Federal reserve forecasts as fiscal news in an identified vector autoregression

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ABSTRACT

This investigation seeks to understand how government spending affects macroeconomic aggregates when policy changes are anticipated. This question is important since many policy actions are debated in congress and discussed in popular news outlets before being enacted. If agents are rational, they will incorporate news about future spending changes before they are enacted. The main contribution of this paper is to bring a new data set to bear on established methodologies. We collected Federal Reserve forecasts for the period 1965 – 2005 from online archives of FOMC meetings. We incorporate the forecasts as a measure of anticipated military spending to identify government spending shocks in a VAR. Two primary results emerge. When we use the raw forecasts, we find that GDP, hours, wages, and consumption all rise following a shock to the news variable. Output multipliers, when measured as the peak response to the shock, range from .5 to slightly larger than unity. When we instead incorporate forecast errors in the VAR we find just the opposite: hours increase while wages and consumption fall after a government spending shock, as is typical with the narrative approach to identifying government spending shock. Thus, the way in which the forecast data is incorporated into the VAR becomes crucially important to the results.

Keywords: *Fiscal multipliers, Fiscal Policy, Government spending, VAR.*

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Highlights of this paper

- This investigation seeks to understand how government spending affects macroeconomic aggregates when policy changes are anticipated.
- We bring a novel data set to bear on established econometric methodologies.
- We find that the way in which the forecast data is incorporated into VAR analyses is crucially important to the results.

1. INTRODUCTION

The ebbs and flows of the macro economy ensure that a near constant stream of buzzwords enter our collective psyche as events unfold. Consider post-financial crisis environment circa 2012: "debt ceiling", "fiscal cliff", and "sequester", were ubiquitous as descriptions of policy maneuvers that aimed to encourage fiscally responsible legislation. The COVID-19 pandemic had its own expressions like "supply-chain disruptions" and "V-shaped recovery". Macroeconomic fluctuations like those witnessed in 2001, 2008-2009 and 2020 typically involve meaningful fiscal policy changes. How the proposed changes in government spending and taxation affect the macro economy is a question that involves a subtle complication. What if the arrival of the news of these policies is enough to instigate a change in behavior before any actual policy is enacted? Do rational agents respond in anticipation of policy change, or only after the legislation is put into force? Unfortunately, the literature is divided on this fundamental question. Further complicating matters, any changes to fiscal policy that emerge from a highly publicized debate are likely to be acted upon by agents before the true economic impact is felt. Legislative and implementation lags provide the necessary time for households to adjust their behavior to new policies before they take effect. Leeper and Yang (2008) and Leeper, Traum, and Walker (2011) show that ignoring such anticipation effects can be troublesome for researchers, leading to a non-fundamental moving average component in structural VAR's that misaligns the agents' and the econometrician's information sets.

There are three primary approaches in the literature used to identify government spending shocks. In a careful investigation, Blanchard and Perotti (2002) analyze institutional tax and spending data to find that output and taxes have no contemporaneous effect on government spending. Thus, spending shocks can be identified using a standard Choleski decomposition with government spending ordered first. Berndt, Lustig, and Yeltekin (2012); Fatas and Mihov (2001); Galí, López-Salido, and Vallés (2007); Mountford and Uhlig (2008) and Perotti (2008) have used this basic approach, generally finding that GDP, hours, wages, and consumption rise following a government spending shock[1]. While this approach has many merits, it does not systematically account for anticipation effects[2].

A second identification strategy, first implemented by Ramey and Shapiro (1997) aims to tackle the foresight issue by examining a few salient military buildups that were likely to be anticipated. The *narrative approach* relies on the fact that military spending is driven by events that are exogenous to the evolution of the domestic economy. This fact is exploited to identify government spending shocks in a vector autoregression (VAR) framework. Ramey (2011a) extends this approach by chronicling military spending in popular news sources to create an extensive *fiscal news* time series that dates to Ramey and Shapiro (1997) also uses Survey of Professional Forecasters (SPF) data in a similar manner to analyze more recent time periods. The narrative approach, also represented by Burnside, Eichenbaum, and Fisher (2004); Cavallo (2005), Edelberg, Eichenbaum, and Fisher (1999) and Eichenbaum and Fisher (2003) typically finds macro aggregates to behave much differently after a government spending shock.

[1] These results are generally taken as support for sticky wage and price models like New Keynesian DSGE models that incorporate monopolistically competitive markets.

[2] Blanchard and Perotti (2002) spent significant time addressing anticipation effects, but did not study the effect on consumption, one of the focal points of this paper.

Consumption and the real wage fall while hours and GDP rise, consistent with the negative wealth effect that characterizes the neoclassical framework typified by Baxter and King (1993). One concern that arises with the narrative approach is that the dates and news sources are chosen by the researcher and therefore subjective. The use of SPF data may mitigate this concern, but unfortunately the available defense spending forecast series is short. To create a longer time series, Ramey combines defense and federal spending forecasts and uses forecast errors[3] rather than the forecasts themselves.

A third approach attempts to address both the subjectivity and the anticipation issues related to the previous two methods. Fisher and Peters (2009) use excess stock returns for defense contractors to identify government spending shocks. The authors find that after a positive excess return innovation output, hours, and consumption are constant for several quarters before rising in a hump-shaped pattern. After an initial decline, wages rise persistently. Taken as a whole, the results are closer to those typical of the first approach.

The main contribution of this paper is two-fold. First, we bring a new data set to bear on the approach of Ramey. Second, we augment Ramey's approach by analyzing VAR's with stochastic as well as deterministic trends, and by examining the possibility that the VAR is misspecified by using a structural DSGE model built to analyze fiscal policy. To achieve the former, we retrieved documents from Federal Reserve archives and compiled defense spending forecasts for the period 1965 – 2005. Since defense spending is forecasted for a much longer time period than found in the SPF, there is no need to combine disparate time series and use forecast errors. We incorporate the forecasts as a measure of anticipated military spending to identify government spending shocks in a VAR. Two primary results emerge. When we use the raw forecasts, we find that GDP, hours, wages, and consumption all rise following a shock to the news variable – in similar fashion to the standard Choleski decomposition. Output multipliers, when measured as the peak response, range from .5 to slightly larger than unity. When we instead incorporate forecast errors in the VAR we find just the opposite: hours increase while wages and consumption fall after a government spending shock as is typical with the narrative approach. Thus, the way in which the forecast data is incorporated into the VAR becomes crucially important to the results.

2. THE VAR AND IDENTIFICATION

The basic econometric framework is owed to Blanchard and Perotti (2002).

$$Y_t = A(L)Y_{t-1} + U_t \quad (1)$$

Where Y_t consists of quarterly real per capita taxes, government spending, and GDP and $A(L)$ is the lag operator. Blanchard and Perotti spend a great deal of time exploring the identification of the model, using institutional information about taxes, spending, and transfer programs to construct parameters that quantify the contemporaneous relationships between taxes, spending, and GDP. After a thorough investigation, they find that government spending does not respond to GDP or taxes contemporaneously. This means that government spending shocks can be identified using a standard Choleski decomposition with government spending ordered first. The same identification scheme is used by several authors, including a 2007 investigation by Perotti that uses a seven-variable system. This paper follows Ramey and Shapiro (1997) and Ramey (2011b) by augmenting a similar VAR with the fiscal news variable ordered first, followed by government spending and a similar set of additional variables for purposes of comparison. In addition to the Federal Reserve forecasts, we will examine VAR's that contain the log of real capita quantities of total government spending, GDP, total hours worked, nondurable plus

[3] The forecast error is the difference between forecasted and actual defense spending growth.

services consumption[4], private fixed investment, the Barro (1974) tax rate, and the log of nominal compensation in private business divided by the deflator in private business[5]. We follow Ramey by using the total hours worked series based on unpublished BLS data, graciously provided on her website, based on the findings on Cavallo (2005) that suggest a significant portion of rises in government spending consists of increases in the government payroll. Ramey and Shapiro (1997) show that the product wage, rather than the consumption wage, is better suited for comparing model predictions from both an empirical and theoretical perspective. The rationale is based on the fact that defense spending tends to be concentrated in a few industries like manufactured goods. Ramey and Shaprio show that the relative price of manufactured goods rises significantly during a defense buildup, possibly leading to a situation where the consumption wage is unchanged or rising while the product wage is falling. For reasons to be discussed in section 3, we estimate two versions of the model. In both cases, four lags of the variables are included, where they differ is in the treatment of the time trend.

3. POST-WAR GOVERNMENT SPENDING

Government spending is commonly broken down into three components: federal defense, federal non-defense, and state and local. What constitutes each type of spending? Defense spending is mostly self-explanatory, but a 2025 Congressional Budget Office report breaking down federal discretionary spending for 2024 indicates nearly 39% of the defense budget went toward operations and maintenance followed by military personnel (20%), procurement (17.8%) and research, development, testing, and evaluation (16.2%). Federal non-defense spending had less disparity between the categories with the largest category being veterans' benefits (14% of discretionary non-defense spending), transportation (13.5%) and education, training, employment, and social services (12.6%), income security (10.7%), and health (10%)[6] over the same period.

Figure 1 illustrates the time series properties of each of these components in real, per-capita terms. Given these facts, what type of spending is best suited to identify the response of consumption to changes in government spending? What econometric challenges do these time series present? In response to the first question, most researchers have focused on defense spending since it is the component most likely to be exogenous with respect to most macroeconomic aggregates. It has been postulated that defense buildups are likely the result of various political and diplomatic exigencies outside the realm of domestic economic activity. Ramey (2011a) points to two specific problems with non-defense spending in the context of this investigation. First, a large portion of non-defense spending is allocated to education. Educational spending is driven in large part by demographic changes (which also have a large impact on the economy) and creates human capital. Second, the efficient provision of public goods may have a positive wealth effect, blurring the distinction between New Keynesian and Classical model predictions.

[4] Chained non-durable and services consumption are aggregated using Whelan (2000) method.

[5] (Ramey, 2011a) results are robust to using Alexander and Seater (2009) update of the Seater (1982) and Stephenson (1998) average marginal tax rate. The Barro (1974) tax rate includes state income taxes whereas the Alexander-Seater series only has federal income and social security taxes.

[6] Other significant categories are administration of justice and international affairs.

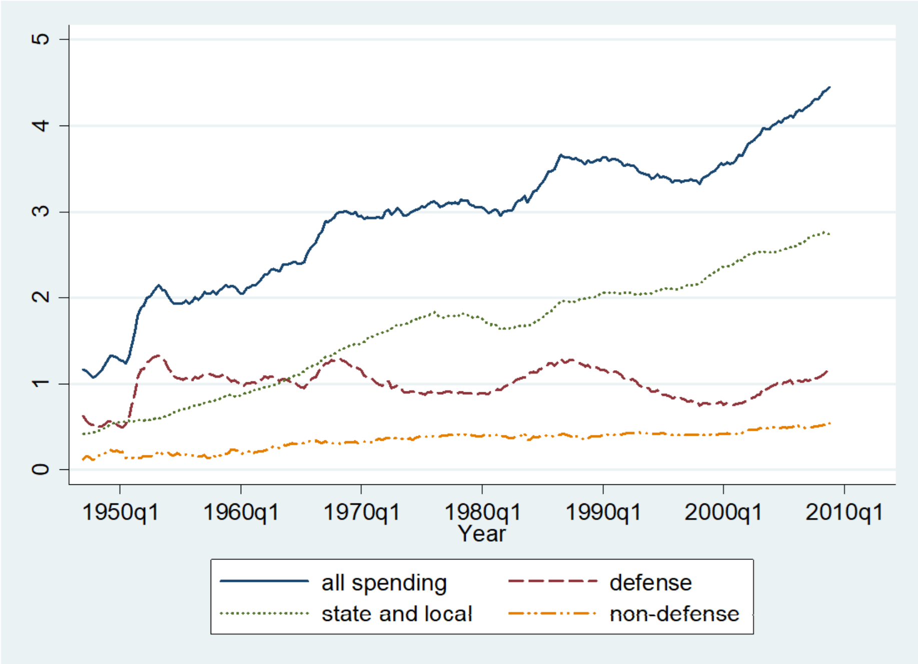


Figure 1. Real per capita components of government spending (1947–2008).

Stationarity and cointegration are two economic issues that merit consideration. Previous authors find no compelling evidence in either direction on the issue of stationarity. In light of this finding, we will follow the two-pronged approach of Blanchard and Perotti (2002) by estimating two forms of the VAR. The first will follow the specification used by Ramey (2011a) and include all variables in levels allowing for a deterministic, quadratic time trend[7]. The second form will allow for a stochastic trend. Blanchard and Perotti (2002) performed a battery of cointegration tests and found little impact on results. Given these findings, we leave the exploration of cointegrating relationships to future work.

4. FEDERAL RESERVE FORECASTS

The Federal Reserve makes Federal Open Market Committee (FOMC) meeting materials available to the public with a five-year lag. The Fed's website contains meeting minutes and policy documents dating back to 1936. Beginning with the June 17 meeting in 1964, the Fed also began archiving the "Green Book" in pdf format, a report prepared by the staff of the Board of Governors of the Federal Reserve System. The Green Book summarizes current economic and financial conditions for meeting participants and is still published to this day. Starting with the FOMC meeting in the second quarter of 1965, the Green Book contains quarterly forecasts of various macro aggregates in nominal terms, including government spending and its components. From the archived Green Books, we were able to construct a consistent, one quarter-ahead forecast for defense spending from 1965:2 to 2005:2. A four quarter-ahead forecast is available beginning in 1974:2. To our knowledge, this is the longest available time series for quarterly forecasts of defense spending. This allows us to incorporate the forecasts themselves in the VAR rather than using forecast errors[8] , which has a material effect on the impulse responses. One notable omission from

[7] The quadratic form is used to match the demographic –induced U-shape observed in the hours worked time series.

[8] Ramey used Survey of Professional Forecasters forecast errors as a measure of fiscal news. The forecast error is calculated as the difference between predicted spending growth in period *t* using *t-1* information and actual spending growth in period *t*. Ramey uses the forecast errors rather than the forecasts themselves to be able to combine samples that use defense spending forecasts and federal spending forecasts.

this sample period is the Korean War buildup, the largest instances of post-WWII military spending. At first blush this would seem problematic, however, some authors have argued though that this period should be omitted from the analysis anyway since it is an outlier in the post 1947 period.

The Fed forecasts will be used in a VAR framework as a new measure of "fiscal news" to explore the timing of government spending shocks and test the Ramey hypothesis. Are the Fed forecasts an appropriate instrument for such an investigation? Formal statistical tests indicate that the forecasts are a valid instrument, though not as powerful as the Survey of Professional Forecasters presented by Ramey and Shapiro (1997). Table 1 presents several regression-based tests for both the full sample period and a subsample starting in 1985 where there appears to be a shift in volatility. While the forecasts appear to be useful instruments, this investigation is most concerned with the timing of information flows. Specifically, are unexplained innovations in the VAR framework predicted by the Federal Reserve forecasters? We answer this question by once again following the procedure used by Ramey (2011a). We first compute the series of VAR shocks by estimating the baseline VAR specification given in section 2 and collecting the residuals. We then perform Granger causality tests to explore the timing with the p-values reported in Table 2. The results are clear: both federal and defense spending forecasts Granger cause the VAR shocks, but the opposite is not true. In other words, we find corroborating evidence for Ramey's premise: variations that appear to be random shocks from the econometrician's perspective can be forecasted.

Table 1. Explanatory power of fed forecasts.

Forecast	Full Sample*			1985-2006		
	R-squared	F-Statistic	Marginal F-Statistic	R-squared	F-Statistic	Marginal F-Statistic
1 Period-ahead, All federal spending	0.114	20.18	14.7	0.1783	17.58	14.15
2 period-ahead, All federal spending	0.06	9.28	7.87	0.0318	2.7	1.27
1 period-ahead defense spending	0.16	29.9	16.68	20.66	21.09	18.04
2 period-ahead, defense spending	0.114	18.15	12.11	0.1272	11.95	7.62

Note: * for 1 period ahead forecasts full sample period is 1965 Q3 - 2005 Q2. For 2 period-ahead forecasts the full sample period is 1969 Q4 - 2005 Q2

Table 2. Granger causality test.

Hypothesis tests		p-value
Do 1 period-ahead Fed forecasts of federal spending Granger-cause VAR shocks?	Yes	0.0475
Do 1 period-ahead Fed forecasts of defense spending Granger-cause VAR shocks?	Yes	0.049
Do VAR shocks Granger-cause 1 period-ahead Fed forecasts of federal spending?	No	0.657
Do VAR shocks Granger-cause 1 period-ahead Fed forecasts of defense spending?	No	0.213

5. VECTOR AUTOREGRESSION RESULTS

5.1. Baseline VAR

To provide a basis for comparison, Figure 2 illustrates the dynamic response of several macro variables to a government spending shock, identified using the standard Choleski decomposition with government spending ordered first. The VAR, consisting of government spending, GDP, total hours worked, nondurable plus services consumption, private fixed investment, the Barro and Redlick (2011) tax rate, and the manufacturing product wage, is typical of the government spending studies in the literature. All variables are in levels, and each equation contains a quadratic time trend. The figure traces the mean response and the 95% confidence bands[9] for a period of twenty

[9] It is common to report 68% confidence bands in the fiscal policy literature, though there is no theoretical justification for this choice. Instead, we show the 95% bands common in the monetary policy literature.

quarters. Throughout this section shocks are normalized so that the log change of government spending after a shock to the news variable is unity at its peak.

Qualitatively, the responses are typical for the literature. The positive government spending shock causes GDP to rise initially and stay positive for several quarters. The mean response of consumption of nondurables and services is also positive for roughly twelve quarters before turning negative. Total hours and the real wage also tend to rise while investment falls as government spending crowds out some private activity. Fiscal multipliers are summarized in Table 3.

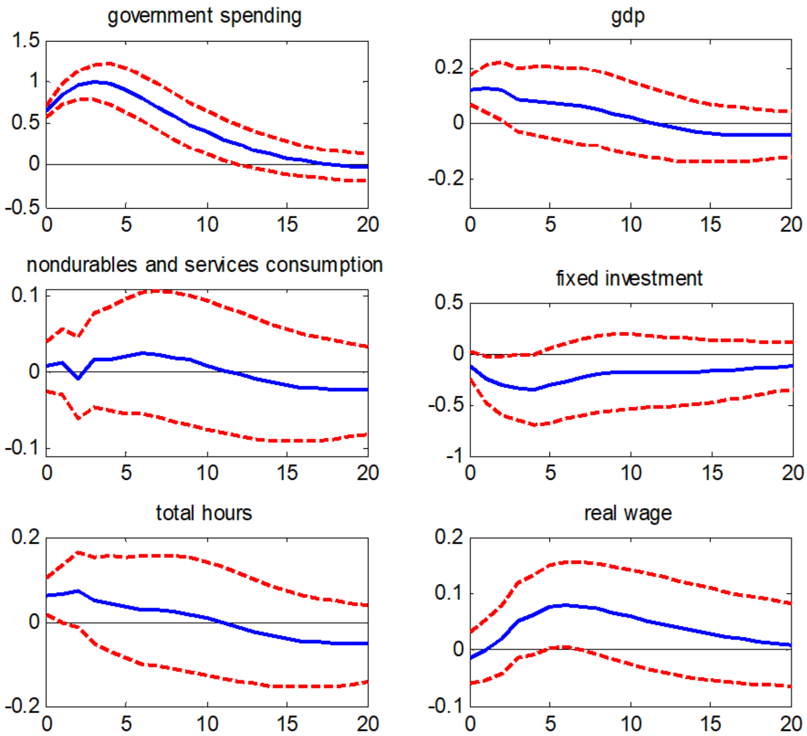


Figure 2. Baseline VAR.

Table 3. Standard dynamic response to a govt. spending shock.

	1 qrt	4 qtrs	8 qtrs	12 qtrs	20 qtrs	peak	cumulative irf
Deterministic trend							
GDP	0.126	0.080	0.052	-0.008	-0.037	0.126	0.567
Consumption*	0.013	0.017	0.020	-0.003	-0.024	0.025	0.010
Fixed investment	-0.249	-0.346	-0.192	-0.177	-0.114	-0.346	-4.255

Note: * Nondurables and services consumption.

5.2. The Fiscal News VAR

One of the primary questions this paper seeks to answer is how do these responses change when anticipation effects are accounted for? To answer this question, we now examine several model specifications involving Federal Reserve forecasts as a measure of fiscal news. We follow Ramey by using the approach of Burnside et al. (2004) which utilizes a set of fixed variables while rotating in other variables of interest one at a time. While this method requires re-estimating the VAR multiple times, it allows us to examine the effect on several variables while maintaining a relatively parsimonious specification. The fixed set of variables includes the Federal Reserve forecasts, the log of real per capita government spending and the log of real per-capita GDP. To control for monetary and tax policy, the three-month T-bill rate and the Barro-Redlick average marginal income tax rate are also included in the fixed set. The extra variables considered are total hours, the manufacturing product wage, the real BAA bond rate (with inflation defined by the CPI), along with the components of consumption and investment spending. This exercise is completed twice, once utilizing a deterministic time trend (DT) and second time a stochastic trend (ST) as described in section II. Finally, we examine the effect of using forecast errors rather than the forecasts themselves as a measure of fiscal news. A summary of the multipliers can be found in tables 5 and 6.

5.3. Deterministic Trend Results

Figure 3 illustrates the response to a shock to the news variable assuming a deterministic trend. As before, the responses are normalized so that the response of government spending peaks at unity. The response of government spending peaks later and is significantly more persistent than the baseline, remaining positive for more than five years. GDP rises upon impact, peaking after five quarters at a value of .5 before turning negative after eleven quarters. The stimulus is more than twice as large as the baseline estimate and significantly larger than that reported by Ramey who found the news shock to be contractionary when using the SPF forecasts as a measure of fiscal news[10]. The cumulative impulse response after five years is 2.46. Interestingly, the response of consumption is largely positive, in stark contrast to the Ramey hypothesis. The response of non-durables and services consumption is positive and persistent, peaking after five quarters at .30. Durables consumption also rises upon impact before turning negative after four quarters. Hours and the real wage increase in a qualitatively similar fashion to the baseline estimate, while investment first rises before falling and remains negative for several quarters. Taken as a whole, the evidence supports much of the existing identified VAR literature that predicts a rise in GDP, hours, the real wage, and consumption after a government spending shock.

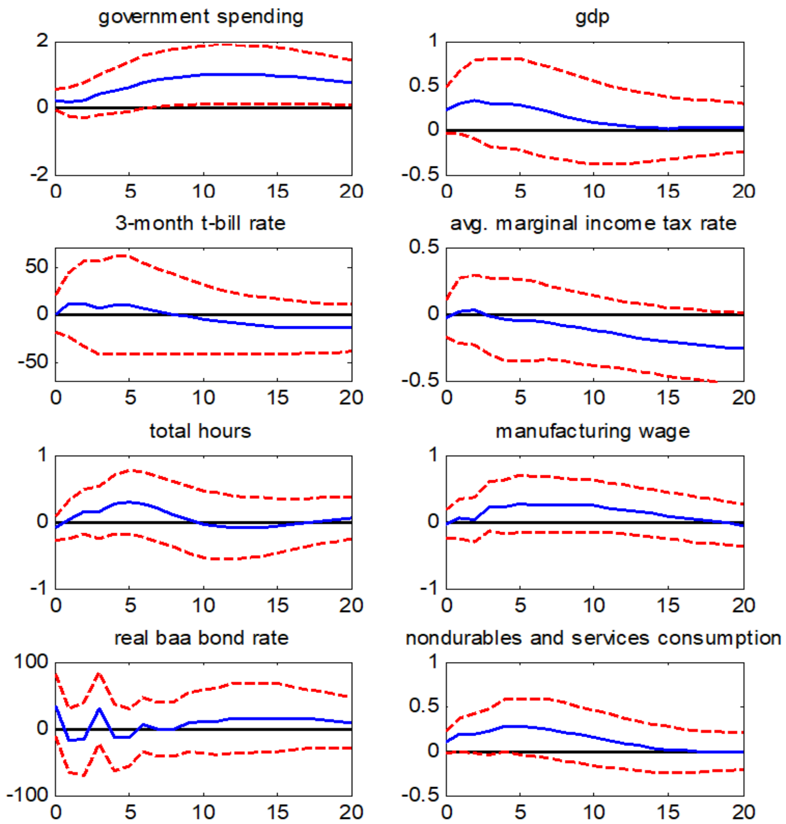
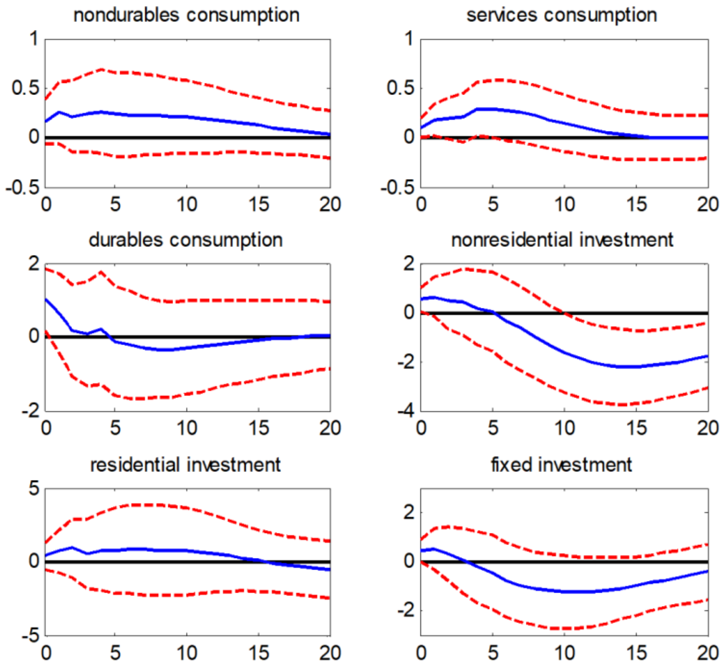


Figure 3. Impulse to expected defense spending.

[10] Ramey reported a peak GDP response of .23 when using a narrative approach.



Continue Figure 3. Impulse to expected defense spending.

5.4. Stochastic Trend Results

Figure 4 depicts the impulse responses when the deterministic trend is replaced with a stochastic trend. Except for the manufacturing wage, the effects are qualitatively similar. GDP, hours, and consumption all tend to rise after the shock while the wage is depressed initially before increasing. GDP peaks soon after the shock at 1.05 and quickly returns to zero. The cumulative response is slightly smaller than the deterministic trend at 2.07. The response of consumption to a change in expected defense spending is again positive, with all components rising for roughly five quarters after impact. The real wage in contrast displays a net negative response after the first year with a slight rise thereafter. All components of investment display the same pattern of rising before falling, although the cumulative effect is less negative in the long run.

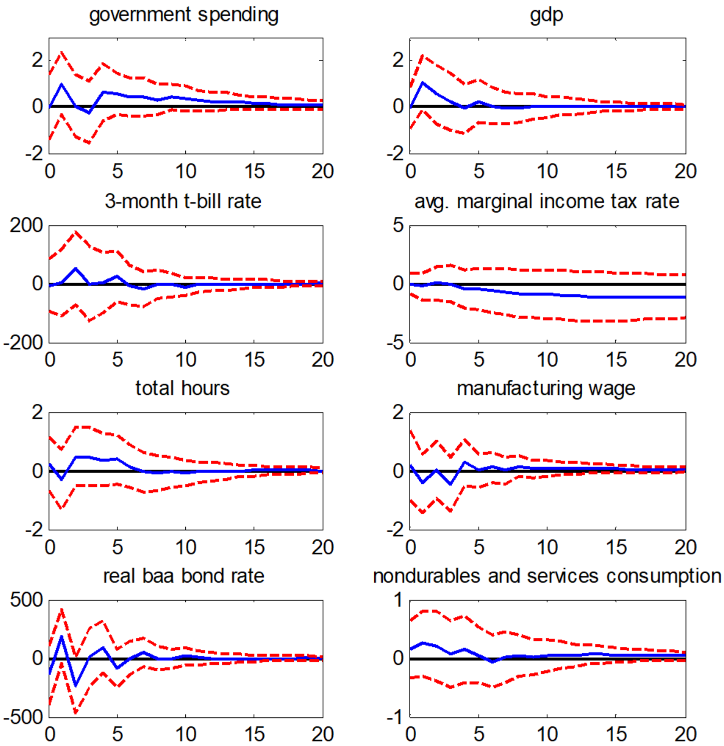
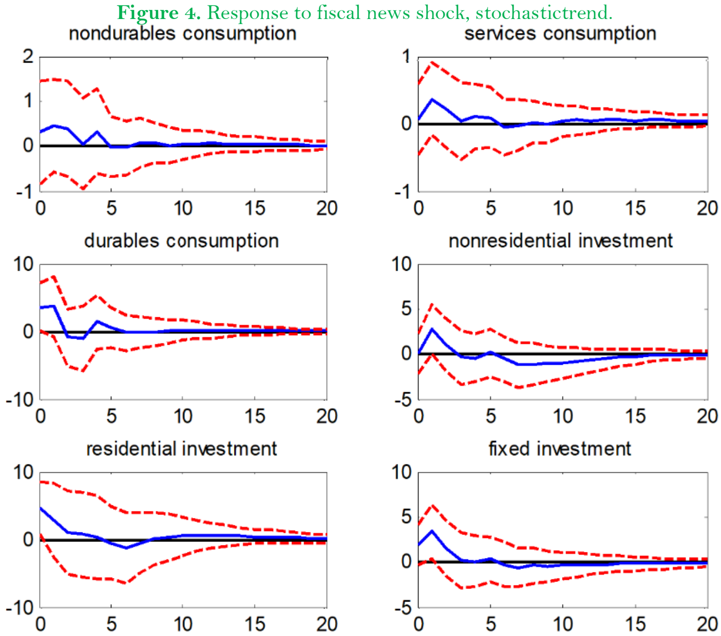


Figure 4. Response to fiscal news shock, stochastictrend.



Continue Figure 4. Response to fiscal news shock, stochastictrend.

5.5. Forecast Error Results

We now turn to the question of how the forecast data should be incorporated in the VAR. Does the use of forecast errors in place of the raw forecasts change the results? To answer this question, we incorporate the Federal Reserve forecast error defined as the difference between forecasted defense spending growth from period *t-1* to *t* made with period *t-1* information, and actual growth from period *t-1* to *t*. The impulse responses following a shock to the forecast errors, shown in Figure 5 tell a dramatically different story. A fiscal news shock is now highly contractionary with output peaking at -.17 and remaining below zero for several years after impact. Nondurables and services consumption also decrease after the shock, peaking at -.26 and -.38 respectively. Only durables consumption shows any tendency to increase after the shock, though this component still decreases upon impact before recovering for several quarters and then eventually decreasing again. The path of real wages is also changed, now showing a substantial drop in response to the shock. Residential investment declines for four years while nonresidential declines for five quarters before eventually rising. Complete multiplier results are presented in Tables 4 and 5.

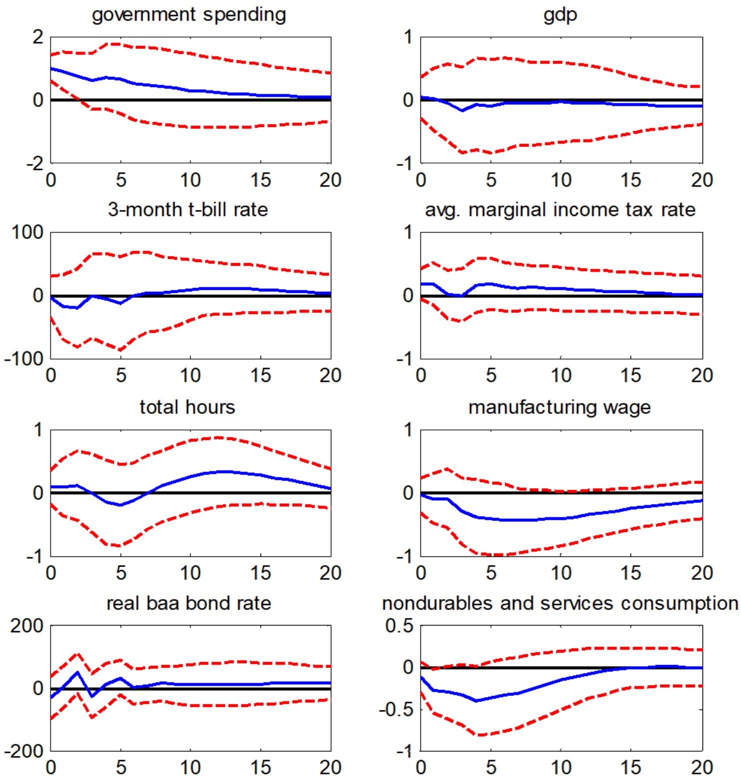
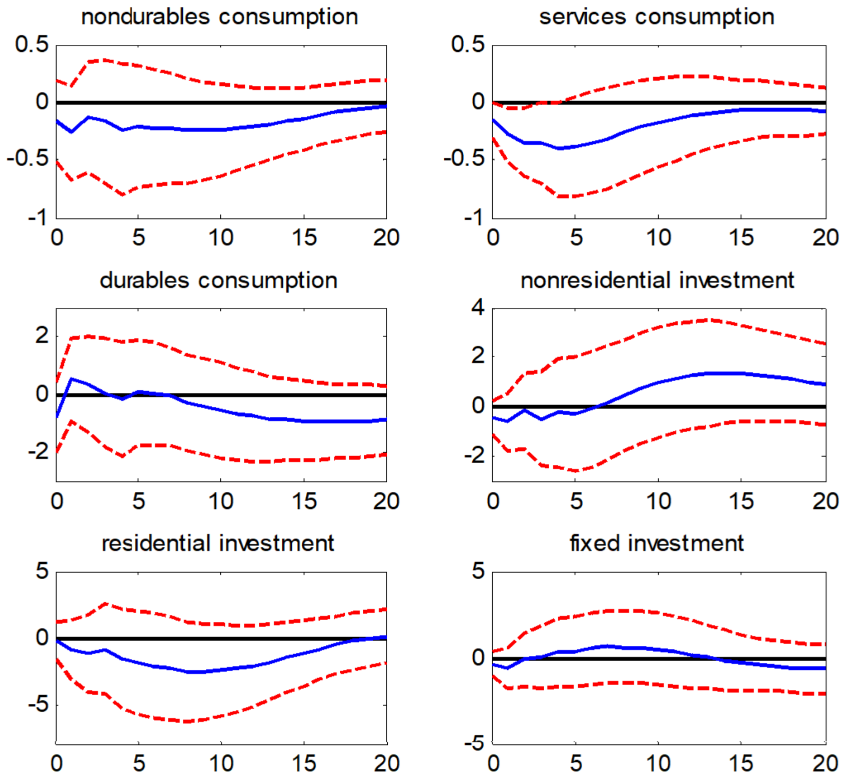


Figure 5. Impulse to expected defense spending using forecast error.



Continue Figure 5. Impulse to expected defense spending using forecast error.

Table 4. Dynamic response to a fiscal news shock, using actual forecasts for period t+1.

	1 qrt	4 qtrs	8 qtrs	12 qtrs	20 qtrs	Peak	Cumulative irf
				Deterministic trend			
GDP	0.313	0.496	0.079	-0.064	0.043	0.496	2.459
Consumption*	0.157	0.303	0.221	0.093	0.008	0.303	2.790
Fixed investment	0.782	0.367	-0.518	-0.896	-0.544	-0.910	-7.209
				Stochastic trend			
GDP	1.049	-0.071	-0.049	0.016	0.008	1.055	2.068
Consumption*	0.256	0.142	0.032	0.045	0.031	0.256	1.346
Fixed investment	3.392	0.043	-0.392	-0.247	-0.118	3.392	3.326

Note: * Nondurables and services consumption

Table 5. Dynamic response to a fisca; news shock, using forecast errors.

	1 qrt	4 qtrs	8 qtrs	12 qtrs	20 qtrs	peak	cumulative irf
				Deterministic trend			
GDP	0.005	-0.073	-0.064	-0.059	-0.098	-0.172	-1.470
Consumption*	-0.283	-0.399	-0.253	-0.078	-0.010	-0.399	-3.347
Fixed investment	-0.535	0.330	0.612	0.188	-0.635	0.612	0.327
				Stochastic trend			
GDP	0.008	0.038	0.040	0.003	0.000	0.121	0.100
Consumption*	-0.011	0.028	0.022	-0.003	0.000	-0.034	0.086
Fixed investment	-0.410	-0.602	-0.080	-0.034	0.010	-0.602	-1.056

Note: * Nondurables and services consumption.

6. DSGE MODEL SIMULATION RESULTS

What if the Granger Causality results of section 4 are the result of misspecification of the time series representation of the data or the omission of important variables from the VAR? Another approach to testing the validity of the Fed forecasts as measure of fiscal news is to analyze a structural model of the economy. In theory, the structural model does not suffer from the same frailties as a reduced-form statistical model and is therefore an appealing source of corroborating evidence. Specifically, do the Federal Reserve forecasts Granger cause the DSGE model residuals for the consumption and hours worked variables? If so, then this lends further credence to the hypothesis that changes in government spending are anticipated by agents and should therefore be modeled formally in a structural setting. If not, then this would cast doubt on the ability of the identified VAR to fully capture the macroeconomic dynamics of anticipated fiscal policy.

6.1. Model Overview

This section provides a brief overview of the structural model employed here. The model is the best-fitting specification of Matecki Edmund "Essays in Fiscal Policy" (2014) and follows closely the neoclassical growth model presented in Leeper, Plante, and Traum (2010) differing primarily by allowing for consumer heterogeneity in the form of two types of representative household. The first household type displays optimizing behavior by maximizing an intertemporal utility function (*Ricardian* households). The second type of representative agent exhibits rule-of-thumb, or *non-Ricardian* behavior. The model also contains a representative firm and the government, featuring a rich specification of fiscal policy rules. The model economy is buffeted by nine temporary innovations: shocks to government spending, capital, labor, and consumption taxes, transfer payments, technology, investment adjustment costs, and preferences. For further details, please see (Matecki Edmund "Essays in Fiscal Policy", 2014).

6.2. Ricardian Households

A fraction of the population $\gamma \in [0,1]$ is non-Ricardian. The remaining $(1-\gamma)$ of households are Ricardian and maximizes expected utility. Preferences common to *all* households are described by the following separable utility function.

$$max\, E_0 \sum_{t=0}^{\infty} \beta^t u_t^b \left[(1-\omega)^{-1}(c_t^J - hC_{t-1})^{1-\omega} - u_t^l (1+\kappa)^{-1} (l_t^J)^{1+\kappa}\right] \quad (2)$$

For $J \in \{r, nr\}$. Utility is derived from consumption, c_t^J, relative to a habit stock defined as a fraction $h \in [0,1]$ of the previous period's aggregate consumption, C_{t-1}. Hours worked, l_t^J, yield disutility. The utility function contains two preference shocks, one general (u_t^b) and one specific to labor supply (u_t^l). The parameters $\omega, \kappa \geq 0$ represent the coefficient of risk aversion and the inverse of the Frisch labor supply elasticity respectively, and $\beta \in [0,1]$ is the discount factor. The shocks $u_t^b$and u_t^l evolve according to the AR(1).

Maximization for Ricardian agents is subject to a flow budget constraint.

$$(1+\tau_t^c)c_t^r + i_t^r + b_t^r = (1-\tau_t^l)w_t^r l_t^r + (1-\tau_t^k)R_t^k v_t K_{t-1}^r + R_{t-1} b_{t-1}^r + z_t^r \quad (3)$$

Ricardians have at their disposal after-tax labor and capital income, interest on government bonds held the previous period, and lump-sum transfer payments from the government, z_t^r. Income is consumed, invested in physical capital, or used to purchase government debt. Capital income is computed as the rental rate of capital,R_t^k, multiplied by the effective quantity of capital employed by Ricardian households in period *t*, $v_t K_{t-1}^r$. The variable v_t is a household control variable that measures the utilization rate of the capital stock. R_{t-1} is the return on one-year government debt owned by Ricardian households, b_t^r. The tax rates on consumption, labor income, and capital income are given byτ_t^c,τ_t^l, and τ_t^krespectively. It should be emphasized that only Ricardian households save and invest in physical capital and consider an intertemporal resource allocation decision.

6.3. Non-Ricardian Households

A fraction $\gamma \in [0,1]$ of households lack access to financial and capital markets and must consume all current disposable income. Income is derived from working (taxed at rate τ_t^l) and lump-sum transfers from the government, z_t^{nr}. Consumption expenditures are subject to taxation at rate τ_t^c. The non-Ricardian budget constraint is therefore given as:

$$(1+\tau_t^c)c_t^{nr} = (1-\tau^l)w_t^{nr} l_t^{nr} + z_t^{nr} \quad (4)$$

We allow for different levels of consumption and labor supply for Ricardians and non-Ricardians. The formulation is similar that of Galí et al. (2007) where non-Ricardians cannot optimize intertemporally, but can still adjust hours to solve a static optimization problem taking their budget constraint as given. Temporarily ignoring taxes, the problem becomes.

$$\max\ U(c^{nr}, 1-l^{nr}) \quad (5)$$

$$s.t.\ c^{nr} = wl^{nr} + z^{nr} \quad (6)$$

The intratemporal Euler equation for non-Ricardians then takes the form.

$$U_c/U_l = \frac{1}{w} \quad (7)$$

In equilibrium, the optimality condition for non-Ricardians is identical to that of Ricardians except for the levels of consumption and labor supply. Thus, the only way labor supply will be equalized across households is if the equilibrium level of consumption is also the same for both Ricardians and non-Ricardians.

6.4. Government Sector

As the focus of this paper is fiscal policy, several salient features of the model are found in the government sector formulation, taken from LPT. The government faces a flow budget constraint.

$$B_t + \tau_t^k R_t^k v_t K_{t-1} + \tau_t^l w_t L_t + \tau_t^c C_t = R_{t-1} B_{t-1} + G_t + Z_t \quad (8)$$

Where and $Z_t$are government spending and transfer payments respectively. In addition to issuing debt, the government sources funds by levying capital, labor, and consumption taxes. Funds are used to service debt, purchase final goods and services, and redistribute wealth via lump-sum transfer payments.

Fiscal instruments behave according to a rich specification that allows for a response to the state of the economy. The fiscal rules capture two important policy considerations: business cycle stabilization and debt stabilization. First, contemporaneous co-movement with output allows fiscal instruments to behave as automatic stabilizers, acting to bring the economy closer to potential GDP. Second, fiscal instruments are allowed to respond to the level of the federal debt. Higher government debt in period *t* will trigger fiscal responses in period *t+1* that tend to bring debt back to its steady state level. Linearized, in terms of log-deviations from the steady state, the policy rules are:

$$\hat{G}_t = -\varphi_g \hat{Y}_t - \gamma_g \hat{B}_{t-1} + \hat{u}_t^g \quad (9)$$

$$\hat{u}_t^g = \rho_g \hat{u}_{t-1}^g + \sigma_g \varepsilon_t^g, \qquad \varepsilon_t^g \sim N(0,1) \quad (10)$$

$$\hat{\tau}_t^k = \varphi_{tk} \hat{Y}_t + \gamma_{tk} \hat{B}_{t-1} + \phi_{kl} \hat{u}_t^{tl} + \phi_{kc} \hat{u}_t^{tc} + \hat{u}_t^{tk} \quad (11)$$

$$\hat{u}_t^{tk} = \rho_g \hat{u}_{t-1}^{tk} + \sigma_k \varepsilon_t^{tk}, \qquad \varepsilon_t^{tk} \sim N(0,1) \quad (12)$$

$$\hat{\tau}_t^l = \varphi_{tl} \hat{Y}_t + \gamma_{tl} \hat{B}_{t-1} + \phi_{kl} \hat{u}_t^{tk} + \phi_{lc} \hat{u}_t^{tc} + \hat{u}_t^{tl} \quad (13)$$

$$\hat{u}_t^{tl} = \rho_l \hat{u}_{t-1}^{tl} + \sigma_{tl} \varepsilon_t^{tl}, \qquad \varepsilon_t^{tl} \sim N(0,1) \quad (14)$$

$$\hat{\tau}_t^c = \phi_{kc} \hat{u}_t^{tk} + \phi_{lc} \hat{u}_t^{tl} + \hat{u}_t^{tc} \quad (15)$$

$$\hat{u}_t^{tc} = \rho_{tc} \hat{u}_{t-1}^{tc} + \sigma_{tc} \varepsilon_t^{tc}, \qquad \varepsilon_t^{tc} \sim N(0,1) \quad (16)$$

$$\hat{Z}_t = -\varphi_z \hat{Y}_t - \gamma_z \hat{B}_{t-1} + \hat{u}_t^z \quad (17)$$

$$\hat{u}_t^z = \rho_z \hat{u}_{t-1}^z + \sigma_z \varepsilon_t^z, \qquad \varepsilon_t^z \sim N(0,1) \quad (18)$$

Where $\varphi_i \geq 0 \; for \; i = (g, k, tl)$ captures the fiscal response to deviations in output from potential GDP and $\gamma_i \geq 0 \; for \; i = (g, k, tl, z)$ models the response to government debt. The consumption tax rate, largely capturing movement in excise taxes on gasoline, tobacco, and the like, is assumed to be an exogenous process. Since excise taxes are used mainly for special funds, it is reasonable to believe they do not respond to changes in economic conditions.

Additionally, each fiscal instrument is subject to persistent, random shocks, represented in the model by the $u_t's$. The coefficients on the lagged shocks ($\rho_i \in [0,1] \; for \; i = (g, tk, tl, tc, z)$) measure the degree of persistence of an exogenous change in policy. Furthermore, exogenous changes in one tax instrument are allowed to affect the remaining tax instruments. This response is quantified by the parameter $\phi_i \; for \; i = (kl, kc, tc)$.

Aggregate quantities of household variables are weighted averages of Ricardian and non-Ricardian components.

$$C_t = (1-\gamma) C_t^r + \gamma C_t^{nr} \quad (19)$$

$$L_t = (1-\gamma) L_t^r + \gamma L_t^{nr} \quad (20)$$

6.5. Methodology and Results

The parameters of the structural model are estimated using Bayesian techniques. Prior distributions are similar to those widely used in the literature. We use quarterly data for nine time series: consumption, investment, hours worked, government debt, government spending, capital tax revenues, labor tax revenues, consumption tax revenues, and government transfers. The data are converted to real terms by dividing by the GDP deflator for personal consumption expenditures. To make the data stationary, we linearly detrend the natural logarithm of each time series independently. After estimating the parameters of the model, the one period-ahead DSGE model forecast errors are computed using the Kalman filter and the time series data. We then test the forecast errors generated by the DSGE model for Granger causality with the Federal Reserve forecasts. Answering the question, do the Federal Reserve forecasts of government spending Granger cause the DSGE model residuals for consumption and hours worked?

We employ two approaches to compute the DSGE forecast errors. In the first, we use the entire data set available to produce a single estimate for the structural parameters, calculated as the mean of the posterior distribution. The posterior distribution is simulated using a random walk Metropolis-Hastings algorithm. However, this approach may bias model predictions by incorporating into the model parameters ex post information about future fiscal policies that were not available to forecasters in real time. To mitigate this concern, we create a series of one step-ahead DSGE forecasts by re-estimating the parameter vector each quarter using only the data available up until that time period. The downside of this approach is that it is very costly from a computational standpoint. To ease this burden, we use the posterior mode as the estimate of the parameter vector rather than simulating the posterior each quarter and calculating the mean. This is similar to the "plug-in" approach described by Del Negro and Schorfheide (2012).

Complete Granger causality tests were performed using one period-ahead Federal Reserve forecasts of defense spending and Ramey's time series of one period-ahead government spending forecast errors computed from the Survey of Professional Forecasters. We test for causality in both directions between the measures of fiscal news and the DSGE model residuals for consumption and hours worked. We perform this battery of tests for both parameter estimation methods described above. In all cases four lags of each dependent variable are incorporated into the regressions. Full results are presented in Table 6. The results are consistent across the numerous tests, regardless of which variable is used as a measure of fiscal news. There is no statistical evidence that forecasted changes in government spending improve the DSGE model forecasts of consumption and hours worked. The results are also consistent across both parameter estimation methodologies.

Table 6. Granger causality tests.

Hypothesis tests: Single Parameter Estimates		**p-value**
Do 1 period-ahead Fed forecasts of defense spending Granger-cause DSGE Consumption forecast errors?	No	0.5871
Do 1 period-ahead Fed forecasts of defense spending Granger-cause DSGE Labor Supply forecast errors?	No	0.9057
Do 1 period-ahead SPF forecasts Granger-cause DSGE Consumption forecast errors?	No	0.4108
Do DSGE Consumption forecast errors Granger-cause 1 period-ahead Fed forecasts of defense spending?	No	0.9200
Do DSGE Labor Supply forecast errors Granger-cause 1 period-ahead Fed forecasts of defense spending?	No	0.2245
Do DSGE Labor Supply forecast errors Granger-cause 1 period-ahead SPF forecasts?	No	0.6957
Hypothesis tests: Rolling Parameter estimates		**p-value**
Do 1 period-ahead Fed forecasts of defense spending Granger-cause DSGE forecast errors?	No	0.5890
Do 1 period-ahead Fed forecasts of defense spending Granger-cause DSGE Labor Supply forecast errors?	No	0.3220
Do 1 period-ahead SPF forecasts Granger-cause DSGE Consumption forecast errors?	No	0.7562
Do DSGE Consumption forecast errors Granger-cause 1 period-ahead Fed forecasts of defense spending?	No	0.9090
Do DSGE Labor Supply forecast errors Granger-cause 1 period-ahead Fed forecasts of defense spending?	No	0.9676
Do DSGE Labor Supply forecast errors Granger-cause 1 period-ahead SPF forecasts?	No	0.5373

7. DISCUSSION AND CONCLUSION

7.1. Discussion

The results of section 5 lead to diametrically opposed conclusions depending on which measure of fiscal news is utilized. When the raw forecasts are used to identify changes in the present discounted value of defense spending, the VAR results corroborate much of the existing literature that finds GDP, consumption, hours, and the real wage to rise after a government spending shock, even when the changing in spending is anticipated. However, if forecast errors are used as the measure of fiscal news then the classical model's predictions mostly ring true: an anticipated government spending shock leads to a reduction in the present value of future income streams, reducing consumption and increasing work effort. This leads to higher output in the short run (a very small increase initially in this study) and a lower marginal product of labor that depresses wages. In the former scenario fiscal stimulus may make some sense as a short-run policy option, while in the latter there is much less incentive to use it as a countercyclical maneuver.

Which measure of news is more appropriate? If testing the merit of the classical model versus the New Keynesian model is the ultimate goal, then the best measure of news is that which immediately captures changes in the present discounted value of future income and tax streams. Since the forecast error incorporates news that arrived last period (the forecast is made in period $t-1$), the raw forecasts made in period t would appear to be a superior measure. Since news arrived last period it is not clear that the timing of agents' decision making is accurately captured when forecast errors are used. Additionally, there may be an econometric case for preferring the raw forecasts over the errors. Since defense and total government spending are highly correlated, it is possible the forecast error, by incorporating the difference between actual and forecasted defense spending, biases the regression results. In any case, the disparate results indicate great care must be taken when incorporating forecast data in a fiscal policy VAR.

The structural model results suggest that perhaps more fundamental questions should be asked. Why do the data fail to speak with a single voice? Is anticipated government spending an important driver of household behavior? A separate but related question is whether or not professional forecasts are a useful proxy for fiscal news. If anticipated fiscal policy were an important part of the data generating process and effective proxies for fiscal news are utilized, then one would expect to find a systematic relationship between the structural model forecast errors and the fiscal news variable. Using a DSGE model designed to capture the complex interactions between the various fiscal instruments used by the government and households, we find little evidence that measures of fiscal news improve the structural model's forecasts. One can conclude that either anticipated fiscal policy is not a visible component of household behavior, or the particular measures of fiscal news used here are not adequately capturing the anticipation effects.

7.2. Conclusion

This investigation seeks to understand how government spending affects macroeconomic aggregates when policy changes are anticipated. This question is important since many policy actions are debated in congress and discussed in popular news outlets before being enacted. If agents are rational, they will incorporate news about future spending changes before they are enacted. Specifically, for a rational agent in the classical model a change in the present discounted value of lifetime income with usher in a negative wealth effect, inducing more work effort and reduced consumption. However, much of the current empirical literature finds just the opposite to be true: a rise in government spending causes output, hours, consumption, and the real wage to increase.

When Federal Reserve forecasts are used to identify government spending shocks we find that consumption, hours, wages, and output all increase following the shock. The output multiplier measured as the peak response is around .5 using a deterministic trend and around unity using a stochastic trend. The responses are qualitatively like those found by authors using the standard Choleski decomposition to identify government spending shocks. Results of this kind are generally taken to support models with imperfect markets such as the New Keynesian DSGE framework. One the other hand, is forecast errors are used in place of the forecasts themselves, the results are quite like those found by authors using the narrative approach of Ramey and Shapiro (1998) and Ramey (2011b). Hours increase following a shock while consumption and wages decrease. Over the five-year response period the shock causes output to contract.

It stands to reason that the raw forecasts are a better measure of changes in the present discounted value of disposable income. If this is the case, then the results of this paper would tend to support sticky price models of the macro economy over the classical paradigm. Still, the evidence presented here is divided and it remains clear that more work must be done to understand the crucial question of how government spending affects the economy.

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Appendix 1. Describes the data.

The Federal Reserve forecasts are described in detail in section 4 of the paper. All other data was graciously made available on Valerie Ramey's website. Below are the descriptions from Ramey (2011a).

1. Data for 1965–2005

Data on nominal GDP, quantity indexes of GDP, and price deflators for GDP and its components were extracted from bea.gov on August 2009. The combined category of real consumption of nondurables plus services was created using Whelan (2000) method. The nominal wage and price indices for business were extracted August 2009 from the bls.gov productivity program. The total hours data used in the baseline post-WWII regressions is from unpublished data from the BLS, kindly provided by Shawn Sprague.

2. Hours: Historical series 1939–2008

1939:1–1947:2: Ramey interpolates Kendrick (1972) annual civilian nonfarm, farm, and military hours series using monthly and quarter series published in various issues of the *Statistical Abstract*. An advantage of Kendrick's civilian series is that it includes hours worked by "emergency workers" as part of the WPA, etc. Various issues of the *Statistical Abstract* (available online through census.gov) report quarterly or monthly data on employed persons and average weekly hours of employed persons for farm and nonfarm civilians from1941:3 through 1945. These are based on the household survey. In 1946, ranges of hours were reported, so that average weekly hours could be constructed. Thus, total hours series for (nonemergency) farm and nonfarm civilians were constructed from these numbers from1941:31946:4. The numbers of employed farm and nonfarm civilians from the household survey were reported from1940:2 on, but average hours were not reported. For 1939:1 to1940:1, the only available series was the establishment based civilian nonfarm employment (available from bls.com). As there was no significant seasonality in the average weekly hours series for civilian nonfarm workers, Ramey used the employment series to extend the civilian nonfarm worker total hours back to 1939:1. There was, however, significant seasonality in the average weekly hours for farm workers. Ramey estimated seasonal hours factors for farm workers using data from1941:3–1947:3 and then applied those to the employment numbers to create total hours back to 1939:1.

1947:3–2008:4: Because the earlier series were based on household data and because the match with Kendrick's series was better, Ramey spliced the earlier data CPS household series from 1947 on. The seasonally unadjusted CPS monthly data were collected by Prescott, Ueberfeldt, and Cociuba (2009). Ramey then seasonally adjusted the entire series using the Census' X12 program, allowing for outliers due to roving Easters and Labor Days. However, because there was a noticeable permanent change in the seasonality of hours from 1946 through 1948, the X12 program led to a few anomalous quarters, 1947:3, 1948:2, and 1948:4. We smoothed these quarters by averaging with the surrounding quarters. The military hours series was available quarterly from unpublished BLS data from 1948 on. As noted above, the initial baseline regression uses the establishment-based hours series rather than the household series for comparability with the rest of the literature.

3. Tax Series

Barro (1974) provide an update for the Barro and Redlick (2011) average marginal tax rate series from 1912 through 2006. Ramey had previously updated Alexander and Seater (2009) series through 2007 using their programs. The annual tax series are converted to quarterly assuming that the tax rate in each quarter of the year was equal to the annual rate for that year.