipated contemporaneous shock ε_t as well as anticipated shocks ε_{t-h} for $h > 0$, where h is the number of foresight periods. The latter are known in advance by rational agents, i.e., agents foresee fiscal moves occurring h-periods ahead. The process g_t is a news-rich process if $|\phi_i| > 1$ for at least one $i > 0$ (Beaudry and Portier (2014)). In all cases, $\{\varepsilon_{t-j}\}_{j=h}^{q}$ is said to be fundamental for g_t if the roots of the polynomial $\Phi(L)$ lie outside the unit circle (Hansen and Sargent (1991)). Importantly, if the g_t process is non-fundamental, its structural shock is not recoverable by employing current and past realizations of g_t only. Consequently, its impulse response to an anticipated shock as well as the dynamic responses of other variables – in this example, y_t – will not be correctly recovered by estimating a VAR in y_t and g_t.

For simplicity, and without loss of generality, consider the case in which the unanticipated component is zero, i.e., $h > 0$. We assume that agents have rational expectations

[1] Leeper, Walker, and Yang (2013) model fiscal foresight associated to tax policies. Schmitt-Grohe and Uribe (2012) find government spending shocks anticipated up to eight quarters to be responsible of about 60% of the overall variability of government spending.

and observe news shocks without noise.[2] To begin with, consider the case $h = q = 1$, so that[3]

$$g_t = \varepsilon_{t-1}.$$

Under rational expectations, the solution for the process y_t reads

$$y_t = \delta\varepsilon_t + \varepsilon_{t-1} + \omega_t. \tag{3}$$

The VMA representation of the vector (y_t, g_t) is:

$$\begin{bmatrix} y_t \\ g_t \end{bmatrix} = \underbrace{\begin{bmatrix} \delta & 1 \\ 0 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} 1 & 0 \\ 1 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix}. \tag{4}$$

The VMA representation (4) is fundamental if all the roots of $|\sum_{i=0}^{q} A_i z^i|$ in absolute value lie outside the unit circle. It is easy to verify that in this case the condition is not met, since one gets $|z| = 0$. Hence, in this economic system, inference based on an estimated VAR which includes y_t and g_t only would be incorrect.

Importantly, if a variable η_t added to the econometrician's information set contains "enough" information about the structural shock ε_t, then the VMA representation becomes invertible and the non-fundamentalness issue is circumvented (Giannone and Reichlin (2006), Sims (2012), Beaudry and Portier (2014), and Forni and Gambetti (2014)). Based on this argument, a way to tackle the issue of non-fundamentalness is to include in the VAR a variable which is informative about the effects that news shocks exert on the endogenous variables of interest.[4] In the case of fiscal foresight, then, one has to find a measure of anticipated fiscal spending shocks to correctly gauge

[2] Forni, Gambetti, Lippi, and Sala (2013) investigate the case in which economic agents deal with noisy news. Agents are assumed to receive signals regarding the future realization of TFP shocks. Since such signals are noisy, agents react not only to genuinely informative news, but also to noise shocks that are unrelated to economic fundamentals. They find that such noise shocks explain about a third of the variance of output, consumption, and investment. We leave the quantification of the role of noise shocks in the fiscal context to future research.

[3] This process is termed "degenerated news-rich process" by Beaudry and Portier (2014). For an application, see Fève, Matheron, and Sahuc (2009).

[4] Alternative ways of dealing with this issue have been proposed in the literature. Lippi and Reichlin (1993) propose to use Blaschke matrices to "flip" the roots that are outside the unit circle in order to recover the fundamental representation of the process of interest. Alessi, Barigozzi, and Capasso (2011) and Forni and Gambetti (2014) propose to augment the VAR with information coming from factors extracted from large datasets. However, in the context of fiscal foresight, non-fundamentalness has a clearly detectable cause, i.e., omitted information due to the absence in the VAR of an informative measure regarding (variations concerning) future fiscal spending moves (Leeper, Walker, and Yang (2013), Beaudry and Portier (2014)). Hence, a direct, fiscal-related way of tackling the presence of foresight appears to be desirable.

the reaction of output to such shocks. It is easy to show that, in the context of model (4), replacing g_t with its one-step-ahead forecast, i.e. $E_t g_{t+1}$, leads to a fundamental VMA representation for the vector $(y_t, E_t g_{t+1})$:

$$\begin{bmatrix} y_t \\ E_t g_{t+1} \end{bmatrix} = \underbrace{\begin{bmatrix} \delta & 1 \\ 1 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix}.$$

This can be seen by verifying that $|A_0 + A_1 z| \neq 0$, $\forall z$.

It is important to notice that expectations *per se* do not necessarily provide a correct measure of fiscal shocks. Consider the case $h = 1$ and $q = 2$, so that

$$g_t = \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2}. \tag{5}$$

The VMA representation for (y_t, g_t) is:

$$\begin{bmatrix} y_t \\ g_t \end{bmatrix} = \underbrace{\begin{bmatrix} \delta(1+\delta\phi_2) & 1 \\ 0 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} 1+\delta\phi_2 & 0 \\ 1 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix} + \underbrace{\begin{bmatrix} \phi_2 & 0 \\ \phi_2 & 0 \end{bmatrix}}_{A_2} \begin{bmatrix} \varepsilon_{t-2} \\ \omega_{t-2} \end{bmatrix}, \tag{6}$$

which is non-fundamental since the roots of $|A_0 + A_1 z + A_2 z^2|$ are $z_1 = 0$ and $|z_2| = \phi_2^{-1}$. In this case, adding the one-step-ahead forecast of g_t does not solve the problem. The VMA representation for the vector $(y_t, E_t g_{t+1})$ is given by:

$$\begin{bmatrix} y_t \\ E_t g_{t+1} \end{bmatrix} = \underbrace{\begin{bmatrix} \delta(1+\delta\phi_2) & 1 \\ 1 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} 1+\delta\phi_2 & 0 \\ \phi_2 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix} + \underbrace{\begin{bmatrix} \phi_2 & 0 \\ 0 & 0 \end{bmatrix}}_{A_2} \begin{bmatrix} \varepsilon_{t-2} \\ \omega_{t-2} \end{bmatrix},$$

which is non-fundamental if $|\phi_2| > 1$.

The role of forecast revisions. Expectation *revisions* help solving the problem. Consider the variable $\eta_t = E_t g_{t+1} - E_{t-1} g_{t+1}$. The VMA representation for the vector (y_t, η_t) is given by:

$$\begin{bmatrix} y_t \\ \eta_t \end{bmatrix} = \underbrace{\begin{bmatrix} \delta(1+\delta\phi_2) & 1 \\ 1 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} 1+\delta\phi_2 & 0 \\ 0 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix} + \underbrace{\begin{bmatrix} \phi_2 & 0 \\ 0 & 0 \end{bmatrix}}_{A_2} \begin{bmatrix} \varepsilon_{t-2} \\ \omega_{t-2} \end{bmatrix},$$

which is fundamental, since $|A_0 + A_1 z + A_2 z^2| \neq 0$, $\forall z$. It can recursively be shown that expectations revisions of the form $E_t g_{t+1} - E_{t-1} g_{t+1}$ help tackling the issue of non-fundamentalness for any $q > h = 1$.

However, when $h > 1$ is unknown, even expectation revisions are not of help. Consider for example the process:

$$g_t = \varepsilon_{t-2} + \phi_3 \varepsilon_{t-3}.$$

This is not an unlikely case, given that typically the implementation lag for fiscal policy decisions is longer than one quarter. The VMA representation for the vector (y_t, g_t) is:

$$\begin{aligned}\begin{bmatrix} y_t \\ g_t \end{bmatrix} &= \underbrace{\begin{bmatrix} \delta^2(1+\delta\phi_3) & 1 \\ 0 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} \delta(1+\delta\phi_3) & 0 \\ 0 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix} \\ &+ \underbrace{\begin{bmatrix} 1+\delta\phi_3 & 0 \\ 1 & 0 \end{bmatrix}}_{A_2} \begin{bmatrix} \varepsilon_{t-2} \\ \omega_{t-2} \end{bmatrix} + \underbrace{\begin{bmatrix} \phi_3 & 0 \\ \phi_3 & 0 \end{bmatrix}}_{A_3} \begin{bmatrix} \varepsilon_{t-3} \\ \omega_{t-3} \end{bmatrix},\end{aligned}$$

and the roots of $|A_0 + A_1 z + A_2 z^2 + A_3 z^3|$ are $z_{1,2} = 0, |z_3| = \phi_3^{-1}$. Using expectations revisions as before is in this case uninformative, since $E_t g_{t+1} - E_{t-1} g_{t+1} = 0$.

Knowing exactly the number of anticipation periods h would solve the problem, since $E_t g_{t+2} - E_{t-1} g_{t+2} = \varepsilon_t$. However, h is typically unknown. To solve this issue, Gambetti (2012a) proposes to use an alternative, more general measure of expectations revisions, i.e., the news variable defined as:

$$\eta_{1J}^g = \sum_{j=1}^{J} \left(E_t g_{t+j} - E_{t-1} g_{t+j} \right),$$

with J large enough to ensure that $J \geq h$. It can be shown that setting $J \geq 2$ leads to a fundamental representation associated with the vector (y_t, η_{1J}^g), since $\eta_{12}^g = \varepsilon_t$, $\eta_{13}^g = (1+\phi_3)\,\varepsilon_t$ and so on. In our example, if $J = 2$, the VMA representation for (y_t, η_{12}^g) is:

$$\begin{aligned}\begin{bmatrix} y_t \\ \eta_{12}^g \end{bmatrix} &= \underbrace{\begin{bmatrix} \delta^2(1+\delta\phi_3) & 1 \\ 1 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} \delta(1+\delta\phi_3) & 0 \\ 0 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix} \\ &+ \underbrace{\begin{bmatrix} 1+\delta\phi_3 & 0 \\ 0 & 0 \end{bmatrix}}_{A_2} \begin{bmatrix} \varepsilon_{t-2} \\ \omega_{t-2} \end{bmatrix} + \underbrace{\begin{bmatrix} \phi_3 & 0 \\ 0 & 0 \end{bmatrix}}_{A_3} \begin{bmatrix} \varepsilon_{t-3} \\ \omega_{t-3} \end{bmatrix},\end{aligned}$$

where the determinant of $|A_0 + A_1 z + A_2 z^2 + A_3 z^3| \neq 0, \forall z$.[5]

[5] It is important to notice that, though related in spirit, Perotti's (2011) variable $(E_t g_t - E_{t-1} g_t) + (E_t g_{t+1} - E_{t-1} g_{t+1})$ is uninformative in a case like this, because it does not contain any valuable information about ε_t, i.e., it is equal to zero. The reason is that the forecast horizon covered by such a variable is too short.

In general, when the period of foresight h is unknown or uncertain, the solution would be to include in the VAR a measure of expectations revisions taken over a long enough horizon:

$$\begin{aligned}\sum_{j=1}^{J}\left(E_t g_{t+j}-E_{t-1}g_{t+j}\right) &= \eta_{1J}^{g}=\sum_{j=1}^{J}\left(E_t g_{t+j}-E_{t-1}g_{t+j}\right) \\ &= \begin{cases}\left(1+\phi_1+...+\phi_{J-h}\right)\varepsilon_t \text{ if } J<q \\ \left(1+\phi_1+...+\phi_{q-h}\right)\varepsilon_t \text{ if } J\geqslant q\end{cases}\end{aligned} \tag{7}$$

(where $\phi_0=0$), which correctly identifies the news shock if $J \geqslant h$.

Estimation of the nonlinear VARs

Consider the model (9)-(12) in the text. Its log-likelihood reads as follows:[6]

$$\log L = const + \frac{1}{2}\sum\nolimits_{t=1}^{T}\log|\mathbf{\Omega}_t| - \frac{1}{2}\sum\nolimits_{t=1}^{T}\boldsymbol{u}_t'\mathbf{\Omega}_t^{-1}\boldsymbol{u}_t \tag{A1}$$

where the vector of residuals $\boldsymbol{u}_t=\boldsymbol{X}_t-(1-F(z_{t-1})\mathbf{\Pi}_E\boldsymbol{X}_{t-1}-F(z_{t-1})\mathbf{\Pi}_R\boldsymbol{X}_{t-1}$. Our goal is to estimate the parameters $\mathbf{\Psi}=\{\gamma,\mathbf{\Omega}_R,\mathbf{\Omega}_E,\mathbf{\Pi}_R(L),\mathbf{\Pi}_E(L)\}$, where $\mathbf{\Pi}_j(L)=\left[\begin{array}{ccc}\mathbf{\Pi}_{j,1} & ... & \mathbf{\Pi}_{j,p}\end{array}\right]$, $j\in\{R,E\}$. The high-non linearity of the model and its many parameters render its estimation with standard optimization routines problematic. Following Auerbach and Gorodnichenko (2012), we employ the procedure described below.

Conditional on $\{\gamma,\mathbf{\Omega}_R,\mathbf{\Omega}_E\}$, the model is linear in $\{\mathbf{\Pi}_R(L),\mathbf{\Pi}_E(L)\}$. Then, for a given guess on $\{\gamma,\mathbf{\Omega}_R,\mathbf{\Omega}_E\}$, the coefficients $\{\mathbf{\Pi}_R(L),\mathbf{\Pi}_E(L)\}$ can be estimated by minimizing $\frac{1}{2}\sum\nolimits_{t=1}^{T}\boldsymbol{u}_t'\mathbf{\Omega}_t^{-1}\boldsymbol{u}_t$. This can be seen by re-writing the regressors as follows. Let $\boldsymbol{W}_t=\left[\begin{array}{ccccc}F(z_{t-1})\boldsymbol{X}_{t-1} & (1-F(z_{t-1})\boldsymbol{X}_{t-1} & ... & F(z_{t-1})\boldsymbol{X}_{t-p} & 1-F(z_{t-1})\boldsymbol{X}_{t-p}\end{array}\right]$ be the extended vector of regressors, and $\mathbf{\Pi}=\left[\begin{array}{cc}\mathbf{\Pi}_R(L) & \mathbf{\Pi}_E(L)\end{array}\right]$. Then, we can write $\boldsymbol{u}_t=\boldsymbol{X}_t-\mathbf{\Pi}\boldsymbol{W}_t'$. Consequently, the objective function becomes

$$\frac{1}{2}\sum\nolimits_{t=1}^{T}(\boldsymbol{X}_t-\mathbf{\Pi}\boldsymbol{W}_t')'\mathbf{\Omega}_t^{-1}(\boldsymbol{X}_t-\mathbf{\Pi}\boldsymbol{W}_t').$$

It can be shown that the first order condition with respect to $\mathbf{\Pi}$ is

$$vec\mathbf{\Pi}'=\left(\sum\nolimits_{t=1}^{T}\left[\mathbf{\Omega}_t^{-1}\otimes\boldsymbol{W}_t'\boldsymbol{W}_t\right]\right)^{-1} vec\left(\sum\nolimits_{t=1}^{T}\boldsymbol{W}_t'\boldsymbol{X}_t\mathbf{\Omega}_t^{-1}\right). \tag{A2}$$

This procedure iterates over different sets of values for $\{\gamma,\mathbf{\Omega}_R,\mathbf{\Omega}_E\}$. For each set of values, $\mathbf{\Pi}$ is obtained and the $logL$ (A1) computed.

[6] This Section heavily draws on Auerbach and Gorodnichenko's (2012) "Appendix: Estimation Procedure".

Given that the model is highly nonlinear in its parameters, several local optima might be present. Hence, it is recommended to try different starting values for $\{\gamma, \boldsymbol{\Omega}_R, \boldsymbol{\Omega}_E\}$. To ensure positive definiteness of the matrices $\boldsymbol{\Omega}_R$ and $\boldsymbol{\Omega}_E$, we focus on the alternative vector of parameters $\boldsymbol{\Psi} = \{\gamma, chol(\boldsymbol{\Omega}_R), chol(\boldsymbol{\Omega}_E), \boldsymbol{\Pi}_R(L), \boldsymbol{\Pi}_E(L)\}$, where $chol$ implements a Cholesky decomposition.

We estimate our nonlinear model by employing the Monte-Carlo Markov-Chain Metropolis-Hastings algorithm proposed by Chernozhukov and Hong (2003). Given a starting value $\boldsymbol{\Psi}^{(0)}$, the procedure constructs chains of length N of the parameters of our model following these steps:

Step 1. Draw a candidate vector of parameter values $\boldsymbol{\Theta}^{(n)} = \boldsymbol{\Psi}^{(n)} + \boldsymbol{\psi}^{(n)}$ for the chain's $n+1$ state, where $\boldsymbol{\Psi}^{(n)}$ is the current state and $\boldsymbol{\psi}^{(n)}$ is a vector of i.i.d. shocks drawn from $N(0, \boldsymbol{\Omega}_\Psi)$, and $\boldsymbol{\Omega}_\Psi$ is a diagonal matrix.

Step 2. Set the $n+1$ state of the chain $\boldsymbol{\Psi}^{(n+1)} = \boldsymbol{\Theta}^{(n)}$ with probability $min\left\{1, L(\boldsymbol{\Theta}^{(n)})/L(\boldsymbol{\Psi}^{(n)})\right\}$, where $L(\boldsymbol{\Theta}^{(n)})$ is the value of the likelihood function conditional on the candidate vector of parameter values, and $L(\boldsymbol{\Psi}^{(n)})$ the value of the likelihood function conditional on the current state of the chain. Otherwise, set $\boldsymbol{\Psi}^{(n+1)} = \boldsymbol{\Psi}^{(n)}$.

The starting value $\boldsymbol{\Theta}^{(0)}$ is computed by working with a second-order Taylor approximation of the model (8)-(11), so that the model can be written as regressing $\boldsymbol{X}_t$ on lags of $\boldsymbol{X}_t$, $\boldsymbol{X}_t z_t$, and $\boldsymbol{X}_t z_t^2$. The residuals from this regression are employed to fit the expression for the reduced-form time-varying variance-covariance matrix of the VAR (see our paper) using maximum likelihood to estimate $\boldsymbol{\Omega}_R$ and $\boldsymbol{\Omega}_E$. Conditional on these estimates and given a calibration for γ, we can construct $\boldsymbol{\Omega}_t$. Conditional on $\boldsymbol{\Omega}_t$, we can get starting values for $\boldsymbol{\Pi}_R(L)$ and $\boldsymbol{\Pi}_E(L)$ via equation (A2).

The initial (diagonal matrix) $\boldsymbol{\Omega}_\Psi$ is calibrated to one percent of the parameter values. It is then adjusted "on the fly" for the first 20,000 draws to generate an acceptance rate close to 0.3, a typical choice for this kind of simulations (Canova (2007)). We employ $N = 50,000$ draws for our estimates, and retain the last 20% for inference.

As shown by CH, $\overline{\boldsymbol{\Psi}} = \frac{1}{N}\sum_{n=1}^{N} \boldsymbol{\Psi}^{(n)}$ is a consistent estimate of $\boldsymbol{\Psi}$ under standard regularity assumptions on maximum likelihood estimators. Moreover, the covariance matrix of $\boldsymbol{\Psi}$ is given by $\boldsymbol{V} = \frac{1}{N}\sum_{n=1}^{N}(\boldsymbol{\Psi}^{(n)} - \overline{\boldsymbol{\Psi}})^2 = var(\boldsymbol{\Psi}^{(n)})$, that is the variance of the estimates in the generated chain.

Generalized Impulse Response Functions

Once calibrated our VAR with the point estimates obtained via the procedure presented in the previous sub-Section, we compute the Generalized Impulse Response Functions from our STVAR model by following the approach proposed by Koop, Pesaran, and Potter (1996). The algorithm features the following steps.

1. Consider the entire available observations, with sample size $t = 1981Q3, \ldots, 2013Q1$, with $T = 123$, and construct the set of all possible histories $\boldsymbol{\Lambda}$ of length $p = 6$:[7] $\{\boldsymbol{\lambda}_i \in \boldsymbol{\Lambda}\}$. $\boldsymbol{\Lambda}$ will contain $T - p + 1$ histories $\boldsymbol{\lambda}_i$.

2. Separate the set of all recessionary histories from that of all expansionary histories. For each $\boldsymbol{\lambda}_i$ calculate the transition variable z_{λ_i}. If $z_{\lambda_i} \leq \overline{z} = -0.75\%$, then $\boldsymbol{\lambda}_i \in \boldsymbol{\Lambda}^R$, where $\boldsymbol{\Lambda}^R$ is the set of all recessionary histories; if $z_{\lambda_i} > -\overline{z} = -0.75\%$, then $\boldsymbol{\lambda}_i \in \boldsymbol{\Lambda}^E$, where $\boldsymbol{\Lambda}^E$ is the set of all expansionary histories.

3. Select at random one history $\boldsymbol{\lambda}_i$ from the set $\boldsymbol{\Lambda}^R$. For the selected history $\boldsymbol{\lambda}_i$, take $\widehat{\boldsymbol{\Omega}}_{\lambda_i}$ obtained as:
$$\widehat{\boldsymbol{\Omega}}_{\lambda_i} = F\left(z_{\lambda i}\right) \widehat{\boldsymbol{\Omega}}_R + \left(1 - F\left(z_{\lambda_i}\right)\right) \widehat{\boldsymbol{\Omega}}_E, \tag{A3}$$
where $\widehat{\boldsymbol{\Omega}}_R$ and $\widehat{\boldsymbol{\Omega}}_E$ are derived from model (8)-(11) estimated over the entire sample. z_{λ_i} is the transition variable calculated for the selected history $\boldsymbol{\lambda}_i$.

4. Cholesky-decompose the estimated variance-covariance matrix $\widehat{\boldsymbol{\Omega}}_{\lambda_i}$:
$$\widehat{\boldsymbol{\Omega}}_{\lambda_i} = \widehat{\mathbf{C}}_{\lambda_i} \widehat{\mathbf{C}}'_{\lambda_i} \tag{A4}$$
and orthogonalize the residuals to get the structural shocks:
$$\mathbf{e}^{(j)}_{\lambda_i} = \widehat{\mathbf{C}}^{-1}_{\lambda_i} \widehat{\boldsymbol{\varepsilon}}. \tag{A5}$$

5. From $\mathbf{e}_{\lambda_i}$ draw with replacement h four-dimensional shocks and get the vector of bootstrapped shocks
$$\mathbf{e}^{(j)*}_{\lambda_i} = \left\{\mathbf{e}^*_{\lambda_i,t}, \mathbf{e}^*_{\lambda_i,t+1}, \ldots, \mathbf{e}^*_{\lambda_i,t+h}\right\}, \tag{A6}$$
where h is the horizon for the IRFs we are interested in.

[7] The choice $p = 6$ is due to the number of moving average terms (four) of our transition variable z_t, which is constructed by considering five realization of the levels of the (log-)real GDP, i.e., four realizations of the growth rates. Moreover, such transition variable enters our STVAR model via the transition probability $F(z_{t-1})$ with one lag.

6. Form another set of bootstrapped shocks which will be equal to (A6) except for the k_{th} shock in $\mathbf{e}_{\lambda_i,t}^{(j)*}$ which is the shock we want to perturbate (news in our model) by an amount equal to δ. Denote the vector of bootstrapped perturbated shocks by $\mathbf{e}_{\lambda_i}^{(j)\delta}$.

7. Transform back $\mathbf{e}_{\lambda_i}^{(j)*}$ and $\mathbf{e}_{\lambda_i}^{(j)\delta}$ as follows:

$$\widehat{\boldsymbol{\varepsilon}}_{\lambda_i}^{(j)*} = \widehat{\mathbf{C}}_{\lambda_i}\mathbf{e}_{\lambda_i}^{(j)*} \tag{A7}$$

   and

$$\widehat{\boldsymbol{\varepsilon}}_{\lambda_i}^{(j)\delta} = \widehat{\mathbf{C}}_{\lambda_i}\mathbf{e}_{\lambda_i}^{(j)\delta}. \tag{A8}$$

8. Use (A7) and (A8) to generate two sequences $\mathbf{X}_{\lambda_i}^{(j)*}$ and $\mathbf{X}_{\lambda_i}^{(j)\delta}$ and get the $GIRF^{(j)}(h, \delta, \lambda_i)$.

9. Conditional on history λ_i, repeat for $j = 1, \ldots, B$ vectors of bootstrapped residuals and get $GIRF^{(1)}(h, \delta, \lambda_i)$, ... $, GIRF^{(B)}(h, \delta, \lambda_i)$. Set $B = 500$.

10. Calculate the GIRF conditional on history λ_i as

$$\widehat{GIRF}^{(i)}(h, \delta, \lambda_i) = B^{-1}\sum_{j=1}^{B} GIRF^{(i,j)}(h, \delta, \lambda_i). \tag{A9}$$

11. Repeat all previous steps for $i = 1, \ldots, 500$ randomly drawn histories belonging to the set of recessionary histories, $\boldsymbol{\lambda}_i \in \boldsymbol{\Lambda}^R$, and get $\widehat{GIRF}^{(1,R)}(h, \delta, \lambda_{1,R})$, ... $, \widehat{GIRF}^{(500,R)}(h, \delta, \lambda_{500,R})$, where now the subscript R denotes explicitly that we are *conditioning upon recessionary histories.*

12. Take the average and get $\widehat{GIRF}^{(R)}\left(h, \delta, \boldsymbol{\Lambda}^R\right)$, which is the average GIRF under recessions.

13. Repeat all previous steps - 3 to 12 - for 500 histories belonging to the set of all expansions and get $\widehat{GIRF}^{(E)}\left(h, \delta, \boldsymbol{\Lambda}^E\right)$.

14. The computation of the 90% confidence bands for our impulse responses is undertaken by picking up, per each horizon of each state, the 5th and 95th percentile of the densities $\widehat{GIRF}^{([1:500],R)}$ and $\widehat{GIRF}^{([1:500],E)}$.

Further robustness checks

Our baseline analysis suggests that evidence in favor of countercyclical fiscal multipliers is borderline when we condition upon recessions vs. expansions, while it becomes much clearer and solid when conditioning upon extreme events. The paper presents the robustness checks conducted by considering a different measure of fiscal spending news (obtained by regressing the baseline fiscal news variable on a constant and a number of controls), a different ordering of the variables in our VAR, the debt/GDP ratio as an extra-variable in our VAR as well as the transition indicator, and a longer sample (an analysis that we conducted by working with Ramey's (2011) indicator of fiscal spending news). Table 6 in the paper documents the robustness of our results by collecting multipliers computed over a 4-year horizon. Table A1 in this Appendix confirms the solidity of our results conditional on a 2-year horizon.

We then conduct a variety of robustness checks to verify the solidity of our results. We present the robustness checks below and discuss our results by referring to Table A2, which summarizes the outcome.

FAVAR. Our baseline VAR is meant to parsimoniously model a set of key macroeconomic indicators crucial to quantify fiscal spending multipliers. A further reason to prefer a parsimonious VAR is the somewhat limited number of observations available to construct the measures of forecast revisions we deal with, as well as the nonlinearity of our framework, in which a large number of VAR coefficients is estimated. Despite its advantages, a parsimonious model might suffer from an omitted-variable problem, which may bias the results of our baseline scenario. In particular, reactions of variables like the real interest rate and the real exchange rate may be important for the computation of the fiscal spending multipliers. Interactions between financial variables and real aggregates may also be at work conditional on our fiscal news shock. We tackle this informational insufficiency issue by adding to our VAR a factor extracted from a large dataset, so to purge the (possibly bias-contaminated) estimated shocks. This strategy leads us to deal with a nonlinear version of the Factor-Augmented VAR (FAVAR) model popularized, in the monetary policy context, by Bernanke, Boivin, and Eliasz (2005). In particular, we consider a large dataset composed of 150 time-series, and extract the common factors which maximize the explained variance of such series (a description of the series included in our dataset, their transformations, and the computation of the factors is provided in the Appendix). Following Stock and Watson (2012) in their recent analysis on the drivers of the post-WWII U.S. economy, we extract six common factors and then focus on the fiscal FAVAR $\boldsymbol{X}_t^{favar} = [f_t^1, G_t, T_t, Y_t, \eta_{13,t}^g]'$, where "$f_t^1$" is the factor explaining the largest share of variance of the series in our enlarged database. Due to the limited number of degrees of freedom, we focus on a VAR model with two lags, a choice that we will keep for all the five-variate VAR we estimate to check the robustness of our baseline results.[8] Results on the difference of the fiscal multiplier in different states of the economy are collected in Table A2 under the label "FAVAR".

Expectation revisions of output. Our baseline results rests on the identifying assumption that our fiscal news variable carries valuable information regarding fiscal shocks which may have led economic agents to revise their expectations of future public spending. However, such revisions may have been undertaken because of "news" about some other shocks. Suppose news about the future evolution of technology become part of agents' information sets between time $t-1$ and t. This might induce agents to revise their expectations regarding future realizations of output. Given the link between output and public spending (due to, e.g., automatic stabilizers), such revisions may induce agents to further revise their expectations of future fiscal spending as well. Hence, revisions of future fiscal spending may be triggered not only by anticipated fiscal shocks, but also by anticipated shocks of a different nature (say, news concerning technology).

We tackle this issue by modeling the five-variate VAR $\boldsymbol{X}_t^Y = [\eta_{13,t}^Y, G_t, T_t, Y_t, \eta_{13,t}^g]'$, where η_{13}^Y stands for the sum of forecast revisions regarding future real GDP. The construction of this variable replicates the construction of η_{13}^g explained in Section 2. We put η_{13}^Y before η_{13}^g in the vector to control for the effects exerted by contemporaneous movements in η_{13}^Y on η_{13}^g.[9] Notice that one can interpret this robustness check as pointing to the role of an identified factor omitted in the baseline analysis, i.e., the role of expectation revisions on output. Table A2 collects our results under the label "η_{13}^Y".

Contemporaneous effects of η_{13}^g shocks. Our approach features a recursive identification scheme. Our choice aims at purging the movements of the η_{13}^g fiscal variable by accounting for its systematic response to government spending, tax revenues, and output. However, such a choice has an obvious limitation, i.e., output is not allowed to move immediately after the realization of the news shock. We then perform a robustness check by focusing on the five-variate VAR $\boldsymbol{X}_t^{\eta^g} = [\eta_{13,t}^g, \eta_{13,t}^Y, G_t, T_t, Y_t]'$,

[8] The entire set of results regarding our robustness checks is not documented in this paper to save space, but it is available upon request.

[9] Given the choice of a Cholesky-identification scheme, the ordering of the variables before η_{13}^g is irrelevant for the computation of our impulse responses to a fiscal news shock.

which enables fiscal news shocks to move output immediately. We keep the measure of news on output to control for the systematic movements of fiscal news due to output news. Notice that this VAR allows for (without forcing) an immediate response of fiscal spending G, which would however be inconsistent with the idea of a news shock. Interestingly, a look at our GIRFs (available upon request) suggest that public spending moves in neither of the two states. This result confirms the potential of the measure of fiscal news shocks employed in this paper to capture anticipated fiscal shocks, i.e., shocks which do not exert an immediate impact on public spending but, possibly, trigger an immediate reaction of output.[10] As for the difference in fiscal multipliers, the results are presented in Table A2 under "η_{13}^{g} first".

Expectation revisions of total government spending. Our baseline analysis hinges upon a η_{13}^{g}, which is based on revisions of forecasts over the growth rates of federal spending only. However, expectations concerning levels of future fiscal spending regarding state and local expenditures are also available. We then construct levels of expected total spending and compute the growth rates of such expected realizations. We use this variable as a proxy of the expected growth rates of total fiscal spending that are not readily available in the SPF dataset. We then use this proxy as an alternative to our η_{13}^{g} variable in our vector. Our results are collected in Table A2 under the label "η_{13}^{g} total".

Ricco's news indicator. In a recent paper, Ricco (2014) shows that the news variable we employ in our study to account for fiscal foresight may be affected by aggregation bias. Our measure is based on forecast revisions constructed by appealing to location measures (e.g., mean, median) of the distribution of the forecasts (across forecasters). However, since the composition of the pool of respondents to the SPF changes over time, one problem related with our measure is that use of measures of central tendency might induce a non negligible bias if the distribution of forecast revisions is skewed. The resulting aggregation bias may in principle imply important quantitative effects for the computation of fiscal multipliers. Ricco (2014) circumvents this problem by constructing a measure of news based on the revisions of expectations of each individual forecaster in the pool, whose forecast is available for at least two consecutive quarters. Ex-post aggregation of such revisions gives rise to a "microfounded" measure

[10] Interestingly, our impulse responses suggest that output moves immediately in recessions, while its contemporaneous response is not significant when expansions are considered (IRFs not shown for the sake of brevity, but available upon request). The contemporaneous zero reaction of public spending to changes in output is consistent with the evidence on the zero contemporaneous output elasticity of government spending in the U.S. surveyed by Caldara and Kamps (2012).

of aggregate news. Even though the correlation between the two measures of fiscal anticipation in our sample is quite high (it reads 0.84), it is of interest to repeat our exercise by employing Ricco's news measure as an alternative to our η_{13}^{g}.[11] Results are documented in Table A2 under "η_{13}^{g} à la Ricco".

Table A2 collects the figures related to the robustness checks discussed above. Two main messages arise. First, the "Normal" scenarios generally points to a rather fragile evidence of countercyclical fiscal multipliers. The most evident exception is the case of the news variable *à la* Ricco, which leads to larger multipliers in recessions. This is in line with the fact that, in presence of a skewed distribution of forecast revisions, our measure of news would downward-bias the estimated fiscal multipliers (see Ricco (2014) for a detailed explanation of the sources of this bias). Second, our extreme events analysis robustly supports larger multipliers in recessions. Hence, our results corroborate a recent statement by Blanchard and Leigh (2013) on the magnitude of fiscal multipliers and the effectiveness of fiscal stabilization policies in periods of substantial economic slack. These results lend support also to Parker's (2011) call for empirical models able to capture the possible countercyclicality of fiscal multipliers.

Computation of the factors for the FAVAR approach

We follow Stock and Watson (2012) to estimate the factors from a large unbalanced data set of US variables. Let $\boldsymbol{X}_t = (X_{1t}, \ldots, X_{nt})'$ denote a vector of n macroeconomic time series, with $t = 1, \ldots, T$. X_{it} is a single time series transformed to be stationary and to have mean zero. The dynamic factor model expresses each of the n time series as the sum of a common component driven by r unobserved factors $\boldsymbol{F}_t$ plus an idiosyncratic disturbance term e_{it}:

$$\mathbf{X}_t = \mathbf{\Lambda F}_t + \mathbf{e}_t \tag{A10}$$

where $\boldsymbol{e}_t = (e_{1t}, \ldots, e_{nt})'$ and $\mathbf{\Lambda}$ is the $n \times r$ matrix of factor loadings.

The factors are assumed to follow a linear and stationary vector autoregression:

$$\mathbf{\Phi}(L)\, \boldsymbol{F}_t = \boldsymbol{\eta}_t \tag{A11}$$

where $\mathbf{\Phi}(L)$ is a $r \times r$ matrix of lag polynomials with the vector of r innovations $\boldsymbol{\eta}_t$. Stationarity implies that $\mathbf{\Phi}(L)$ can be inverted and $\boldsymbol{F}_t$ has the moving average representation:

$$\boldsymbol{F}_t = \mathbf{\Phi}(L)^{-1} \boldsymbol{\eta}_t. \tag{A12}$$

[11] We thank Giovanni Ricco for providing us with his measure of fiscal news.

With n large, under the assumption that there is a single-factor structure, simple cross-sectional averaging provides an estimate of $\boldsymbol{F}_t$ good enough to treat $\widehat{\boldsymbol{F}}_t$ as data in a regression without a generated regressor problem. With multiple factors, Stock and Watson (2002) show that a consistent estimate of $\boldsymbol{F}_t$ is obtained using principal components.

Our data set is standard in the recent literature on factor models (see Stock and Watson, 2012, and Forni and Gambetti, 2014). It contains an unbalanced panel of 150 quarterly series, with starting date 1947Q1 and end date 2012Q3. The data are grouped into 12 categories: NIPA variables (31); industrial production (16); employment and unemployment (14); housing starts (6); inventories, orders and sales (12); prices (15); earnings and productivity (13); interest rates (10); money and credit (12); stock prices (5); exchange rates (7); and other (9). Earnings and productivity data include TFP-adjusted measures of capacity utilization introduced by Basu, Fernald, and Kimball (2006). The category labeled "other" includes expectations variables.

The transformation implemented for the series to be stationary with zero mean are reported in Table A3. The factors were estimated using principal components as in Stock and Watson (2012). The assumption that the factors can be estimated with no breaks over the period 1947Q2-2012Q3 is motivated by the findings of Stock and Watson (2002), who show that the space spanned by the factors can be estimated consistently even if there is instability in $\boldsymbol{\Lambda}$.

Multipliers: "Sum" vs. "Peak" measures.

The multipliers documented in the paper are "sum" multipliers. They are computed as the integral of the response of output divided by the integral of the response of fiscal expenditure, i.e., $\sum_{h=1}^{H} Y_h / \sum_{h=1}^{H} G_h$, where Y_h and G_h represent the impulse responses of output and public spending respectively h-horizon after the shock, and the ratio is then rescaled for the sample mean ratio of the levels of Y over G. This measure is designed to account for the persistence of fiscal shocks (Woodford (2011)). Another measure often employed by the literature (e.g., Blanchard and Perotti (2002)) is the "peak" one, which is calculated as the peak response of output divided by the peak response of fiscal expenditure over the first H horizons, i.e., it is equal to $\frac{max_{h=1,\dots,H}\{Y_h\}}{max_{h=1,\dots,H}\{G_h\}}$. Again, percent changes are then converted into dollars by rescaling such a ratio by the sample mean ratio of the levels of output over public spending.[12] Tables A4-A7 extend

[12] Ramey and Zubairy (2014) warn against this practice by noticing that, in a long U.S. data sample spanning the 1889-2011 period, the output-over-public spending ratio varies from 2 to 24 with a mean

the information contained in Tables 3-6 in the main text, and Figures A1 and A2 extend the one in Figures 5 and 8.

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of 8. Hence, the choice of a constant value for such ratio may importantly bias the estimation of the multipliers. In our sample, the mean value of such a 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. The average value of the output-public spending ratio in our sample in 5.81 in NBER recessions, and 6.02 in NBER expansions. Our results are robust to the employment of state-dependent output-public spending ratios.

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	Peak			
Scenario/State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
Baseline	0.79 [0.45,1.09]	2.27 [1.45,2.93]	1.09 [0.72,2.31]	2.72 [1.32,3.96]
$\widetilde{\eta}^g_{13}$ *last*	0.45 [0.20,0.63]	3.37 [2.03,4.34]	1.05 [0.48,3.77]	3.15 [1.50,4.21]
$\widetilde{\eta}^g_{13}$ *first*	1.21 [0.25,1.94]	3.05 [1.84,6.72]	2.17 [0.93,4.97]	3.64 [1.58,6.80]
Long sample (Ramey's news)	0.47 [0.19,0.80]	2.83 [1.56,5.92]	0.68 [0.23,1.56]	2.59 [1.22,6.60]
	High debt	*Mod.$^+$ debt*	*Mod.$^-$ debt*	*Low debt*
Debt/GDP ratio	1.79 [1.62,2.00]	1.35 [0.68,2.15]	1.95 [1.68,2.44]	2.08 [1.54,2.78]

	Sum			
Scenario/State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
Baseline	−2.26 [−5.63,−0.78]	1.60 [0.18,2.63]	−1.40 [−3.91,0.65]	1.38 [−0.48,3.02]
$\widetilde{\eta}^g_{13}$ *last*	−0.42 [−1.56,0.13]	3.65 [2.09,4.99]	0.76 [−0.62,3.86]	3.17 [0.99,4.43]
$\widetilde{\eta}^g_{13}$ *first*	0.76 [−1.02,2.20]	3.95 [1.59,8.72]	2.35 [0.38,5.43]	3.95 [1.27,8.17]
Long sample (Ramey's news)	0.43 [0.06,0.85]	2.49 [0.19,8.66]	0.02 [−1.77,1.08]	2.21 [−0.68,9.72]
	High debt	*Mod.$^+$ debt*	*Mod.$^-$ debt*	*Low debt*
Debt/GDP ratio	2.43 [2.13,2.72]	0.99 [0.36,1.77]	2.29 [1.93,2.59]	2.07 [1.43,2.54]

Table A1: **Fiscal spending multipliers: Extreme events. Different Scenarios.** Two-year integral multipliers. Figures conditional on our VAR analysis with GIRFs conditional on four different sets of initial conditions. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

		Peak				
Scenario/Horizon	*Cycle*	$h = 4$	$h = 8$	$h = 12$	$h = 16$	$h = 20$
Baseline	*Normal*	87.80	90.80	90.00	90.60	90.20
	Extreme	99.60	100.00	100.00	100.00	100.00
FAVAR	*Normal*	87.40	91.00	93.20	93.40	93.40
	Extreme	100.00	99.80	99.60	99.60	99.60
η_{13}^{Y}	*Normal*	62.60	80.60	82.20	84.00	84.80
	Extreme	93.00	99.20	99.40	99.20	99.20
η_{13}^{g} *first*	*Normal*	81.00	86.80	88.60	90.00	90.00
	Extreme	97.60	99.20	99.40	99.60	99.60
η_{13}^{g} *total*	*Normal*	94.60	92.60	92.60	93.20	93.40
	Extreme	100.00	100.00	100.00	100.00	100.00
η_{13}^{g} *à la Ricco*	*Normal*	95.00	94.00	94.00	94.20	94.40
	Extreme	100.00	100.00	100.0	100.00	100.00

		Sum				
Scenario/Horizon	*Cycle*	$h = 4$	$h = 8$	$h = 12$	$h = 16$	$h = 20$
Baseline	*Normal*	84.80	91.60	93.60	95.40	96.60
	Extreme	100.00	100.00	100.00	100.00	100.00
FAVAR	*Normal*	89.80	85.20	85.60	88.20	89.80
	Extreme	100.00	100.00	100.00	100.00	100.00
η_{13}^{Y}	*Normal*	36.80	73.00	79.80	83.00	86.40
	Extreme	86.20	100.00	100.00	100.00	100.00
η_{13}^{g} *first*	*Normal*	74.20	84.60	88.20	90.40	91.40
	Extreme	96.20	99.80	100.00	100.00	100.0
η_{13}^{g} *total*	*Normal*	89.80	86.60	85.40	85.80	87.00
	Extreme	98.60	95.20	99.00	100.00	100.00
η_{13}^{g} *à la Ricco*	*Normal*	93.00	90.80	90.60	90.20	90.40
	Extreme	99.80	99.80	99.80	99.80	99.80

Table A2: **Fiscal spending multipliers: Shares of multipliers larger in recessions**. Figures conditional on our VAR analysis with GIRFs conditional on four different sets of initial conditions. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

N	Series	Mnemonic	Tr.	Start	End
1	Real Gross Domestic Product, 1 Decimal	GDPC1	5	1947Q1	2012Q3
2	Real Gross National Product	GNPC96	5	1947Q1	2012Q3
3	Real National Income	NICUR/GDPDEF	5	1947Q1	2012Q3
4	Real Disposable Income	DPIC96	5	1947Q1	2012Q3
5	Real Personal Income	RPI	6	1959Q1	2012Q3
6	Nonfarm Business Sector: Output	OUTNFB	5	1947Q1	2012Q3
7	Real Final Sales of Domestic Product, 1 Decimal	FINSLC1	5	1947Q1	2012Q3
8	Real Private Fixed Investment, 1 Decimal	FPIC1	5	1995Q1	2012Q3
9	Real Private Residential Fixed Investment, 1 Decimal	PRFIC1	5	1995Q1	2012Q3
10	Real Private Nonresidential Fixed Investment, 1 Decimal	PNFIC1	5	1995Q1	2012Q3
11	Real Gross Private Domestic Investment, 1 Decimal	GPDIC1	5	1947Q1	2012Q3
12	Real Personal Consumption Expenditure	PCECC96	5	1947Q1	2012Q3
13	Real Personal Consumption Expenditure: Nondurable Goods	PCNDGC96	5	1995Q1	2012Q3
14	Real Personal Consumption Expenditure: Durable Goods	PCDGCC96	5	1995Q1	2012Q3
15	Real Personal Consumption Expenditure: Services	PCESVC96	5	1995Q1	2012Q3
16	Real Gross Private Saving	GPSAVE/GDPDEF	5	1947Q1	2012Q3
17	Real Federal Consumption Expenditures, Gross Investment, 1 Decimal	FGCEC1	5	1995Q1	2012Q3
18	Federal Goverment: Current Expenditures, Real	FGEXPND/GDPDEF	5	1947Q1	2012Q3
19	Federal Goverment: Current Receipts, Real	FGRECPT/GDPDEF	5	1947Q1	2012Q3
20	Net Federal Government Saving	FGDEF	2	1947Q1	2012Q3
21	Government Current Expenditures/GDP Deflator	GEXPND/GDPDEF	5	1947Q1	2012Q3
22	Government Current Receipts/GDP Deflator	GRECPT/GDPDEF	5	1947Q1	2012Q3
23	Government Real Expenditures minus Real Receipts	GDEF	2	1947Q1	2012Q3
24	Real Government Consumption Expenditures, Gross Investment, 1 Decimal	GCEC1	5	1947Q1	2012Q3
25	Real Change in Private Inventories, 1 Decimal	CBIC1	1	1947Q1	2012Q3
26	Real Exports of Goods and Services, 1 Decimal	EXPGSC1	5	1947Q1	2012Q3
27	Real Imports of Goods and Services, 1 Decimal	IMPGSC1	5	1947Q1	2012Q3
28	Corporate Profits After Tax, Real	CP/GDPDEF	5	1947Q1	2012Q3
29	Nonfinancial Corporate Business: Profits After Tax, Real	NFCPATAX/GDPDEF	5	1947Q1	2012Q3
30	Corporate Net Cash Flow, Real	CNCF/GDPDEF	5	1947Q1	2012Q3
31	Net Corporate Dividends, Real	DIVIDEND/GDPDEF	5	1947Q1	2012Q3
32	Industrial Production Index	INDPRO	5	1947Q1	2012Q3
33	Industrial Production: Business Equipment	IPBUSEQ	5	1947Q1	2012Q3
34	Industrial Production: Consumer Goods	IPCONGD	5	1947Q1	2012Q3
35	Industrial Production: Durable Consumer Goods	IPDCONGD	5	1947Q1	2012Q3
36	Industrial Production: Final Products (Market Group)	IPFINAL	5	1947Q1	2012Q3
37	Industrial Production: Materials	IPMAT	5	1947Q1	2012Q3
38	Industrial Production: Nondurable Consumer Goods	IPNCONGD	5	1947Q1	2012Q3
39	Capacity Utilization: Manufacturing	MCUMFN	4	1972Q1	2012Q3
40	Industrial Production: Manufacturing	IPMAN	5	1972Q1	2012Q3
41	Industrial Production: Durable Manufacturing	IPDMAN	5	1972Q1	2012Q3
42	Industrial Production: Mining	IPMINE	5	1972Q1	2012Q3
43	Industrial Production: Nondurable Manufacturing	IPNMAN	5	1972Q1	2012Q3
44	Industrial Production: Durable Materials	IPDMAT	5	1947Q1	2012Q3
45	Industrial Production: Electric and Gas Utilities	IPUTIL	5	1972Q1	2012Q3
46	ISM Manufacturing: PMI Composite Index	NAPM	1	1948Q1	2012Q3
47	ISM Manufacturing: Production Index	NAPMPI	1	1948Q1	2012Q3
48	Average Weekly Hours of Production and Nonsupervisory Employees: Manuf.	AWHMAN	1	1948Q1	2012Q3
49	Average Weekly Overtime Hours of Prod. and Nonsupervisory Employees: Manuf.	AWOTMAN	2	1948Q1	2012Q3
50	Civilian Labor Force Participation Rate	CIVPART	2	1948Q1	2012Q3

Table A3. **Time series employed for the computation of the factors**. Description of the Table in two pages.

N	Series	Mnemonic	Tr.	Start	End
51	Civilian Labor Force	CLF160V	5	1948Q1	2012Q3
52	Civilian Employment	CE160V	5	1948Q1	2012Q3
53	All Employees: Total Private Industries	USPRIV	5	1947Q1	2012Q3
54	All Employees: Goods-Producing Industries	USGOOD	5	1947Q1	2012Q3
55	All Employees: Service-Providing Industries	SRVPRD	5	1947Q1	2012Q3
56	Unemployed	UNEMPLOY	5	1948Q1	2012Q3
57	Average (Mean) Duration of Unemployment	UEMPMEAN	2	1948Q1	2012Q3
58	Civilian Unemployment Rate	UNRATE	2	1948Q1	2012Q3
59	Index of Help-Wanted Advertising in Newspapers	A0M046	1	1959Q1	2012Q3
60	HOANBS/CNP160V	HOANBS/CNP160V	4	1948Q1	2012Q3
61	Initial Claims	ICSA	5	1967Q3	2012Q3
62	Housing Starts: Total: New Privately Owned Units Started	HOUST	5	1959Q1	2012Q3
63	Housing Starts in Northeast Census Region	HOUSTNE	5	1959Q1	2012Q3
64	Housing Starts in Midwest Census Region	HOUSTMW	5	1959Q1	2012Q3
65	Housing Starts in South Census Region	HOUSTS	5	1959Q1	2012Q3
66	Housing Starts in West Census Region	HOUSTW	5	1959Q1	2012Q3
67	New Private Housing Units Authorized by Building Permits	PERMIT	5	1960Q1	2012Q3
68	US Manufacturers New Orders for Non Defense Capital Goods	USNOIDN.D	5	1959Q2	2012Q3
69	US New Orders of Consumer Goods and Materials	USCNORCGD	5	1959Q2	2012Q3
70	US ISM Manufacturers Survey: New Orders Index SADJ	USNAPMNO	1	1950Q2	2012Q3
71	Retail Sales: Total (Excluding Food Services)	RSXFS	5	1992Q1	2012Q3
72	Value of Manufacturers' Total Inventories for All Manufacturing Industries	UMTMTI	5	1992Q1	2012Q3
73	Value of Manufacturers' Total Inventories for Durable Goods	AMDMTI	5	1992Q1	2012Q3
74	Value of Manufacturers' Total Inventories for Nondurable Goods Industries	AMNMTI	5	1992Q1	2012Q3
75	ISM Manufacturing: Inventories Index	NAPMII	1	1948Q1	2012Q3
76	ISM Manufacturing: New Orders Index	NAPMNOI	1	1948Q1	2012Q3
77	Value of Manufacturers' New Orders for Cons. Goods: Cons. Dur. Goods Ind.s	ACDGNO	5	1992Q1	2012Q3
78	Manuf.s' New Orders: Durable Goods	DGORDER	5	1992Q1	2012Q3
79	Value of Manuf.s' New Orders for Dur. Goods Ind.: Transp. Equipment	ANAPNO	5	1992Q1	2012Q3
80	Gross Domestic Product: Chain-type Price Index	GDPCTPI	5	1947Q1	2012Q3
81	Gross National Product: Chain-type Price Index	GNPCTPI	5	1947Q1	2012Q3
82	Gross Domestic Product: Implicit Price Deflator	GDPDEF	5	1947Q1	2012Q3
83	Gross National Product: Implicit Price Deflator	GNPDEF	5	1947Q1	2012Q3
84	Consumer Price Index for All Urban Consumers: All Items	CPIAUCSL	6	1947Q1	2012Q3
85	Consumer Price Index for All Urban Consumers: All Items Less Food	CPIULFSL	6	1947Q1	2012Q3
86	Consumer Price Index for All Urban Consumers: All Items Less Energy	CPILEGSL	6	1957Q1	2012Q3
87	Consumer Price Index for All Urban Consumers: All Items Less Food & Energy	CPILFESL	6	1957Q1	2012Q3
88	Consumer Price Index for All Urban Consumers: Energy	CPIENGSL	6	1947Q1	2012Q3
89	Consumer Price Index for All Urban Consumers: Food	CPIUFDSL	6	1947Q1	2012Q3
90	Producer Price Index: Finished Goods: Capital Equipment	PPICPE	6	1947Q1	2012Q3
91	Producer Price Index: Crude Materials for Further Processing	PPICRM	6	1947Q1	2012Q3
92	Producer Price Index: Finished Consumer Goods	PPIFCG	6	1947Q1	2012Q3
93	Producer Price Index: Finished Goods	PPIFGS	6	1947Q1	2012Q3
94	Spot Oil Price: West Texas Intermediate	OILPRICE	6	1947Q1	2012Q3
95	Nonfarm Business Sector: Hours of All Persons	HOANBS	5	1947Q1	2012Q3
96	Nonfarm Business Secotr: Output Per Hour of All Persons	OPHNFB	5	1947Q1	2012Q3
97	Nonfarm Business Sector: Unit Nonlabor Payments	UNLPNBS	5	1947Q1	2012Q3
98	Nonfarm Business Sector: Unit Labor Cost	ULCNFB	5	1947Q1	2012Q3
99	Compensation of Employees: Wages and Salary Accruals, Real	WASCUR/CPI	5	1947Q1	2012Q3
100	Nonfarm Business Sector: Compensation Per Hour	COMPNFB	5	1947Q1	2012Q3

Table A3 (continued). **Time series employed for the computation of the factors**. Description of the Table in the following page.

N	Series	Mnemonic	Tr.	Start	End
101	Nonfarm Business Sector: Real Compensation Per Hour	COMPRNFB	5	1947Q1	2012Q3
102	Growth in utilization-adjusted TFP	dtfp_util	1	1947Q2	2012Q3
103	Growth in business sector TFP	dtfp	1	1947Q2	2012Q3
104	Utilization in producing investment	du_invest	1	1947Q2	2012Q3
105	Utilization in producing non-investment business output	du_consumption	1	1947Q2	2012Q3
106	Utilization-adjusted TFP in producing equipment and consumer durables	dtfp_I_util	1	1947Q2	2012Q3
107	Utilization-adjusted TFP in producing non-equipment output	dtfp_C_util	1	1947Q2	2012Q3
108	Effective Federal Funds Rate	FEDFUNDS	2	1954Q3	2012Q3
109	3-Month Treasury Bill: Secondary Market Rate	TB3MS	2	1947Q1	2012Q3
110	1-Year Treasury Constant Maturity Rate	GS1	2	1953Q2	2012Q3
111	10-Year Treasury Constant Maturity Rate	GS10	2	1953Q2	2012Q3
112	Moody's Seasoned Aaa Corporate Bond Yield	AAA	2	1947Q1	2012Q3
113	Moody's Seasoned Baa Corporate Bond Yield	BAA	2	1947Q1	2012Q3
114	Bank Prime Loan Rate	MPRIME	2	1949Q1	2012Q3
115	GS10-FEDFUNDS Spread	GS10-FEDFUNDS	1	1954Q3	2012Q3
116	GS1-FEDFUNDS Spread	GS1-FEDFUNDS	1	1954Q3	2012Q3
117	BAA-FEDFUNDS Spread	BAA-FEDFUNDS	1	1954Q3	2012Q3
118	Non-Borrowed Reserves of Depository Institutions	BOGNONBR	5	1959Q1	2012Q3
119	Board of Gov. Total Reserves, Adjusted for Changes in Reserve Requirements	TRARR	5	1959Q1	2012Q3
120	Board of Gov. Monetary Base, Adjusted for Changes in Reserve Requirements	BOGAMBSL	5	1959Q1	2012Q3
121	M1 Money Stock	M1SL	5	1959Q1	2012Q3
122	M2 Less Small Time Deposits	M2MSL	5	1959Q1	2012Q3
123	M2 Money Stock	M2SL	5	1959Q1	2012Q3
124	Commercial and Industrial Loans at All Commercial Banks	BUSLOANS	5	1947Q1	2012Q3
125	Consumer Loans at All Commercial Banks	CONSUMER	5	1947Q1	2012Q3
126	Bank Credit at All Commercial Banks	LOANINV	5	1947Q1	2012Q3
127	Real Estate Loans at All Commercial Banks	REALLN	5	1947Q1	2012Q3
128	Total Consumer Credit Owned and Securitized, Outstanding	TOTALSL	5	1947Q1	2012Q3
129	St. Louis Adjusted Monetary Base	AMBSL (CHNG)	5	1947Q1	2012Q3
130	US Dow Jones Industrials Share Price Index (EP)	USSHRPRCF	5	1950Q2	2012Q3
131	US Standard & Poor's Index of 500 Common Stocks	US500STK	5	1950Q2	2012Q3
132	US Share Price Index NADJ	USI62...F	5	1957Q2	2012Q3
133	Dow Jones/GDP Deflator	DOW Jones/GDPDEF	5	1950Q2	2012Q3
134	S&P/GDP Deflator	S&P/GDPDEF	5	1950Q2	2012Q3
135	Trade Weighted U.S. Dollar Index: Major Currencies	TWEXMMTH	2	1973Q1	2012Q3
136	Euro/U.S. Foreign Exchange Rate	EXUSEU(-1)	5	1999Q1	2012Q3
137	Germany/U.S. Foreign Exchange Rate	EXGEUS	5	1971Q1	2001Q4
138	Switzerland/U.S. Foreign Exchange Rate	EXSZUS	5	1971Q1	2012Q3
139	Japan/U.S. Foreign Exchange Rate	EXJPUS	5	1971Q1	2012Q3
140	U.K./U.S. Foreign Exchange Rate	EXUSUK(-1)	5	1971Q1	2012Q3
141	Canada/U.S. Foreign Exchange Rate	EXCAUS	5	1971Q1	2012Q3
142	US The Conference Board Leading Economic Indicators Index SADJ	USCYLEADQ	5	1959Q1	2012Q3
143	US Economic Cycle Research Institute Weekly Leading Index	USECRIWLH	5	1950Q2	2012Q3
144	University of Michigan Consumer Sentiment: Personal Finances, Current	USUMPFNCH	2	1978Q1	2012Q3
145	University of Michigan Consumer Sentiment: Personal Finances, Expected	USUMPFNEH	2	1978Q1	2012Q3
146	University of Michigan Consumer Sentiment: Economic Outlook, 12 Months	USUMECO1H	2	1978Q1	2012Q3
147	University of Michigan Consumer Sentiment: Economic Outlook, 5 Years	USUMECO5H	2	1978Q1	2012Q3
148	University of Michigan Consumer Sentiment: Buying Conditions, Durables	USUMBUYDH	2	1978Q1	2012Q3
149	University of Michigan Consumer Sentiment Index	USUMCONSH	2	1991Q1	2012Q3
150	University of Michigan Consumer Sentiment - Current Conditions	USUMCNSUR	2	1991Q1	2012Q3

Table A3 (continued). **Time series employed for the computation of the factors**. Classification of the series: 1-31: "NIPA"; 32-47: "Industrial Production"; 48-61: "Employment and Unemployment"; 62-67: "Housing Starts"; 68-79: "Inventories", "Orders and Sales"; 80-94: "Prices"; 95-107: "Earnings and Productivity"; 108-117: "Interest Rates"; 118-129: "Money and Credit"; 130-134: "Stock Prices"; 135-141: "Exchange Rates"; 142-150: "Others". The column labeled "Tr." indicates the transformation applied to the series (1 = level, 2 = first difference, 3 = logarithm, 4 = second difference, 5 = first difference of logarithm, 6 = second difference of logarithm). Data source: Federal Reserve Bank of St. Louis' website.

	Peak		*Sum*	
Horizon/State	*Expansion*	*Recession*	*Expansion*	*Recession*
4	1.68 [1.12,3.49]	3.38 [1.77,4.70]	1.73 [0.52,3.50]	3.15 [1.71,4.27]
8	1.24 [0.80,3.19]	3.32 [1.55,4.91]	0.33 [−1.05,2.77]	3.05 [0.68,4.70]
12	1.11 [0.74,2.69]	2.77 [1.40,4.28]	−0.57 [−2.24,1.54]	2.13 [0.13,3.82]
16	1.09 [0.71,2.43]	2.60 [1.38,3.96]	−1.41 [−3.96,0.74]	1.54 [−0.42,2.95]
20	1.09 [0.71,2.41]	2.58 [1.38,3.90]	−2.27 [−6.23,−0.01]	1.00 [−0.94,2.47]

Table A4: **Fiscal spending multipliers**. Figures conditional on our baseline VAR analysis. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

Peak				
Hor./State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
4	1.24 [0.78,1.88]	3.57 [2.14,4.73]	1.68 [1.15,3.44]	3.23 [1.74,4.69]
8	0.86 [0.53,1.25]	3.58 [1.94,4.75]	1.24 [0.82,3.16]	3.24 [1.56,4.72]
12	0.79 [0.48,1.10]	2.39 [1.48,3.30]	1.11 [0.75,2.56]	2.88 [1.32,4.20]
16	0.79 [0.45,1.09]	2.27 [1.45,2.93]	1.09 [0.72,2.31]	2.72 [1.32,3.96]
20	0.79 [0.43,1.08]	2.24 [1.44,2.90]	1.09 [0.72,2.29]	2.71 [1.31,3.94]

Sum				
Hor./State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
4	1.03 [−0.51,2.03]	3.42 [2.05,4.35]	1.69 [0.64,3.40]	3.09 [1.71,4.14]
8	−0.26 [−2.01,0.84]	3.42 [1.22,5.14]	0.30 [−0.87,2.83]	2.94 [0.56,4.46]
12	−1.32 [−3.68,−0.03]	2.21 [0.61,3.54]	−0.62 [−2.15,1.48]	2.06 [0.03,3.78]
16	−2.26 [−5.63,−0.78]	1.60 [0.18,2.63]	−1.40 [−3.91,0.65]	1.38 [−0.48,3.02]
20	−3.28 [−7.00,−1.56]	1.09 [−0.31,2.07]	−2.37 [−6.08,0.01]	0.83 [−0.97,2.54]

Table A5: **Fiscal spending multipliers: Extreme events, two-year horizon multipliers**. Figures conditional on our VAR analysis with GIRFs conditional on four different sets of initial conditions. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

Peak						
Scenario/Horizon	*Cycle*	h=4	h=8	h=12	h=16	h=20
Baseline	*Normal*	87.8	90.8	90.0	90.6	90.2
	Extreme	100	100	100	100	100
$\tilde{\eta}^g_{13}$ *last*	*Normal*	84.0	87.0	87.8	88.8	89.2
	Extreme	100	100	100	100	100
$\tilde{\eta}^g_{13}$ *first*	*Normal*	69.0	76.2	76.8	79.8	80.6
	Extreme	86.4	96.4	96.2	96.0	96.0
Long sample (Ramey's news)	*Normal*	96.8	98.2	98.0	98.0	98.0
	Extreme	99.0	100	100	100	100

Sum						
Scenario/Horizon	*Cycle*	h=4	h=8	h=12	h=16	h=20
Baseline	*Normal*	84.8	91.6	93.6	95.4	96.6
	Extreme	100	100	100	100	100
$\tilde{\eta}^g_{13}$ *last*	*Normal*	78.2	86.4	89.4	90.6	92.6
	Extreme	100	100	100	100	100
$\tilde{\eta}^g_{13}$ *first*	*Normal*	58.2	76.2	82.2	89.8	92.0
	Extreme	71.6	93.0	97.8	98.8	99.2
Long sample (Ramey's news)	*Normal*	82.8	89.6	87.6	86.4	86.6
	Extreme	90.2	92.8	92.8	93.0	93.6

Table A6: **Fiscal spending multipliers: Shares of multipliers larger in recessions**. Normal scenarios: Fraction of multipliers which are larger in recessions than expansions out of 500 draws from their empirical distributions. Extreme scenarios: Fraction of multipliers which are larger in deep recessions than strong expansions out of 500 draws from their empirical distributions. 'h' identifies the number of quarters after the shock.

	Peak			
Scenario/State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
Baseline	0.79 [0.45,1.09]	2.27 [1.45,2.93]	1.09 [0.72,2.31]	2.72 [1.32,3.96]
$\widetilde{\eta}^g_{13}$ *last*	0.43 [0.19,0.61]	2.55 [1.66,3.34]	0.97 [0.45,3.01]	2.88 [1.44,3.72]
$\widetilde{\eta}^g_{13}$ *first*	1.14 [0.24,1.82]	2.74 [1.65,4.48]	1.91 [0.85,3.72]	3.23 [1.51,5.14]
Long sample (Ramey's news)	0.49 [0.20,0.81]	2.61 [1.55,4.62]	0.77 [0.28,1.50]	2.51 [1.21,5.31]
	High debt	*Mod.$^+$ debt*	*Mod.$^-$ debt*	*Low debt*
Debt/GDP ratio	1.35 [1.15,1.54]	1.22 [0.58,1.81]	1.56 [1.31,2.00]	1.66 [1.24,2.55]

	Sum			
Scenario/State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
Baseline	−2.26 [−5.63,−0.78]	1.60 [0.18,2.63]	−1.40 [−3.91,0.65]	1.38 [−0.48,3.02]
$\widetilde{\eta}^g_{13}$ *last*	−1.57 [−2.92,−0.91]	2.28 [1.23,3.10]	−0.44 [−1.97,2.29]	2.16 [0.22,3.00]
$\widetilde{\eta}^g_{13}$ *first*	−0.70 [−2.50,0.43]	2.36 [0.99,4.29]	0.66 [−1.04,2.90]	2.50 [0.59,4.39]
Long sample (Ramey's news)	0.15 [−0.24,0.53]	1.74 [0.08,3.92]	0.07 [−1.23,0.96]	1.52 [0.60,4.62]
	High debt	*Mod.$^+$ debt*	*Mod.$^-$ debt*	*Low debt*
Debt/GDP ratio	0.68 [0.15,1.37]	0.74 [−1.02,1.15]	1.33 [0.95,1.66]	1.33 [0.81,1.97]

Table A7: **Fiscal spending multipliers: Extreme events, four-year horizon multipliers**. Figures conditional on our VAR analysis with GIRFs conditional on four different sets of initial conditions. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

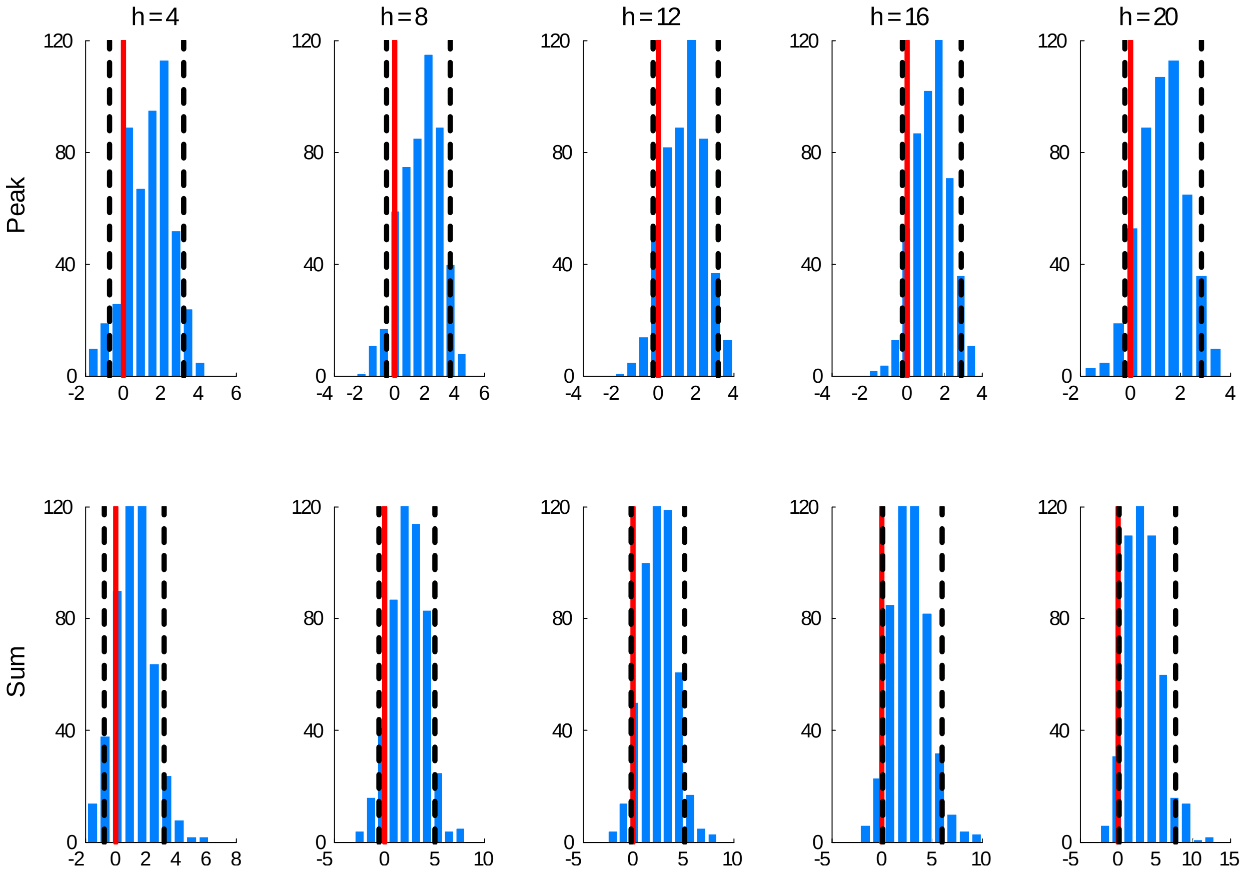

Figure A1: **Difference in multipliers between recessions and expansions: All histories.** Empirical densities of the differences computed as multipliers in recessions minus multipliers in expansions. Densities constructed by considering all recessions and expansions (initial conditions) present in the sample. Multipliers conditional on the same set of draws of the stochastic elements of our STVAR model as well as the same realizations of the coefficients of the vector. Densities based on 500 realizations of such differences per each horizon of interest. 'h' identifies the number of quarters after the shock.

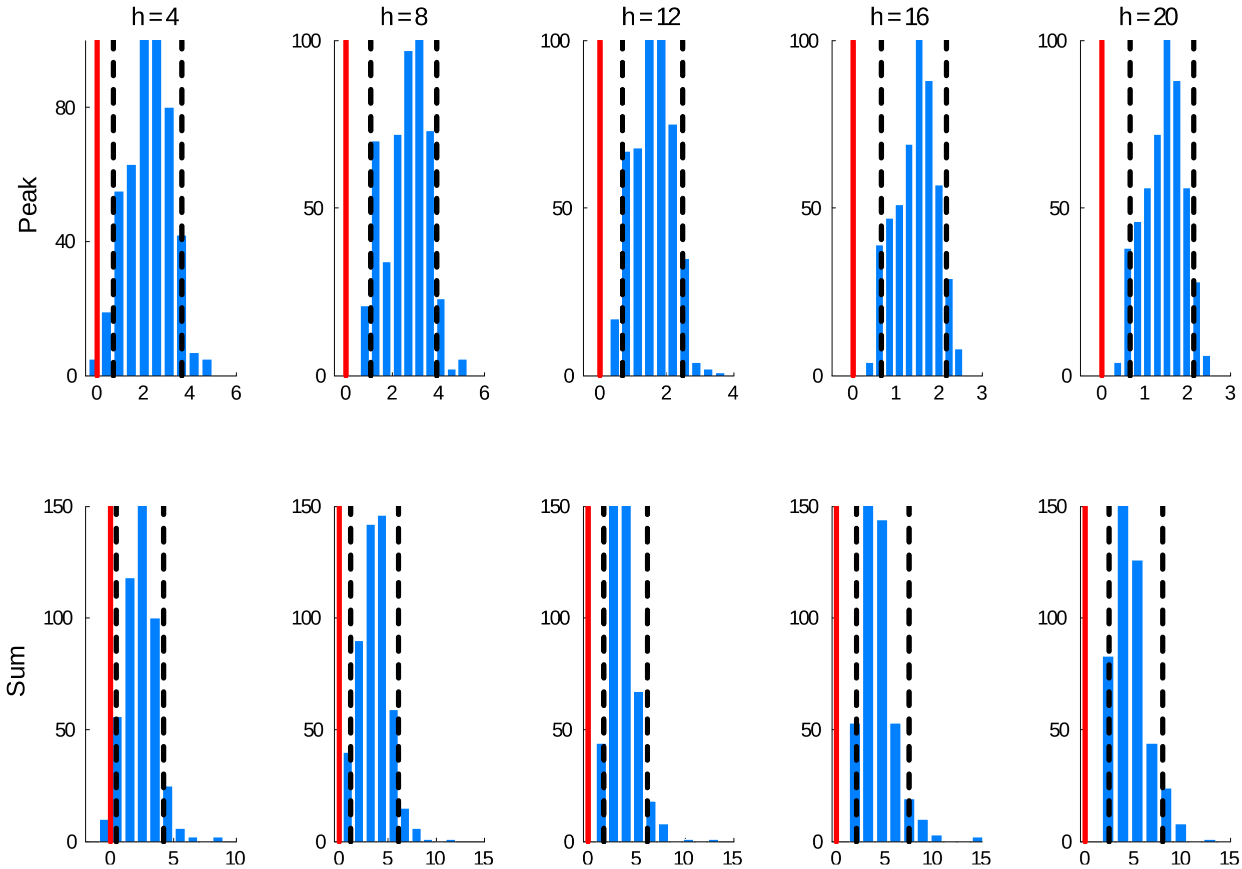

Figure A2: **Difference in multipliers between recessions and expansions: Extreme events.** Empirical densities of the differences computed as multipliers in recessions minus multipliers in expansions. Densities constructed by considering just extreme realizations of recessions and expansions (initial conditions) present in the sample. Multipliers conditional on the same set of draws of the stochastic elements of our STVAR model as well as the same realizations of the coefficients of the vector. Densities based on 500 realizations of such differences per each horizon of interest. 'h' identifies the number of quarters after the shock.