

ESTIMATING FISCAL MULTIPLIERS: NEWS FROM A NON-LINEAR WORLD*

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We estimate non-linear VARs to assess to what extent fiscal spending multipliers are countercyclical in the US. We deal with the issue of non-fundamentality 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 generalised impulse responses suggest that fiscal spending multipliers in recessions are greater than one, but not statistically larger than those in expansions. However, non-linearities arise when focusing on ‘extreme’ events, that is, deep recessions *versus* strong expansionary periods.

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, 2011*a*). 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 *et al.*, 2011; Leeper *et al.*, 2011; Woodford, 2011; Fernández-Villaverde *et al.*, 2012), higher returns from public spending due to countercyclical financial frictions and credit constraints (Canzoneri *et al.*, 2011), and lower crowding out of private employment due to a milder increase in labour market tightness (Michaillat, 2014; Roulleau-Pasdeloup, 2014). Empirical evidence in favour of state-dependent fiscal multipliers is provided by, among others, Tagkalakis (2008), Auerbach and Gorodnichenko (2012, 2013*a,b*), Bachmann and Sims (2012), Batini *et al.* (2012), Baum *et al.*

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(2012), Mittnik and Semmler (2012), Fazzari *et al.* (2014).¹ Second, anticipation effects are likely to be of great relevance to 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, 2011*b*; Favero and Giavazzi, 2012; Kriwoluzky, 2012; Ellahie and Ricco, 2013; Leeper *et al.*, 2013; Forni and Gambetti, 2014a). Modelling a standard set of US variables with a medium-scale structural model that allows for foresight up to eight quarters, Schmitt-Grohe and Uribe (2012) find that about 60% 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 interpret the dynamics of the modelled variables – are typically ‘non-fundamental’, in that they do not embed the information related to ‘news shocks’, that is, future shocks anticipated by rational agents.² Leeper *et al.* (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 (2011*b*) show that government spending shocks estimated with standard fiscal VARs are predictable, that is, they are non-fundamental.

This article estimates state-dependent fiscal multipliers by explicitly addressing the issue of fiscal foresight. We tackle the issue of non-fundamentality by jointly modelling 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 Forni and Gambetti (2014a), 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 US fiscal policy decisions.³ We include this measure of fiscal news in a non-linear smooth transition vector autoregressive (STVAR) model, which we use to discriminate dynamic responses to fiscal shocks in bad and good times (i.e. recessions *versus* 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

¹ Other forms of state-dependence have been identified in the literature. Corsetti *et al.* (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. Canova and Pappa (2011) and Rossi and Zubairy (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 *versus* abnormal debt-to-GDP ratios, see Cantore *et al.* (2013).

² For a recent discussion on non-fundamentality 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 post-war US income tax legislation is about seven months. Mertens and Ravn (2011) find that the median implementation lag is six quarters. Leeper *et al.* (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 the employment of an alternative way of computing fiscal multipliers, that is, 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 output over public spending. Online Appendix documents the results obtained with this alternative way of computing fiscal multipliers.

output and estimate fiscal multipliers in recessions and expansions, we compute generalised 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 *et al.* (1996), GIRFs allow us to scrutinise the role played by different initial conditions. We then isolate ‘extreme’ events, that is, deep recessions and 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 US business cycle;
- (iii) the reaction becomes statistically different for extreme phases of the business cycle, that is, deep recessions *versus* strong expansions;
- (iv) fiscal multipliers in recessions are statistically larger than one; and
- (v) spending shocks in recessions have a noticeable stabilisation 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 (2011*b*), 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; and
- (iv) several different VAR specifications.

Our article 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 endogenise the possibly stabilising effects of fiscal policy. Third, the use of GIRFs allows us to address a previously unexplored issue, that is, 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 stylised facts about government spending multipliers in the US, 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, 2013*a*), Owyang *et al.* (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. In contrast we focus on anticipated changes in fiscal spending. Second, their impulse responses are conditionally linear, that is, 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 modelled. Third, our focus is on 'extreme' events, that is, realisations on the tails of the distribution of our business cycle indicator (like the 2007–9 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 *versus* expansions), they are likely to be large in the presence of particularly severe economic conditions. Owyang *et al.* (2013) and Ramey and Zubairy (2014) employ local projection methods *à la* Jordá (2005) to investigate the non-linearity of fiscal multipliers. They find no evidence of larger fiscal multipliers during downturns as for the US. The comparability between our exercises and theirs is not immediate due to a number of different modelling 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 *versus* 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 US military contractors which is shown to anticipate future military spending shocks. Ben Zeev and Pappa (2014) identify US defence news shocks as the shocks that best explain future movements in defence spending over a five year horizon and are orthogonal to current defence spending. All these contributions show that, at least qualitatively, anticipated positive fiscal shocks

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

induce a significant increase in output.⁶ Perotti (2007, 2011), Ramey (2011*b*), Blanchard and Leigh (2013), Alesina *et al.* (2014), Forni and Gambetti (2014*a*) and Ricco (2014) work with expectations revisions in different modelling frameworks. Our article complements these contributions, in that it quantifies the effects of anticipated fiscal spending shocks with a non-linear model focusing on extreme events.⁷

The structure of the article is as follows. Section 1 deals with the issue of non-fundamentality 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 2 offers statistical support to the role of non-linearities in this context and presents the smooth transition VAR model employed in our analysis. Our main results are shown in Section 3, which deals with the computation of fiscal multipliers in recessions and expansions, and Section 4, which focuses on extreme events. Section 5 documents a battery of robustness checks. Concluding remarks are provided in Section 6.

1. Non-fundamentality and Expectations Revisions

1.1. *The Role of Expectations Revisions*

As previously anticipated, standard fiscal VARs may return severely biased impulse responses in presence of news shocks. Consider the model

$$y_t = \delta E_t y_{t+1} + g_t + \omega_t \quad (1)$$

$$g_t = \varepsilon_{t-h} + \phi_1 \varepsilon_{t-h-1} + \dots + \phi_{q-h-1} \varepsilon_{t-(q-1)} + \phi_{q-h} \varepsilon_{t-q} = \Phi(L) \varepsilon_t \quad (2)$$

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

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; Kueng, 2014). Leeper *et al.* (2012) show that spreads with maturity lengths of one and five years are very informative about future tax events. Our article deals with anticipated fiscal spending shocks. We leave the analysis of anticipated tax shocks to future research.

⁷ Admittedly, the theoretical articles modelling non-linearities cited in this Introduction mainly consider models in which government spending is implemented without lags. As for the zero lower bound, however, Christiano *et al.* (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 characterised by state-dependent financial constraints and labour market downward rigidities.

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 realisations 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 $h \geq 1$ 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 $h = q$; and
- (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, Forni and Gambetti (2014a) propose to use a news variable defined as:

$$\eta_{1J}^g = \sum_{j=1}^J (E_t g_{t+j} - E_{t-1} g_{t+j}) = \begin{cases} (1 + \phi_1 + \dots + \phi_{J-h})\varepsilon_t & \text{if } J < q \\ (1 + \phi_1 + \dots + \phi_{q-h})\varepsilon_t & \text{if } J \geq q \end{cases}, \quad (3)$$

which correctly identifies the news shock if $J \geq h$.⁹ The online Appendix provides further discussions and derivations as regards this news variable.

1.2. 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:

$$\eta_{13}^g = \sum_{j=1}^3 (E_t \Delta g_{t+j} - E_{t-1} \Delta g_{t+j}). \quad (4)$$

where $E_t \Delta g_{t+j}$ 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, $E_t \Delta g_{t+j} - E_{t-1} \Delta g_{t+j}$ 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

⁸ Forni *et al.* (2013) investigate the case in which economic agents deal with noisy news. Agents are assumed to receive signals regarding the future realisation 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 *et al.* (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 realisation 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 .

$t + 3$. This is the reason why our baseline analysis will be conducted by considering the variable η_{13}^g .¹⁰

1.3. 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 modelling 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 (orthogonalised) 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 realisations of public expenditure. In contrast, revisions of expectations based on nowcasting, that is, $E_t \Delta g_t - E_{t-1} \Delta g_t$, 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 expenditures) are possibly of help in identifying truly unanticipated fiscal shocks, rather than anticipated, news shocks.¹²

Table 1
Anticipated Fiscal Spending Shocks: Statistical Relevance

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

Notes. 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 with a predictive power of news found to be significant at a 10% 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 heteroscedasticity and serial correlation.

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 modelling choices of our baseline VAR analysis (specified in the next Section).

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.

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; and
- (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 Forni and Gambetti (2014a), who show that η_{13}^g Granger causes fiscal spending at different horizons.¹³

1.4. *Extreme Realisations of the News Spending Variable: An interpretation*

Figure 1 plots our news variable (an updated version of Forni and Gambetti, 2014a). The standardised variable η_{13}^g conveys useful information about fiscal policy shocks in the US. To see this, we isolate the seven realisations which exceed two in absolute value, and provide an interpretation based on recent US fiscal history. The 1983Q1 positive realisation is associated with Ronald Reagan's 'Evil Empire' and 'Star Wars' speeches, with which the US 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 rationalises the positive peak in 2001Q4. Finally, the upward spike in 2009Q1 can be associated with Barack Obama's stimulus package.

1.5. *Comparison with Ramey's (2011b) News Variable*

Figure 1 also plots the military spending news variable constructed by Ramey (2011b), and extended up to 2010Q4 by Owyang *et al.* (2013).¹⁴ It appears that the η_{13}^g 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 *et al.*, 2013) and the η_{13}^g variable.

¹³ In a recent article, Perotti (2011) questions the use of the SPF forecast errors employed by Ramey (2011b) 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 .

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

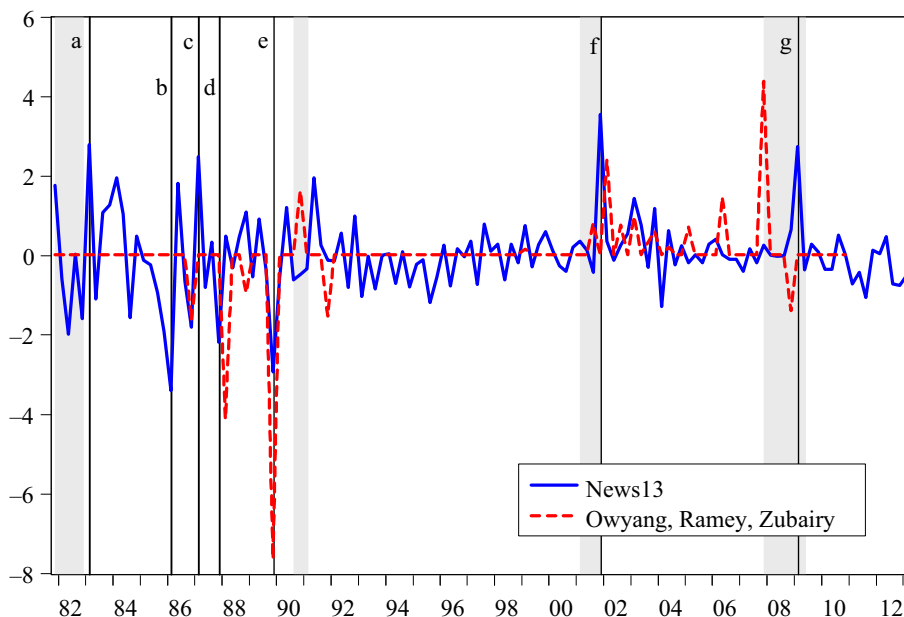


Fig. 1. *News13 (This Paper) Versus Owyang et al.'s (2013) News Variable*

Notes. Grey 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. Dashed line: news variable constructed by Owyang *et al.* (2013), who extended Ramey's (2011*a, b*) news variable up to 2010Q4. Ramey's (2011*a, b*) variable is constructed by considering the present discounted value of expected changes in defence spending (nominal spending divided by nominal GDP one period before). Both news measures in this Figure are standardised.

Table 2 collects the outcome (p-values associated with 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,

Table 2

News à la Ramey Versus Forecast Revisions: Granger Causality Tests

Sample	Ramey	η_{13}^R	ORZ	η_{13}^O
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

Notes. 'Ramey' stands for the news variable employed by Ramey (2011*a, b*), 'ORZ' stands for its updated version employed by Owyang *et al.* (2013). p-values related to the exclusion Wald-test of one period-lagged covariate of interest. Figures in bold are associated with a predictive power of news found to be significant at a 10% confidence level. Results based on a bivariate VAR with one lag. Null hypothesis: column variable does not Granger cause the alternative news measure.

for the first five years in the benchmark sample, Ramey's (2011*b*) 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 *et al.* (2013), which includes observations related to the 2007–9 recession. Again, these results are in line with those reported in Forni and Gambetti (2014*a*), who also finds Ramey's news shock to be predicted by forecast revisions over one quarter.

2. Econometric Approach: A STVAR Macro-fiscal Model

2.1. Modelling 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 *et al.*, 2010). Our STVAR framework reads as follows:

$$\mathbf{x}_t = F(z_{t-1})\mathbf{\Pi}_R(L)\mathbf{x}_t + [1 - F(z_{t-1})]\mathbf{\Pi}_E(L)\mathbf{x}_t + \boldsymbol{\varepsilon}_t, \quad (5)$$

$$\boldsymbol{\varepsilon}_t \sim N(0, \mathbf{\Omega}_t), \quad (6)$$

$$\mathbf{\Omega}_t = F(z_{t-1})\mathbf{\Omega}_R + [1 - F(z_{t-1})]\mathbf{\Omega}_E, \quad (7)$$

$$F(z_t) = \exp(-\gamma z_t) / [1 + \exp(-\gamma z_t)], \quad \gamma > 0, z_t \sim N(0, 1), \quad (8)$$

where \mathbf{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, $\mathbf{\Pi}_R$ and $\mathbf{\Pi}_E$ are the VAR co-efficients 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 $\mathbf{\Omega}_t$, and $\mathbf{\Omega}_R$ and $\mathbf{\Omega}_E$ stand for the covariance structure of the residuals in recessions and expansions, respectively. The modelling 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 standardised transition variable z_t . The smoothness parameter γ affects the probability of being in a recession $F(z_t)$, that is, the larger the value of γ , the faster the transition from a state to another. Notably, the model (5)–(8) allows for non-linearities to arise from both the contemporaneous and the dynamic relationships of the economic system.

Our baseline analysis refers to the vector $\mathbf{x}_t = (g_t, t_t, y_t, \eta_{13,t}^g)'$, 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

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.

closely follows Auerbach and Gorodnichenko (2013a).¹⁶ The variable η_{13}^g is the public expenditure news variable (4). The variables are expressed in levels because of possible cointegration relationships. Consistently, the variable η_{13}^g is considered in cumulated sums to preserve the same order of integration as the other variables included in the vector. Our sample of US 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 *et al.* (2014) and Berger and Vavra (2014), we employ a standardised moving average of the real GDP quarter-on-quarter percentage growth rate.¹⁸ We calibrate the smoothness parameter γ to match the observed frequencies of the US recessions as identified by the NBER business cycle dates, that is, 15% in our sample. Then, we define as ‘recession’ a period in which $F(z_t) \geq 0.85$, and calibrate γ to obtain $\Pr(F(z_t) \geq 0.85) \approx 15\%$. This metric implies a calibration $\gamma = 2.3$. The choice is consistent with the threshold value $\bar{z} = -0.75\%$ discriminating recessions and expansions, that is, realisations of the standardised transition variable z lower (higher) than the threshold will be associated with recessions (expansions).¹⁹ Figure 2 plots the transition function $F(z_t)$. Clearly, high realisations 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).

2.2. Identification of the Anticipated Fiscal Shock

Following Fisher and Peters (2010), we order the news variable η_{13}^g last in our vector and orthogonalise the reduced-form residuals of the VAR via a Cholesky decomposition of the variance-covariance matrix. We analyse the implications of this *versus* alternative strategies to identify fiscal news shocks in Section 4.

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).

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

¹⁹ The corresponding threshold value for the non-standardised moving average real GDP growth rate is equal to 0.34%. The sample mean of the non-standardised 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 standardised transition indicator z , that is, $\bar{z}^{nonstd} = -0.75 \times 0.50 + 0.71 = 0.34$.

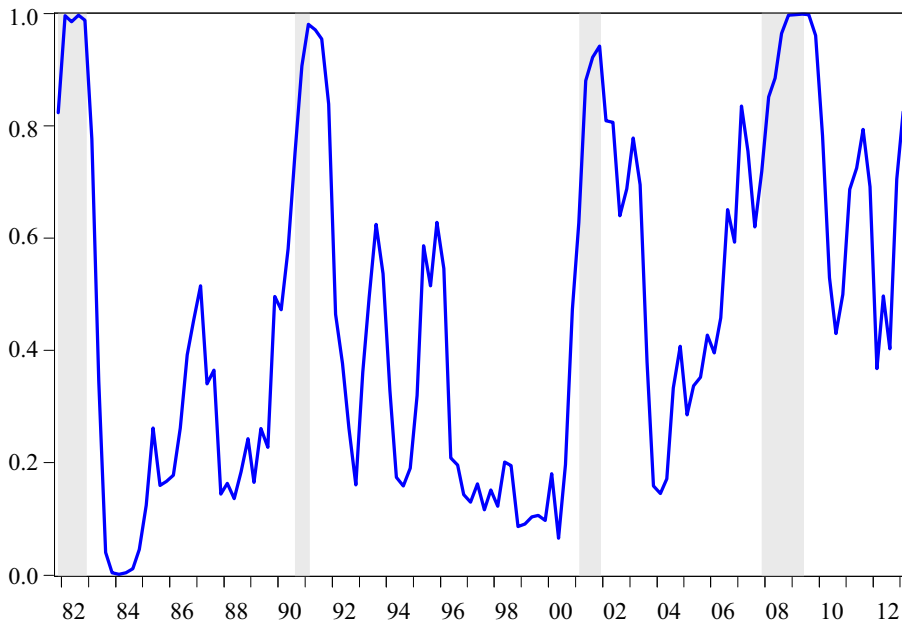


Fig. 2. *Probability of Being in a Recessionary Phase*

Notes. $F(z)$ computed according to the logistic function presented in the text. Transition variable: standardised backward-looking moving average constructed with four realisations of the quarter-on-quarter real GDP growth rate. Value of the slope parameter: 2.3.

2.3. *Statistical Evidence in Favour of Non-linearity and Model Estimation*

For our vector of endogenous variables \mathbf{x}_t , we test and clearly reject the null hypothesis of linearity in favour of the (logistic) STVAR via the multivariate test proposed by Teräsvirta and Yang (2013) in the presence of a single transition variable. Details on this test and its implementation are presented in the online Appendix.

2.4. *Model Estimation*

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

3. **Generalised Impulse Responses and Fiscal Multipliers**

This Section reports the estimated impulse responses to an anticipated fiscal spending shock. Following Koop *et al.* (1996), we compute generalised 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 endogenised.²⁰ Koop *et al.* (1996) and Ehrmann *et al.* (2003) show that initial conditions affect the computation of the GIRFs. In our benchmark exercise, we randomise all possible histories within each state, so to control for the role of initial conditions.²¹ We compute the GIRFs by normalising the news shocks to one.²²

3.1. GIRFs

Figure 3 reports the impact of a government spending news shock computed with our linear and non-linear 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. In contrast, 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.

Next, we look at the evidence coming from the non-linear 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 Ramey and coauthors (Ramey, 2011*b*; Owyang *et al.*, 2013; Ramey and Zubairy, 2014), which are obtained with a different identification strategy (fiscal spending news shocks constructed following Ramey's, 2011*b* approach) and methodology (local projections *à la* Jordá, 2005). At a first glance, the evidence seems to be at

²⁰ Recall that our transition indicator $z_t \equiv 1/4(\Delta y_t + \Delta y_{t-1} + \Delta y_{t-2} + \Delta y_{t-3})$, that is, the relationship between z_t and Δy_{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 *et al.* (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 *et al.* (1996), our GIRFs are computed as follows. First, we draw an initial condition, that is, 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 realisation 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 realisations of our GIRFs, then store the median realisation. We repeat these steps until 500 initial conditions (drawn by allowing for repetitions) associated with recessions (expansions) are considered. Then, we construct the distribution of our GIRFs by considering these 500 median realisations. The online 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.

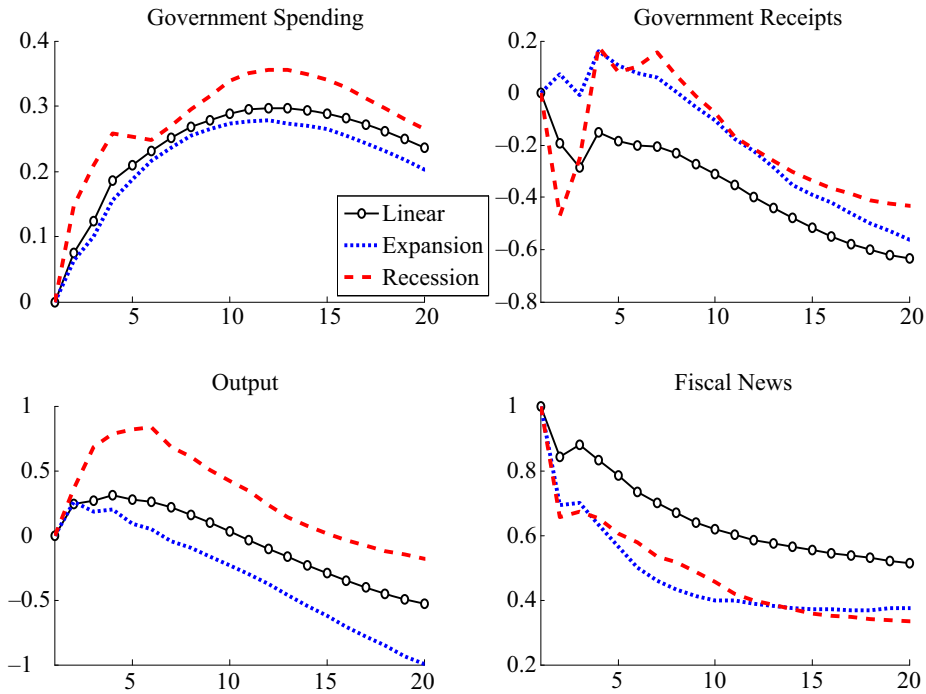


Fig. 3. *Generalised Impulse Responses to a Fiscal News (Anticipated) Spending Shock: Linear Model, Recessions, Expansions*

Notes. Median responses to a fiscal news shock normalised 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 percentage changes in dollars.

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 20 quarters. In contrast, 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 all histories belonging to a given state (recessions, expansions). We elaborate on the role played by initial conditions in Section 4.

3.2. *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,

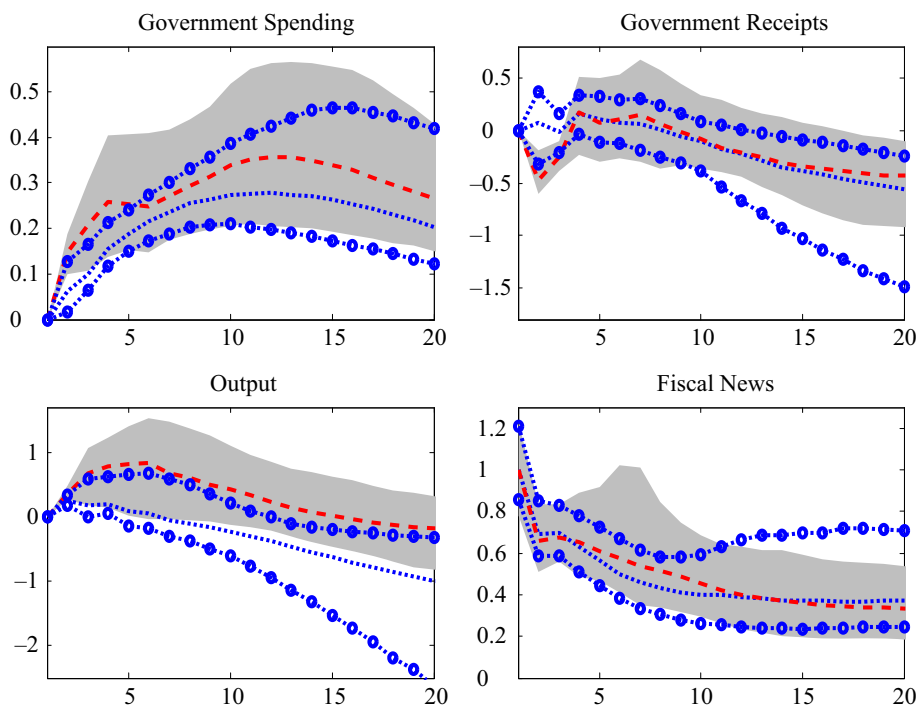


Fig. 4. *Generalised Impulse Responses to a Fiscal News (Anticipated) Spending Shock: Recessions Versus Expansions*

Notes. Median responses to a fiscal news shock normalised to one. 90% confidence intervals identified with gray areas (recessions) and circled lines (expansions). Dashed light grey lines: recessions. Dotted dark grey 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 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 percentage changes in dollars.

that is, $\frac{\sum_{h=1}^H y_h}{\sum_{h=1}^H g_h}$, where H is a chosen horizon. Percentage 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 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 favour of larger (short-run) fiscal spending multipliers in recessions, with values between 3.05

²³ Ramey and Zubairy (2014) warn against this practice by noticing that, in a long US 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, 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 is 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.

Table 3
Fiscal Spending Multipliers

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]

Notes. 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 percentage changes in dollars.

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

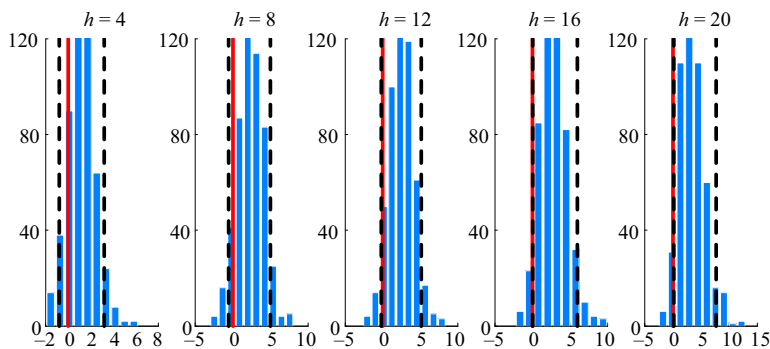


Fig. 5. Difference in Multipliers between Recessions and Expansions: All Histories

Notes. 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 realisations of the co-efficients of the vector. Densities based on 500 realisations of such differences per each horizon of interest. ‘h’ identifies the number of quarters after the shock.

²⁴ In short, we compute differences of our multipliers in recessions *versus* expansions conditional on the same set of draws of the stochastic elements of our model as well as the same realisations of the co-efficients of the vector. The empirical density of the difference between our multipliers is based on 500 realisations of such differences for each horizon of interest.

the difference of our multipliers for a range of horizons of our impulse responses along with 90% confidence bands. Evidence in favour 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

3.3. The Stabilising Effects of Anticipated Fiscal Shocks

Our STVAR allows us 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, $F(z)$,

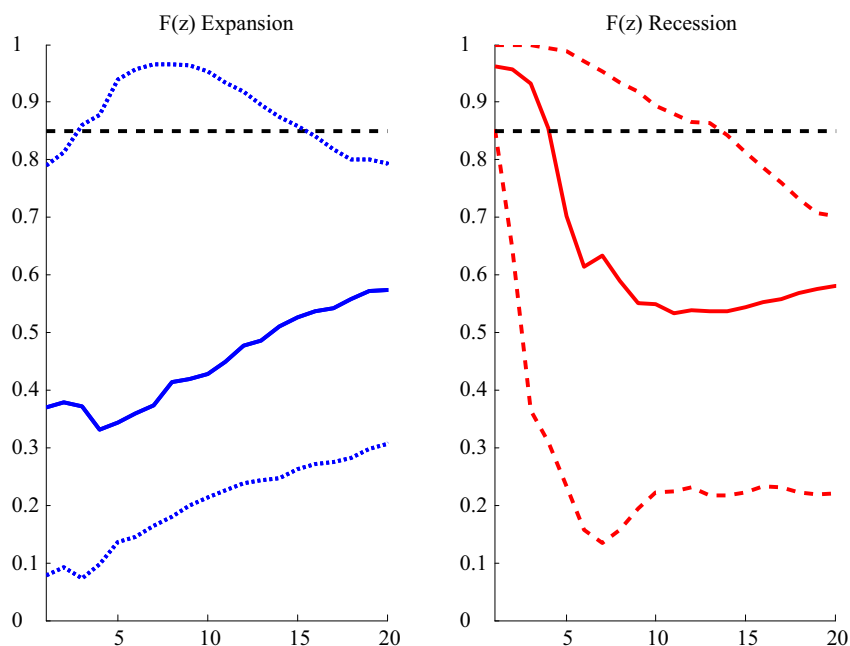


Fig. 6. *Evolution of the Probability of Being in a Recessionary Phase $F(z)$ Consistent with Our GIRFs*
 Notes. Solid lines: Median reactions. Dark gray dotted/light gray dashed lines: 90% confidence intervals. Black dashed horizontal line: threshold value to switch from a regime to another. Probability computed according to the logistic function presented in the text and the evolution of output conditional on a fiscal news shock. Transition variable: standardised backward-looking moving average constructed with four realisations of the quarter-on-quarter real GDP growth rate. Value of the slope parameter: 2.3.

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.

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 behaviour 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 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 $\bar{F} = 0.85$ just after five quarters, which is exactly the average duration of an 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 expansion is basically zero, though such a probability is quite imprecisely estimated.

4. Fiscal Multipliers in Presence of ‘Extreme’ Events

4.1. *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 favour of countercyclical spending multipliers. The next question we address is whether evidence of non-linearities might arise when recessions and expansions are ‘extreme’ events. We then re-compute the GIRFs by randomising over different subsets of histories associated to recessions and expansions. We label ‘deep’ recessions/‘strong’ expansions the histories associated with realisations of the transition variable which are below/above two standard deviations from the mean. Given that our transition variable is standardised, this amounts to saying that all historical realisations of z above two are associated with a strong expansion, while all realisations below minus two are associated with a deep recession. This criterion leads us to isolate four realisations in deep recessions corresponding to the recent great recession (2008Q4–2009Q3) and three realisations which belong to the ‘strong’ expansions category (1983Q4–1984Q2). In a complementary fashion, mild recessions/weak expansions are associated with the history consistent with realisations of the transition variable below/above the threshold value $\bar{z} = -0.75$ but within the range $[-2, 2]$. We then re-compute the GIRFs by randomising 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.

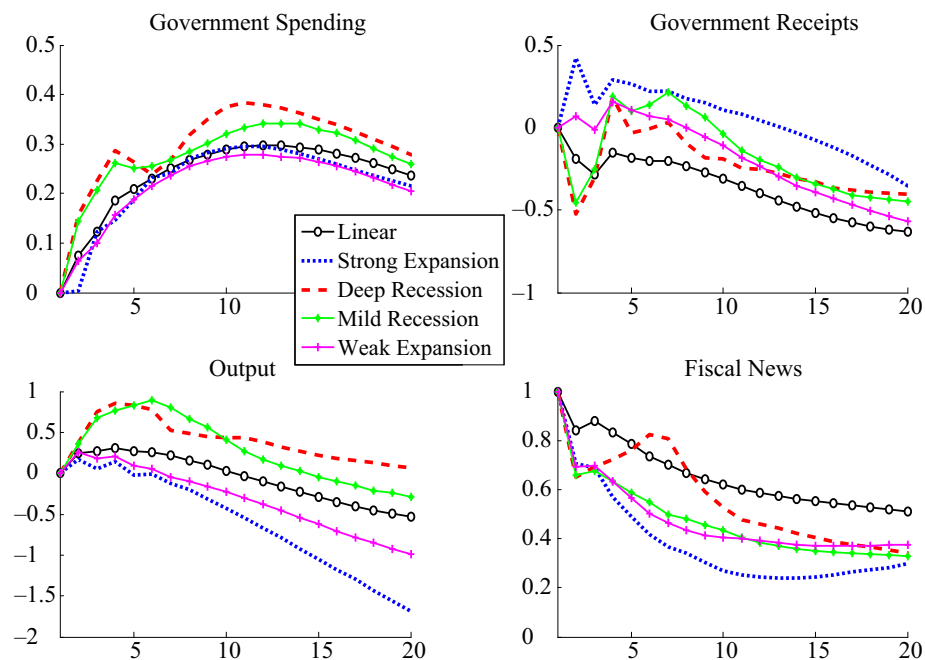


Fig. 7. *Generalised Impulse Responses to a Fiscal News (Anticipated) Spending Shock: Linear Model, Deep Versus Mild Recessions, Strong Versus Weak Expansions*

Notes. Deep recessions/strong expansions associated with histories consistent with realisations of our transition variable which are below/above two standard deviations. Mild recessions/weak expansions associated with histories consistent with realisations of our transition variable below/above -0.75 but within the range $[-2, 2]$. Median responses to a fiscal news shock normalised 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 percentage changes in dollars.

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 four-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 with deficit-financed increases in public spending, while expansions are associated with increases in fiscal spending which are

Table 4
Fiscal Spending Multipliers: Extreme Events

Horizon/state	Strong expansion	Deep recession	Weak expansion	Mild recession
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]

Notes. 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 percentage changes in dollars.

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 2007–9 recession, hence in a period classified as ('weak') expansion in our sample. As shown by Leeper *et al.* (2011), multipliers may be larger than one when an active fiscal policy is accompanied by a passive monetary policy.²⁷

When we turn to a 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 strong evidence in terms of non-linear 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 realisations of the business cycle is supported regardless of the horizon.

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 with expansions by the NBER in which the zero lower bound is in place is 15, that is, 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 liquidity trap caused by a self-fulfilling state of low confidence in a model with nominal rigidities and a Taylor-type interest rate rule, see Mertens and Ravn (2014).

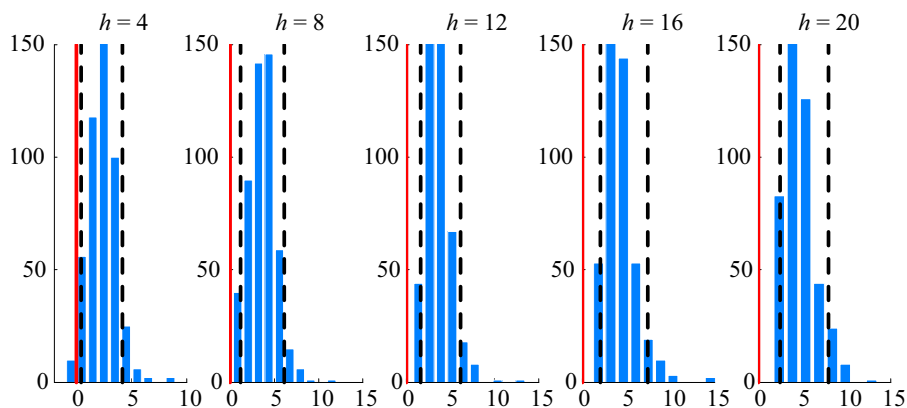


Fig. 8. *Difference in Multipliers between Recessions and Expansions: Extreme Events*

Notes. Empirical densities of the differences computed as multipliers in recessions minus multipliers in expansions. Densities constructed by considering just extreme realisations 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 realisations of the coefficients of the vector. Densities based on 500 realisations of such differences per each horizon of interest. ‘ h ’ identifies the number of quarters after the shock.

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 favour 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 *versus* all expansions) case, evidence in favour of

Table 5
Fiscal Spending Multipliers: Shares of Multipliers Larger in Recessions

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
$\tilde{\eta}_{13}^{\sigma}$ last	Normal	78.2	86.4	89.4	90.6	92.6
	Extreme	100	100	100	100	100
$\tilde{\eta}_{13}^{\sigma}$ 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

Notes. 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.

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 $F(z)$ 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 $F(z)$ 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 US economy from a deep recession to an expansionary path. The probability of moving away from a strong

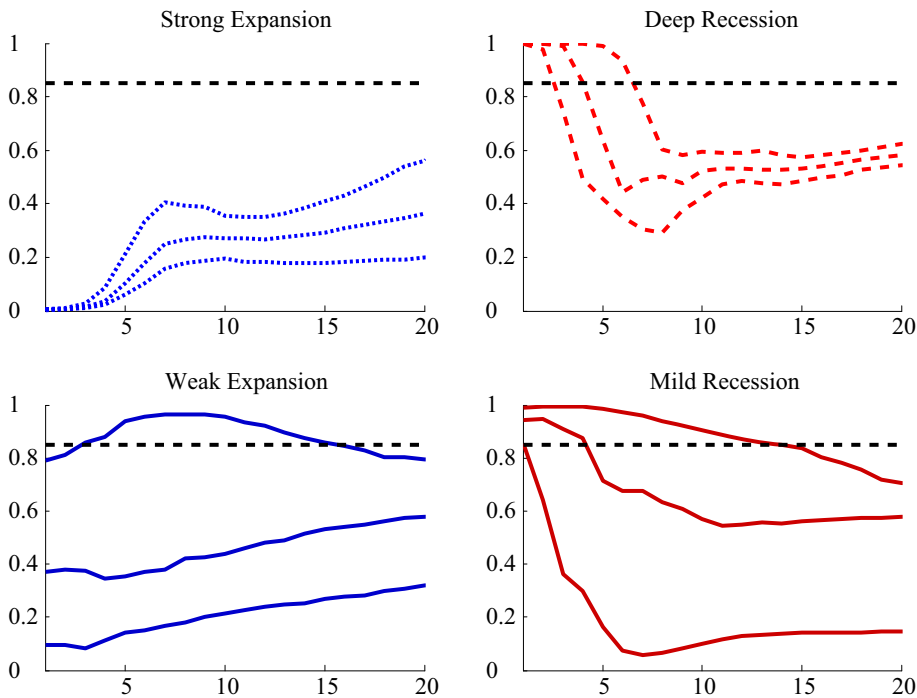


Fig. 9. Evolution of the Probability of Being in a Recessionary Phase $F(z)$ Consistent with Our GIRFs: Extreme Events

Notes. Median reactions and 90% confidence intervals. Black dashed horizontal line: threshold value to switch from a regime to another. Deep recessions/strong expansions associated with history consistent with realisations of our transition variable which are below/above 2 SDs. Mild recessions/weak expansions associated with history consistent with realisations 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: standardised backward-looking moving average constructed with four realisations of the quarter-on-quarter real GDP growth rate. Value of the slope parameter: 2.3.

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.

4.2. *Estimated Multipliers: Comparison with the Literature*

Our evidence points to larger multipliers in recessions (around 1.6 for the four-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, 2013*a*) deal with unexpected fiscal shocks in a non-linear 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 *et al.* (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 *et al.* (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 *et al.* (2011) rationalise 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 US military contractors, find a multiplier of 1.5. The same figure is found by Ricco (2014), who employs 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 US fiscal multipliers to range between 2 and 4.

Our findings qualify those by Auerbach and Gorodnichenko (2012, 2013*a*), 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.

Overall, our analysis based on ‘disaggregated’ recessions and expansions shows that non-linearities are likely to arise when we look within each of the two states typically investigated in a business cycle context, that is, recessions and expansions. In

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 Corsetti *et al.* (2012, p. 562).

particular, we find support in favour of a larger fiscal multiplier when deep recessions are considered.

5. Further Investigations

Our baseline analysis suggests that evidence in favour of countercyclical fiscal multipliers is borderline when we condition upon recessions *versus* 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; and
- (iv) several different VAR specifications.

5.1. Identification

5.1.1. 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 $g_t = \delta z_t + \xi_t$, where z_t is a vector of m indicators of the business cycle (say, output, unemployment, inflation, interest rates), δ is the vector of loadings relating z_t to g_t , and $\xi_t = \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + \dots + \phi_n \varepsilon_{t-n}$ is a moving average process modelling the unexpected fiscal shock ε_t as well as the expected ones $\varepsilon_{t-j}, j = 1, \dots, n$. Then, $\eta_{13}^g = \sum_{j=1}^3 (E_t g_{t+j} - E_{t-1} g_{t+j}) = \delta \sum_{j=1}^3 (E_t z_{t+j} - E_{t-1} z_{t+j}) + \tilde{\eta}_{13}^g$, where $\tilde{\eta}_{13}^g = \sum_{j=1}^3 \phi_j \varepsilon_{t-j}$. 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 three-month Treasury bill rate and the 10-year Treasury bond rate.²⁹ Figure 10 displays the raw and purged versions of the news variable, denoted by η_{13}^g and $\tilde{\eta}_{13}^g$ respectively. Two considerations are in order. First, the correlation between these two variables is quite high (0.95). Second, the most extreme realisations, documented in Figure 1 and reproduced here, are clearly captured by both variables. Hence, most of

²⁹ Forecasts of the debt-to-GDP ratio are not included in the SPF survey. We run further regressions by adding lagged realisations 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 realisations of the debt-to-GDP ratio on the right-hand side of the regression is due to the timing of the SPF. The questionnaire of the 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 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-centre/survey>.

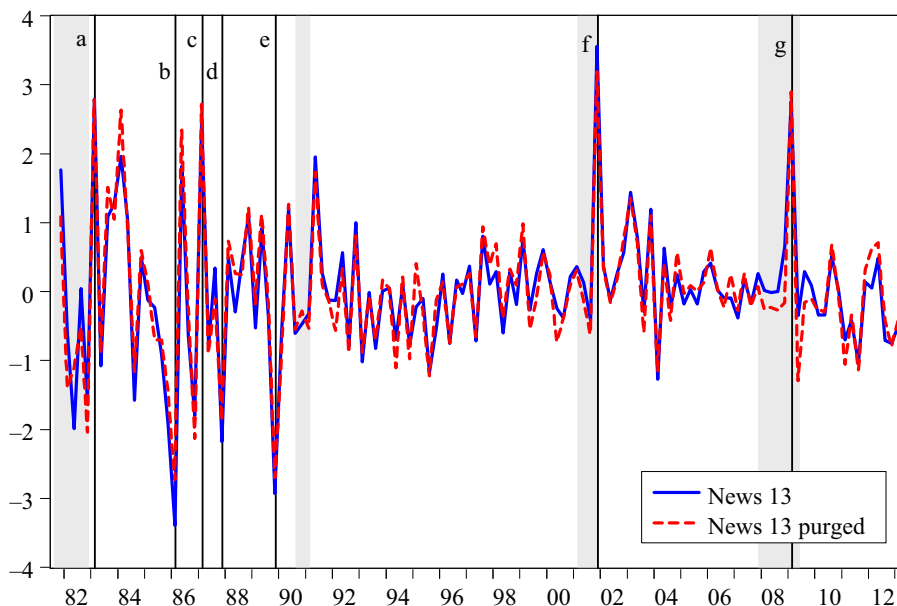


Fig. 10. *News13 Versus News13 Purged*

Notes. Dark grey 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. Light grey, dashed line, 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 standardised.

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 $\tilde{\eta}_{13}^g$ in our VAR, and re-run our estimations and simulations. Table 6 (' $\tilde{\eta}_{13}^g$ 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.

5.1.2. *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, that is, output

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

Table 6
Fiscal Spending Multipliers: Extreme Events. Different Scenarios

Scenario/state	Strong expansion	Deep recession	Weak expansion	Mild recession
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]
$\tilde{\eta}_{13}^g$ 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]
$\tilde{\eta}_{13}^g$ 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]

Notes. 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 percentage changes in dollars.

is not allowed to move immediately after the realisation of the news shock. We then perform a robustness check by focusing on the four-variate VAR $\mathbf{x}_t^{\eta^g} = (\tilde{\eta}_{13,t}^g, g_t, t_t, y_t)'$, 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 ($\tilde{\eta}_{13}^g$ 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.

5.2. Longer Sample

The non-linear 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, that is, 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, that is, 1947Q1–2013Q1. To do so, we use an updated version of Ramey's (2011*b*) 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 (2011*b*), 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

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).

importance of looking at extreme events to find non-linearities in the fiscal multipliers even in long samples.

5.3. *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 (Corsetti *et al.*, 2012; Ilzetzki *et al.*, 2013). Hence, it could in principle be possible that the non-linearities 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 modelling choice in the literature (see, among others, Leeper *et al.*, 2011, 2012, 2013; Corsetti *et al.*, 2012), 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’ *versus* ‘low’ realisations 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. Realisations of the debt/GDP ratio 1 SD above (below) the HP-trend are interpreted as phases of ‘high’ (‘low’) debt. Positive (negative) realisations 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 behaviour 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, that is, ‘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’ *versus* ‘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 US when adding debt. It is important to stress, however, that this conclusion is not inconsistent with cross-country studies which point to relevant non-linearities of fiscal policy effects due to different levels of debt, in particular for developing countries.

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.

5.4. *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 (2014*b*);
- (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); and
- (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 in online Appendix.

6. Conclusions

This article quantifies the fiscal spending multiplier in the US and tests the theoretical prediction of a larger reaction of output to fiscal shocks in economic downturns. Following Forni and Gambetti (2014*a*), 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 non-linear 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 *versus* expansions' classification of the phases of the US business cycle, our results do not support the idea of a countercyclical fiscal multiplier. In contrast, 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 article highlight the relevance of the different initial economic conditions within each of the two states typically considered for classifying the US business cycle. Fiscal multipliers may very well be larger when a fiscal shock occurs in presence of a deep recession like that of 2007–9 than when it occurs in presence of milder economic downturns. Our results imply that a correct measurement of the fiscal

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

multipliers can be performed just if flexible-enough econometric models are put at work.

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Additional Supporting Information may be found in the online version of this article:

Appendix A. Non-fundamentalness and the Role of Expectations Revisions.

Appendix B. Estimation of the Non-linear VARs.

Appendix C. Generalised Impulse Response Functions.

Appendix D. Further Robustness Checks.

Appendix E. Computation of the Factors for the FAVAR Approach.

Appendix F. Multipliers: ‘Sum’ *Versus* ‘Peak’ Measures.

Data S1.

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