

Spending cuts and their effects on output, unemployment and the deficit*

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December 19, 2013

Abstract

We compare output, unemployment and deficit effects of fiscal adjustments in different types of government outlays in the US, Canada, Japan, and the UK. We identify shocks in government consumption, investment, employment and wages in a structural VAR using sign restrictions from a sticky price DSGE model with matching frictions in the private and public sector, endogenous labor participation and heterogeneous unemployed jobseekers. Government employment cuts induce the highest output losses and the smallest deficit reductions and significant unemployment losses in the US and the UK. On the other hand, wage cuts generate the lowest output and unemployment losses and typically the highest deficit gains. According to our theoretical model, public wage cuts increase labor supply in the private sector and can undo the negative effects of the tightening, while public vacancy cuts reduce it and result in stronger contractions.

JEL classification: C11, E12, E32, E62.

Keywords: austerity, output and unemployment multipliers, VARs, sign restrictions, search and matching frictions, DSGE model

*We would like to thank Pedro Gomes for useful suggestions and participants of the 27th Annual Congress of the EEA (2012), the 10th CRETE (2012), the 4th IMAEF (2012), the 17th ICMAIF (2013) and the 9th Econ Day at ENSAI (2013), as well as seminar participants at the Bank of Italy, Bank of Brazil, National University of Singapore, University of Helsinki, Universitat Autònoma de Barcelona, and the European University Institute. Financial support from the Spanish Ministry of Economy and Competitiveness through grant ECO2012-32392 and the Generalitat of Catalonia through grant SGR2009-00350 is greatly acknowledged.

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1 Introduction

How does an economy react to budget cuts? This question has become central in academic and policy circles over the last years. Recovery from financial distress has been rather slow and fragile in many regions of the world. Growth has been throttled by excessive government debt and financial distress transformed into a fiscal crisis in many countries, calling for fiscal consolidation on the policy front.

Austerity measures are usually expected to imply short-term contractionary effects on output. Alesina et al. (2012) and Leigh et al. (2010) suggest that output effects depend on how the consolidation occurs. Using multi-year fiscal consolidation episodes identified in Devries et al. (2011) they show that fiscal adjustments based upon spending cuts are less costly in terms of output losses than tax-based ones. On the theoretical front, Erceg and Lindé (2013) focus on the interactions between fiscal consolidation and monetary policy and show, using a two-country Dynamic Stochastic General Equilibrium (henceforth, DSGE) model of a monetary union, that the effects of tax-based versus expenditure-based consolidations depend on the degree of monetary accommodation.

The current fiscal retrenchment primarily involves cuts in expenditures in many countries, since taxes are usually adjusted less frequently and more painfully. Most of the recent existing analysis considers general cuts in government expenditures, but are all components of government spending equally harmful in reducing demand, or is there a lever which is stronger for a given amount cut? This paper compares the losses in terms of output and unemployment and the gains in terms of deficit reductions generated by adjustments in different types of government outlays. We use a structural VAR and identify fiscal shocks via sign restrictions derived from theory.¹ To this end, we build a general DSGE model with matching frictions, endogenous labor force participation, and unemployment that can be either long- or short-term, extending the model of Brückner and Pappa (2012) by incorporating a public sector. Using sign restrictions

¹There are different approaches for the identification of fiscal shocks and reported effects of fiscal policy often depend on the approach adopted. According to the ‘Dummy Variable’ approach, which considers fiscal shocks as episodes of significant exogenous and unforeseen increases in government spending for national defense (see, e.g., Rotemberg and Woodford (1992), Ramey and Shapiro (1998), Edelberg et al. (1999), and Burnside et al. (2004) among others), multipliers are typically small; According to the Structural Vector Autoregression (SVAR) methodology, which identifies fiscal shocks assuming that fiscal variables do not contemporaneously react to changes in economic conditions (see, e.g., Blanchard and Perotti (2002), Perotti (2002), Fatas and Mihov (2001), Galí et al. (2007) among others), estimated multipliers vary in the range of (0.8, 1.2); Canova and Pappa (2006) and (2007), Pappa (2009), Canova and Paustian (2011), Mountford and Uhlig (2009), and Forni and Gambetti (2010) have used sign restrictions to identify fiscal shocks and find output multipliers larger than one, and even higher tax multipliers. Perotti (2007) and Caldara and Kamps (2008) reconcile the results of the different approaches.

we identify shocks to government (a) consumption, (b) investment, (c) employment through vacancy cuts and (d) wages in order to assess which item is the least detrimental and most effective to cut. The analysis focuses on the US, but to robustify inference we also look at three other OECD countries for which we have data (Canada, Japan and the UK). Once shocks are identified, we compute medium term output and unemployment multipliers to quantify the losses associated with the different types of spending cuts. We also compute a measure that quantifies how much the deficit-to-GDP ratio is reduced after a fiscal contraction.

When we apply our methodology to identify total expenditure cuts, we obtain results which are similar to the ones in the existing literature: Government spending cuts reduce output significantly, and have no significant effects in increasing unemployment in most countries and horizons, except for the US after one year. Yet, when we consider shocks to different spending components, we find that the associated output and unemployment multipliers differ significantly. Cuts in the wage bill component identified as government vacancy cuts generate the largest output losses and achieve the smallest deficit reductions, regardless of the sample and the country, and significant unemployment losses in the US and the UK, while wage cuts have, if anything, insignificant expansionary effects and achieve the largest deficit reductions. Our results are robust to different identification schemes, specifications of the SVAR, sample periods and countries.

We use our model to explain the empirical findings: shocks to government consumption and investment decrease public demand but increase private consumption and investment, inducing mild contractions in economic activity. Instead, public wage cuts can be expansionary since they reallocate jobseekers from the public to the private sector, shifting labor supply in the private sector and leading to a fall in real wages and increases in private hiring as well as a reduction in unemployment. On the other hand, a cut in public jobs induces a smaller reallocation of workers from the public to the private sector and, most importantly, it induces a fall in labor force participation and an inward shift of private labor supply, propagating the initial fiscal contraction. Hence, our model demonstrates that changes in government spending components have an impact not only on government employment, as in Ramey (2012), but also on private employment. Also, contrary to Michaillat (2014), a fall in public employment does not increase private employment since many long-term unemployed decide to exit labor force as they face a lower probability of finding a job.

Earlier studies have investigated the effects of fiscal consolidations in different types of government outlays. Alesina and Perotti (1995) and Perotti (1996) found that the most successful

episodes of consolidations are based on spending cuts on transfers and on the wage bill, while Lane and Perotti (1998) found that cuts in the wage component of government consumption cause much stronger contractions in exports. More recently and in accordance to our findings, Hernández de Cos and Moral-Benito (2011) also conclude, using Bayesian model-averaging techniques, that cuts in public wages are the most appropriate ingredients of successful fiscal consolidations. Also, Burgert and Gomes (2011) highlight potential problems of using aggregate data of government spending to estimate its effects on output and other variables and examine how changes in different government outlays propagate in the economy. In accordance with our findings, they report higher government employment multipliers, but contrary to us they also report high multipliers from increases in public wages. Since both the methodology to recover the fiscal shocks and the model used are different, it is difficult to pin down the reasons for the differences in results. We believe that our empirical methodology is more general, since it can account for the correlation between the different fiscal components, and that by looking at different countries we are able to establish stylized facts for the behavior of the economy in response to the different components and provide a model that can explain the empirical regularities.

The facts we uncover are useful to policymakers in a number of ways. First, estimating the output losses of total government spending cuts may be misleading, since different items of the budget have different macroeconomic effects. Second, unexpected contractions in government vacancies appear to be the most harmful austerity measure in terms of output losses. Contrary to common wisdom, government investment cuts do not generate stronger output effects at the horizons of interest. Third, government wage cuts seem the most preferable austerity measure, since they have insignificant output and unemployment effects and reduce the deficit significantly. Fourth, although all spending components reduce deficits, only government employment cuts in the US and the UK seem to affect unemployment, implying that government spending cuts in consumption, investment or wages do not significantly affect unemployment. Fifth, while it is difficult to draw general conclusions, the contractionary effects of vacancy cuts and the expansionary effects of wage cuts in the public sector seem to have been significantly amplified during the last two decades. Our model gives some guidance in explaining changes in the transmission of these shocks over time: decreases in replacement rates and a more aggressive monetary policy increase the absolute size of the government vacancy and wage multipliers. For instance, the fact that Japan and Canada have experienced significant reductions in replacement rates (see, Gnocchi and Pappa (2012)), the adoption of explicit inflation targeting in

Canada and the UK, and the appointment of Paul Volcker as chairman of the Federal Reserve Board can therefore explain the changing effects of fiscal shocks to the wage bill component of public spending over the last three decades.

The rest of the paper is organized as follows. The next section describes the methodology for extracting fiscal shocks. Empirical results appear in Section 3 and Section 4 studies their robustness. Section 5 investigates how we can reconcile the empirical evidence with our theoretical model and Section 6 concludes.

2 Methodology

The methodology to examine the effects of fiscal shocks in the data involves four steps (see also Pappa (2009)). In the first step, we establish robust theoretical restrictions for the comovements of the deficit, employment, tax revenues, and the government wage bill for the fiscal shocks we consider. In the second step, we describe restrictions that allow us to distinguish fiscal from other shocks in the model. In the third step, we show how model-based restrictions can be used to identify fiscal shocks in the data. Finally, we compute the magnitude of the output, unemployment and deficit-to-GDP multipliers generated by the identified fiscal shocks.

2.1 The model

We consider a model with search and matching frictions, endogenous labor participation choice, heterogeneous unemployed jobseekers, and sticky prices. There are three types of firms in the economy: (i) a public firm that produces a good used for productive and utility-enhancing purposes; (ii) private competitive intermediate firms that use private inputs and the public good for production; (iii) monopolistic competitive retailers that use all intermediate varieties to produce the final good. Price rigidities arise at the retail level, while search frictions occur in the intermediate goods sector. The household members consist of employees, unemployed, and labor force non-participants.

2.1.1 Labor market

The process through which workers and firms find each other is represented by a matching function that accounts for imperfections and transaction costs in the labor market. These frictions prevent some unemployed from finding a job. In this context, Campolmi and Gnocchi

(2011) have added a labor force participation choice and Brückner and Pappa (2012) jobseekers' heterogeneity in DSGE models with nominal rigidities. Following Ravn (2008), the participation choice is modelled as a trade-off between the cost of giving up leisure to engage in labor search activities and the foregoing benefits associated with the prospect of finding a job. The unemployed are of two types: short-term and long-term unemployed, with the latter being less advantageous in the job searching process. Long- and short-term unemployed in turn can search for a job either in the public or the private sector.

In particular, at any point in time a fraction n_t^p (n_t^g) of the representative household's members are private (public) employees, a fraction u_t^S (u_t^L) are short- (long-) term unemployed but actively searching, and a fraction l_t are out of the labor force, so that:

$$n_t^p + n_t^g + u_t^S + u_t^L + l_t = 1 \quad (1)$$

The difference between the two types of unmatched agents is that labor force non-participants are not currently looking for a job, while the unemployed are active jobseekers. In line with Quadrini and Trigari (2007) and Gomes (2012), we assume that the unemployed choose in which sector they want to search. A share s_t^S (s_t^L) of the short- (long-) term unemployed looks for a public job, while the remaining part, $1 - s_t^S$ ($1 - s_t^L$), is seeking a private job.

In each period, jobs in each sector $j = p, g$ (i.e. private/public) are destroyed at a constant fraction σ^j and a measure m^j of new matches are formed. The evolution of each type of employment is thus given by:

$$n_{t+1}^j = (1 - \sigma^j)n_t^j + m_t^j \quad (2)$$

assuming that in general $\sigma^p > \sigma^g$ in order to capture the fact that, relatively speaking, public employment is more permanent than private employment.

Workers that experience a termination of their match enter into a period of short-term unemployment and in the next period, they may either remain unemployed, find a new job match, or become long-term unemployed. Short-term unemployed become long-term unemployed with probability $\xi \in [0, 1]$. The transition equation for short-term unemployment is given by:

$$u_{t+1}^S = (1 - \xi)u_t^S + \sigma^p n_t^p + \sigma^g n_t^g - m_t^{pS} - m_t^{gS} \quad (3)$$

where m_t^{jS} denote matches for short-term unemployed in each sector $j = p, g$. The aggregate

matches in each sector are given by:

$$m_t^p = \underbrace{\rho_m^{pS} (v_t^p)^\alpha [(1 - s_t^S) u_t^S]^{1-\alpha}}_{m_t^{pS}} + \underbrace{\rho_m^{pL} (v_t^p)^\alpha [(1 - s_t^L) u_t^L]^{1-\alpha}}_{m_t^{pL}} \quad (4)$$

$$m_t^g = \underbrace{\rho_m^{gS} (v_t^g)^\alpha (s_t^S u_t^S)^{1-\alpha}}_{m_t^{gS}} + \underbrace{\rho_m^{gL} (v_t^g)^\alpha (s_t^L u_t^L)^{1-\alpha}}_{m_t^{gL}} \quad (5)$$

where we assume that the matching efficiency is higher for the short- rather than the long-term unemployed, i.e. $\rho_m^{jS} > \rho_m^{jL}$, and v_t^j for $j = p, g$ denotes vacancies. Notice that short-term unemployed are likely to be better off searching than non-participating since they are faced with a better matching technology. Long-term unemployed instead have to decide whether they should participate in the labor market by taking into account the fact that they are penalized in matching with firms.

From the matching functions specified above we can define the probabilities of a short- (long-) term unemployed being hired, ψ_t^{hjS} (ψ_t^{hjL}), and of a vacancy being filled, ψ_t^{fj} :

$$\begin{aligned} \psi_t^{hp} &\equiv \frac{m_t^p}{(1 - s_t) u_t}, & \psi_t^{hg} &\equiv \frac{m_t^g}{s_t u_t} \\ \psi_t^{hpS} &\equiv \frac{m_t^{pS}}{(1 - s_t^S) u_t^S}, & \psi_t^{hgS} &\equiv \frac{m_t^{gS}}{s_t^S u_t^S} \\ \psi_t^{hpL} &\equiv \frac{m_t^{pL}}{(1 - s_t^L) u_t^L}, & \psi_t^{hgL} &\equiv \frac{m_t^{gL}}{s_t^L u_t^L} \end{aligned} \quad (6)$$

$$\psi_t^{fj} \equiv \frac{m_t^j}{v_t^j} \quad (7)$$

Finally, market tightness in the two sectors is defined as:

$$\theta_t^p \equiv \frac{v_t^p}{(1 - s_t^S) u_t^S + (1 - s_t^L) u_t^L}, \quad \theta_t^g \equiv \frac{v_t^g}{s_t^S u_t^S + s_t^L u_t^L} \quad (8)$$

2.1.2 Household's behavior

Each household is infinitely lived and derives utility from private consumption, c_t^p , the public good, y_t^g , which is supplied free of cost by the government, and the fraction of members that

are out of the labor force and enjoy leisure, l_t :

$$U(c_t^p, y_t^g, l_t) = \Theta_t \frac{(c_t^p + zy_t^g)^{1-\eta}}{1-\eta} + \Phi \frac{(l_t)^{1-\psi}}{1-\psi} \quad (9)$$

where $z \geq 0$ determines the size of the utility gains from the consumption of the public good, $\frac{1}{\eta}$ is the intertemporal elasticity of substitution, $\Phi > 0$ is a preference parameter related to leisure, ψ is the inverse of the Frisch elasticity of labor supply, $\Theta_t \equiv (C_t^p + zy_t^g)/Z_t$, $Z_t \equiv Z_{t-1}^\gamma (C_t^p + zy_t^g)^{1-\gamma}$, $0 < \gamma < 1$, and C_t^p is aggregate consumption (taken as given by each individual household). Notice that if γ takes values close to one, changes in consumption will have small effects on labor supply. In other words, parameter γ regulates the strength of the wealth effect in the utility function. Since many studies (see e.g. Hall (2009) and Woodford (2011)) show that the size of the wealth effect is crucial for determining the effects of fiscal shocks, this specification allows us to study the robustness of our restrictions to changes in γ .

The household owns the private capital stock, which evolves over time according to:

$$k_{t+1}^p = i_t^p + (1 - \delta^p)k_t^p - \frac{\omega}{2} \left(\frac{k_{t+1}^p}{k_t^p} - 1 \right)^2 k_t^p \quad (10)$$

where δ^p is a constant depreciation rate and $\frac{\omega}{2} \left(\frac{k_{t+1}^p}{k_t^p} - 1 \right)^2 k_t^p$ are adjustment costs, paid by the household.

The household keeps its financial wealth in terms of bond holdings, B_t , and the intertemporal budget constraint is given by:

$$(1 + \tau^c)c_t^p + i_t^p + \frac{B_{t+1}}{p_t R_t} \leq [r_t^p - \tau^k(r_t^p - \delta^p)] k_t^p + (1 - \tau_t^n)(w_t^p n_t^p + w_t^g n_t^g) + bu_t + \frac{B_t}{p_t} + \Pi_t^p - T_t \quad (11)$$

where p_t is the price level, w_t^j for $j = p, g$ is the real wage in the two sectors, r_t^p is the real return to private capital, b denotes unemployment benefits, R_t is the gross nominal interest rate, and Π_t^p are the profits of the monopolistically competitive firms (see below). Finally, τ^c , τ^k , τ_t^n and T_t represent taxes on private consumption, capital income (allowing for depreciation), labor income and lump-sum taxes, respectively. We assume that the labor tax rate evolves according to:

$$\tau_t^n = (1 - \rho_{\tau_n})\tau^n + \rho_{\tau_n}\tau_t^n + \varepsilon_t^{\tau_n} \quad (12)$$

where ε_t^n is an i.i.d.

The optimization problem involves choosing sequences of c_t^p , u_t^L , s_t^L , s_t^S , u_{t+1}^S , n_{t+1}^p , n_{t+1}^g , k_{t+1}^p , B_{t+1} so as to maximize expected lifetime utility subject to (1), (2), (3), (6), (10), and (11):

$$n_{t+1}^p = (1 - \sigma^p)n_t^p + \psi_t^{hpS}(1 - s_t^S)u_t^S + \psi_t^{hpL}(1 - s_t^L)u_t^L \quad (13)$$

$$n_{t+1}^g = (1 - \sigma^g)n_t^g + \psi_t^{hgS}s_t^S u_t^S + \psi_t^{hgL}s_t^L u_t^L \quad (14)$$

$$u_{t+1}^S = \sigma^p n_t^p + \sigma^g n_t^g + (1 - \xi)u_t^S - \left[\psi_t^{hpS}(1 - s_t^S) + \psi_t^{hgS}s_t^S \right] u_t^S \quad (15)$$

where (13)-(15) correspond to (2)-(3) after using (6). The first-order conditions from the household's maximization problem are presented in the Companion Appendix.²

The expected marginal value to the household of having an additional member employed in the private sector, $V_{n^p t}^H$, is:

$$V_{n^p t}^H = \Theta_t (c_t^p + z y_t^g)^{-\eta} (1 - \tau_t^n) w_t^p - U_{l,t} + (1 - \sigma^p) \lambda_{n^p t} + \underbrace{\sigma^p \beta E_t V_{u^S t+1}^H}_{\lambda_{u^S t}} \quad (16)$$

According to (16), $V_{n^p t}^H$ has the following components: first, the increase in utility given by the real after-tax wage; second, the decrease in utility from lower leisure; third, the continuation utility values, which depend on the separation probability: a private employee may continue having the same job next period with probability $1 - \sigma^p$ or experience a termination of his match and become a short-term unemployed with probability σ^p .

2.1.3 The production side

Intermediate goods firms Intermediate goods are produced with a Cobb-Douglas technology:

$$y_t^p = (\varepsilon_t^A n_t^p)^{1-\varphi} (k_t^p)^\varphi (y_t^g)^\nu \quad (17)$$

where ε_t^A is an aggregate technology shock that follows an AR(1) process with persistence ρ_A , k_t^p and n_t^p are private capital and labor inputs, and y_t^g is the public good used in productive activities, taken as exogenous by the firms. The parameter ν regulates how the public input affects private production: when ν is zero, the government good is unproductive.

Since current hires give future value to intermediate firms, the optimization problem is dynamic and hence firms maximize the discounted value of future profits. The number of

²The Companion Appendix is available online at www.eui.eu/Personal/Pappa/research.html.

workers currently employed, n_t^p , is taken as given and the employment decision concerns the number of vacancies posted in the current period, v_t^p , so as to employ the desired number of workers next period, n_{t+1}^p .³ Firms also decide the amount of the private capital, k_t^p , needed for production. The problem of an intermediate firm with n_t^p currently employed workers consists of choosing k_t^p and v_t^p to maximize:

$$Q^p(n_t^p, k_t^p) = \max_{k_t^p, v_t^p} \left\{ x_t (\varepsilon_t^A n_t^p)^{1-\varphi} (k_t^p)^\varphi (y_t^g)^\nu - w_t^p n_t^p - r_t^p k_t^p - \kappa v_t^p + E_t [\Lambda_{t,t+1} Q^p(n_{t+1}^p, k_{t+1}^p)] \right\} \quad (18)$$

where x_t is the relative price of intermediate goods, κ is a utility cost associated with posting a new vacancy, and $\Lambda_{t,t+1} = \frac{\beta^s U_{c_{t+s}}}{U_{c_t}}$ is a discount factor. The maximization takes place subject to the private employment transition equation:

$$n_{t+1}^p = (1 - \sigma^p) n_t^p + \psi_t^{fp} v_t^p \quad (19)$$

The first-order conditions are:

$$x_t \varphi \frac{y_t^p}{k_t^p} = r_t^p \quad (20)$$

$$\frac{\kappa}{\psi_t^{fp}} = E_t \Lambda_{t,t+1} \left[x_{t+1} (1 - \varphi) \frac{y_{t+1}^p}{n_{t+1}^p} - w_{t+1}^p + \frac{(1 - \sigma^p) \kappa}{\psi_{t+1}^{fp}} \right] \quad (21)$$

According to (20) and (21) the value of the marginal product of private capital should be equal to the real rental rate and the marginal cost of opening a vacancy should equal the expected marginal benefit. The latter includes the marginal productivity of labor minus the wage plus the continuation value, knowing that with probability σ^p the match can be destroyed.

The expected value of the marginal job for the intermediate firm, $V_{n_t^p}^F$ is:

$$V_{n_t^p}^F \equiv \frac{\partial Q^p}{\partial n_t^p} = x_t (1 - \varphi) \frac{y_t^p}{n_t^p} - w_t^p + \frac{(1 - \sigma^p) \kappa}{\psi_t^{fp}} \quad (22)$$

Retailers There is a continuum of monopolistically competitive retailers indexed by i on the unit interval. Retailers buy intermediate goods and differentiate them with a technology that transforms one unit of intermediate goods into one unit of retail goods. Note that the relative

³Firms adjust employment by varying the number of workers (extensive margin) rather than the number of hours per worker. According to Hansen (1985), most of the employment fluctuations arise from movements in this margin.

price of intermediate goods, x_t , coincides with the real marginal cost faced by the retailers. Let y_{it} be the quantity of output sold by retailer i . Final goods can be expressed as:

$$y_t^p = \left[\int_0^1 (y_{it}^p)^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}} \quad (23)$$

where $\varepsilon > 1$ is the constant elasticity of demand for intermediate goods. The retail good is sold at its price, $p_t = \left[\int_0^1 p_{it}^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}}$. The demand for each intermediate good depends on its relative price and aggregate demand:

$$y_{it}^p = \left(\frac{p_{it}}{p_t} \right)^{-\varepsilon} y_t^p \quad (24)$$

Following Calvo (1983), we assume that in any given period each retailer can reset her price with a fixed probability $1 - \chi$. Hence, the price index is:

$$p_t = [(1 - \chi)(p_t^*)^{1-\varepsilon} + \chi(p_{t-1})^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \quad (25)$$

The firms that are able to reset their price, p_{it}^* , choose it so as to maximize expected profits given by:

$$E_t \sum_{s=0}^{\infty} \chi^s \Lambda_{t+s} (p_{it}^* - x_{t+s}) y_{it+s}^p$$

The resulting expression for p_{it}^* is:

$$p_{it}^* = \frac{\varepsilon}{\varepsilon - 1} \frac{E_t \sum_{s=0}^{\infty} \chi^s \Lambda_{t+s} x_{t+s} y_{it+s}^p}{E_t \sum_{s=0}^{\infty} \chi^s \Lambda_{t+s} y_{it+s}^p} \quad (26)$$

2.1.4 Bargaining over the private wage

Wages are determined by ex post (after matching) Nash bargaining. Workers and private firms split rents and the part of the surplus they receive depends on their bargaining power. If $\vartheta \in (0, 1)$ is the firm's bargaining power, the problem is to maximize the weighted sum of log surpluses:

$$\max_{w_t^p} \{ (1 - \vartheta) \ln V_{n^p t}^H + \vartheta \ln V_{n^p t}^F \}$$

where $V_{n^p t}^H$ and $V_{n^p t}^F$ have been defined in (16) and (22), respectively. The optimization problem leads to:

$$(1 - \vartheta)(1 - \tau_t^n)\Theta_t (c_t^p + zy_t^g)^{-\eta} V_{n^p t}^F = \vartheta V_{n^p t}^H \quad (27)$$

As we show in detail in the Companion Appendix, solving (27) for w_t^p , using the household's FOC, results in:

$$w_t^p = (1 - \vartheta) \left[x_t(1 - \varphi) \frac{y_t^p}{n_t^p} + \frac{\kappa}{\psi_t^{fp}} \psi_t^{hpo} \right] + \frac{\vartheta}{(1 - \tau_t^n)} \left[b - \sigma^p \frac{\beta E_t V_{u^t+1}^H}{\Theta_t (c_t^p + zy_t^g)^{-\eta}} \right] \quad (28)$$

Hence, the equilibrium wage is the sum of the value of the marginal product of employment and the value to the firm of the marginal job multiplied by the hiring probability for a long-term unemployed, weighted by the worker's bargaining power, and the outside option of being unemployed minus the expected value of becoming a short-term unemployed next period if the match is terminated, weighted by the firm's bargaining power. In equilibrium, the value of working is the same for short- and long-term unemployed because otherwise firms could make profits by hiring fewer workers with a lower value and more workers with a higher value. In other words, there are decreasing returns to unemployment in matching, so in equilibrium the value of work should be the same to avoid arbitrage opportunities. The wage paid to matched short-term unemployed will therefore be the same as the wage paid to matched long-term ones.

2.1.5 Government

The government sector produces a public good using public inputs (capital and labor) and vacancy costs are deducted from production⁴:

$$y_t^g = (\varepsilon_t^A n_t^g)^{1-\mu} (k_t^g)^\mu - \kappa v_t^g \quad (29)$$

where μ is the share of public capital in the public production. The public good provides productivity- and utility-enhancing services.

The government holds the public capital stock. As for private capital, the government

⁴See also Gomes (2012).

capital stock evolves according to:

$$k_{t+1}^g = i_t^g + (1 - \delta^g)k_t^g - \frac{\omega}{2} \left(\frac{k_{t+1}^g}{k_t^g} - 1 \right)^2 k_t^g \quad (30)$$

Following Quadrini and Trigari (2007), who reported -using US data over the period 1970-2003 - that public wages comove with private wages with an elasticity equal to 0.94, and Gomes (2012), we assume that the government sets the public wage according to the rule:

$$\log w_t^g = \log w^g + \pi_w (\log w_{t-1}^p - \log w^p) + \varepsilon_t^{w_g} \quad (31)$$

where $\varepsilon_t^{w_g}$ is a shock to the public wage and $\pi_w > 0$ is the elasticity of the public wage to changes in the private one.⁵

Government's income consists of tax revenues, while expenditures consist of consumption and investment purchases, salaries and wages and unemployment benefits. The government deficit is defined by:

$$DF_t = c_t^g + i_t^g + w_t^g n_t^g + bu_t - \tau^k (r_t^p - \delta^p) k_t^p - \tau_t^n (w_t^p n_t^p + w_t^g n_t^g) - \tau^c c_t^p - T_t \quad (32)$$

and the government budget constraint is given by:

$$B_t + P_t DF_t = R_t^{-1} B_{t+1} \quad (33)$$

where B_t denotes government bonds. To ensure determinacy of equilibrium and a non-explosive solution for debt (see e.g. Leeper (1991)), we assume a debt-targeting rule of the form:

$$T_t = \bar{T} \exp(\zeta_{\beta} (\beta_t - \bar{\beta})) \quad (34)$$

where $\bar{\beta}$ is the steady state level of debt to GDP ratio, $\beta_t = \frac{B_t}{y_t}$.

⁵If the labor market was frictionless, then the wages should be equal across sectors. However, this is not the case with labor market frictions that are not symmetric across sectors. Note that we have also assumed a rule in which public wages react contemporaneously to changes in private wages, i.e. $\log w_t^g = \log w^g + \pi_w (\log w_t^p - \log w^p) + \varepsilon_t^{w_g}$. Such a rule changes the dynamics of deficits to a government wage shock by making the reaction of deficits to the shock immediate. In exercises that are available upon request we show that the timing of the restriction in deficits regarding the public wage shock is not crucial for the results we present.

If $\Psi^g = c^g, i^g, v^g$ denotes the different fiscal instruments, we assume fiscal rules of the form:

$$\Psi_t^g = \bar{\Psi}^g (\Psi_{t-1}^g)^{\varrho_g^\psi} \exp(\varrho_g^{\psi y} \Delta y_t + \varrho_g^{\psi b} (\beta_t - \bar{\beta}) - \varepsilon_t^{\psi g}) \quad (35)$$

where Δy_t is total output growth defined as $\Delta y_t \equiv \Delta \left(y_t^p + \frac{p_t^g}{p_t} y_t^g \right)$ with $\frac{p_t^g}{p_t}$ being the implicit relative price of public goods determined by the consumers' demand for public goods, $\varepsilon_t^{\psi g}$ is a zero-mean, white-noise disturbance, ϱ_g^ψ determines the persistence of the different government components processes, $\varrho_g^{\psi y}$ determines the degree of procyclicality of government spending and $\varrho_g^{\psi b}$ determines the elasticity of the fiscal instrument to changes in the debt target.

2.1.6 Monetary policy

There is an independent monetary authority that sets the nominal interest rate according to the rule:

$$R_t = \bar{R} \exp(\zeta_\pi \pi_t + \zeta_y \tilde{y}_t + \varepsilon_t^R) \quad (36)$$

where ε_t^R is a monetary policy shock, π_t measures inflation in deviation from the steady state and \tilde{y}_t measures deviations of output from its flexible-price counterpart.

2.1.7 Closing the model

The aggregate resource constraint is given by:

$$y_t^p = c_t^p + i_t^p + c_t^g + i_t^g + \kappa v_t^p \quad (37)$$

The model features seven exogenous disturbances: The shocks to public vacancies and fiscal spending components, as described in (35), the labor-income tax shock described in (12), the productivity, the public wage and the monetary policy shocks. The vector of the last three shocks, $S_t = [\varepsilon_t^A, \varepsilon_t^{w_g}, \varepsilon_t^R]'$, is parameterized as:

$$\log(S_t) = (I - \rho) \log(\bar{S}) + \rho \log(S_{t-1}) + V_t \quad (38)$$

where V is a (3×1) vector of innovations, I is a (3×3) identity matrix, ρ is a (3×3) diagonal matrix, and \bar{S} is the mean of S . The innovation vector V is a stationary, zero-mean, white noise process, and the roots of ρ are all less than one in modulus.

We solve the model by approximating the equilibrium conditions around a non-stochastic steady state (setting all shocks equal to their mean values) in which all prices are flexible, the price of the private good is normalized to unity, and inflation is zero. The derivation of the steady state relationships is presented in the Companion Appendix.

In sketching the model we have left some features out of the analysis on purpose. For example, we do not consider a model of a small open economy as in this case the interest rate would be given. We would therefore be unable to study the interaction between monetary and fiscal policy, which as Christiano et al. (2011) and Canova and Pappa (2011) show, are very important for determining the size of the multiplier. Also, we have not considered the case of sticky private wages given that such rigidities in combination with matching frictions distort aggregate job creation and create inefficient dispersion in hiring rates across firms (Thomas (2008)). We believe that those abstractions, though, are not crucial for the robustness of our sign restrictions.

2.2 Robust restrictions

2.2.1 Parameter ranges

The model period is a quarter. We let $\theta = (\theta_1, \theta_2)$, where θ_1 represents the parameters which are fixed to a particular value to avoid indeterminacies or because of steady state considerations, while θ_2 are the parameters which are allowed to vary. The intervals for the remaining parameters are centered around calibrated values and include values that have been either estimated in the literature or assumed in calibration exercises (See Table 1). Although the intervals for the majority of parameters should be uncontroversial, the selection of some ranges needs to be discussed. The share of public goods in total consumption, z , is usually set to zero. Theoretical considerations suggest that z has to be low since the size of the private wealth effect following fiscal shocks crucially depends on this parameter. For that reason we limit z to the $[0.0, 0.5]$ interval. The parameter ν controls the interactions between public and private goods in production. We choose a range that includes both the case of unproductive government goods and most of the estimates for the elasticity of output to changes in public inputs in the literature. Parameter γ determines the size of the wealth effect after an increase in the government's absorption we allow for a wide range of this parameter to control for the robustness of our results to the utility specification assumed. Finally, the parameter ranges for the steady state values of the fiscal variables are chosen to match the average values of their US data counterparts.

2.2.2 Dynamics

Figure 1 plots pointwise 68% probability bands for the responses of output, total employment, the nominal interest rate, deficit, the government wage bill and tax revenues to a surprise 1% change in government consumption (first row), government investment (second row), public vacancies (third row), public wages (fourth row), TFP (fifth row), interest rate (sixth row) and income taxes (last row) when parameters vary over the ranges reported in Table 1. We normalize all shocks to be contractionary.

All fiscal shocks, except for government wage cuts, robustly decrease total employment one or more periods after the shock and the deficit on impact. Yet, using restrictions on employment and deficits would not help distinguish TFP or interest rate from fiscal shocks. In order to distinguish such shocks from fiscal shocks we take advantage of the opposite movements of output and interest rates: Since negative TFP shocks increase inflation, the interest rate typically increases after a contractionary supply shock on impact. Also, a contractionary monetary policy shock, by definition, reduces output with a lag. On the other hand, with fiscal shocks the interest rate and output commove. We orthogonalize the fiscal shocks to disturbances that move output and the interest rates in opposite directions on impact for TFP shocks. We also require our shocks to be orthogonal to shocks that induce a negative lag correlation between the interest rate and output and the government wage bill in order to exclude the possibility of confusing interest rate with wage cuts.

Besides, income tax hikes imply similar restrictions with government spending cuts, especially in the case of government consumption and investment, since they decrease employment and deficits on impact and increase the government wage bill with a lag. Yet, tax shocks increase tax revenues on impact, while spending shocks robustly reduce deficits with a lag. In order to distinguish tax hikes from government spending contractions in consumption or investment we require the identified shocks to be orthogonal to shocks that move deficits and tax revenues in opposite direction on impact, and deficits and the wage bill in opposite direction with a lag. Notice that such orthogonalization is sufficient to distinguish tax shocks from government vacancy and wage shocks as well. Finally, to account for possible correlation among the four fiscal components, we shut the responses of the unshocked government spending variables on impact.

Table 2 summarizes our robust restrictions. Notice that output and unemployment responses are left unrestricted for the identification of fiscal shocks since it is exactly the dynamics of those variables that we want to evaluate in our empirical exercise. On the other hand, deficit dynamics

are restricted on impact in the same manner for all the shocks considered.

Let Σ be the covariance matrix of the VAR shocks and let $PP' = \Sigma$ an orthogonal decomposition of Σ . Then, structural shocks ε_t are constructed as $\varepsilon_t = P^{-1}u_t$, where u_t are reduced form shocks and, for each element of ε_t , we check if the required restrictions are satisfied. If no structural shock produces the required comovements in the variables, the orthogonal decomposition is rotated by an orthonormal matrix $H(\lambda)$, with $H(\lambda)H(\lambda)' = I$, where λ measures the angle of rotation, and the comovements in response to the new set of shocks are examined (see Canova (2007)). This search process continues, randomly varying λ in the range $(0, \pi)$, and randomly rotating the columns of $H(\lambda)$. Since many $H(\lambda)$'s can in principle produce the required pattern, the error bands we report reflect not only the uncertainty in the reduced form parameter estimates but also how responses vary with different λ 's and H 's.

2.3 Data and the reduced form model

We use quarterly, seasonally adjusted data for Canada and the UK from 1970 to 2007, Japan from 1962 to 2007 and the US from 1960 to 2007, thus, excluding the current financial crisis. The series come from the OECD Economic Outlook.

The reduced form model contains a constant, a linear trend and nine endogenous variables: The log of real per capita GDP, the log of total employment, the log of real per-capita net tax revenues, the log of real per capita government expenditure in goods purchases, defined as government expenditures minus government wage expenditures, and in gross fixed investment, the log of average real (GDP deflated) public wage per job, the log of government employment and a measure of the short term interest rate. We also include a labor market variable in the system that alternates between (i) the unemployment rate, (ii) the labor force participation rate, or (iii) the log of average real (GDP deflated) private wage per job. Finally, we include oil prices as exogenous in order to control for global supply effects. We set the lag length of the VAR to two. We use flat priors on the coefficients of the model and the covariance matrix of the shocks and Bayesian techniques to compute posterior distributions.⁶

Before proceeding with the results, notice that the use of sign restrictions allows us to

⁶We have also examined other variants of the model (e.g. revenues and expenditures expressed in percentage of GDP or in growth rates). In addition, we have tried specifications in which (a) we include five endogenous variables by considering one spending component at a time; (b) we include a factor for the various labor market variables, instead of alternating variables in the VAR; (c) we use the wage bill deflator, instead of the average wage. Results are not significantly affected in all cases and are available upon request or presented in the Online Appendix.

identify shocks in public vacancies even if we do not have actual series in the data. What we label as ‘public employment shock’ is actually a shock in public vacancies in the theoretical model that we are able to recover in the data, since we have enough identifying restrictions to distinguish shocks to public vacancies from other fiscal disturbances.

In order to take a preliminary view of the variations in our data, we plot in Figure 2 the cyclical component of the quarterly growth changes in the different fiscal components we consider in our exercise for the US. As can be readily seen, deviations are not correlated: public investment falls substantially in the last quarter of 1970 and peaks in the last quarter of 1978, while government consumption peaks in the last quarter of 1966 and decreases substantially in 1983 and 2008. The data point to a significant increase in public employment in 1966 - when the National Historic Preservation Act led to major changes in the federal and state employment in historic preservation fields; in 1977 after Carter’s appointment and job creation stimulus; in 1990 when President Bush increased government employment for defense in the face of the German reunification; and to a fall in public employment in 1980, after Reagan won the presidential election and cut the Comprehensive Employment and Training Act of 1974. Significant changes in government wages are observed in 1964, after the Civil Rights Act was passed, making the discrimination of employees based on race illegal; when the minimum wage increased to \$1.30 per hour in February 1969 and with the Minimum Wage Act of 1983.

3 Results

We present in Figure 3 the responses of output, total employment, the real wage, the labor force participation and the unemployment rate in the US to the four fiscal shocks considered. Shocks are scaled to be the same by representing a 1% cut of total government spending. Each graph presents median estimates (solid line) and pointwise 68% credible bands (shaded area). Output decreases significantly for some periods after the first three shocks and it increases insignificantly with respect to government wage cuts. Not surprisingly, total employment decreases significantly in response to the first three shocks, but increases insignificantly with respect to government wage cuts. The responses of the real wage, the unemployment rate and labor force participation are only significant for government employment shocks.

Although responses are similar qualitatively, there are striking quantitative differences: output is strongly reduced and unemployment significantly increased after a public employment shock. A similar pattern arises in other OECD countries. In Figure 4 we present the output

responses after a government consumption (first column), investment (second column), employment (third column) and wage (last column) shock in Canada, Japan, and the UK. The public employment cuts significantly contract output in all three countries, while the other three shocks have mostly insignificant output effects.⁷

The difference in the impulse responses translates into differences in the output multipliers and, hence, output losses. Table 3 presents point estimates of the impact output, unemployment, and deficit-to-GDP multipliers and the medium-run cumulative multipliers one, three and five years after the shock. Multipliers are computed by dividing the cumulative response of output by the cumulative response of total government spending after a shock to each spending component. Similarly, unemployment multipliers measure what the percentage-point change in the unemployment rate is when total government spending increases by 1% of GDP after a shock to each spending component. Finally, the deficit-to-GDP multipliers express the percentage change in the deficit-to-GDP ratio. Values for which corresponding 68% credible intervals do not include zero are indicated with an asterisk.

For the US, shocks to the government wage bill originating from cuts in public vacancies have the highest output multipliers at all horizons. A 1% of GDP decrease in government spending, induced by a shock to government consumption, investment and employment respectively, implies a fall in output on impact by 2.27%, 2.62% and 3.58%, respectively. After three years the cumulative effect on output is 1.82%, 1.22% and 2.74% and after five years 1.43%, 1.09%, and 2.33%, respectively. Long run output multipliers are statistically significant for government employment shocks only, while only government investment and employment shocks generate significant output effects on impact. The results for the other countries are similar: the output multipliers of the government vacancy shocks are always higher and significant⁸. For Canada and the UK, government consumption shocks also induce significant output losses in the short run and for Canada the output losses after government investment shocks are significant on impact. In contrast, government wage cuts generate insignificant and very often positive output effects in all countries. Unemployment multipliers are significant only for government employment shocks in the US and the UK. In terms of deficit reductions, government

⁷The complete set of impulse responses for all countries are provided in the Companion Appendix.

⁸To provide further evidence on the effects of government vacancy shocks, we also use a narrative approach for identifying these shocks, based on the suspension of conscription in 29 European countries. We apply a difference-in-difference estimation using as treatment group countries that have gone through changes in conscription and as control group countries that have not. Reforms in conscription increase GDP and the government wage bill significantly, while they do not have a significant effect on the real wage, suggesting that this special category of government vacancy shocks indeed generates significant output effects. Results are available in the Online Appendix.

wage cuts appear to be the most successful tool in reducing deficits in all countries, except for Japan. Although government employment shocks are associated with the highest output losses in all countries and significant unemployment losses in the US and the UK, they do not seem to generate significant deficit reductions. Hence, government employment cuts seem the most destructive and government wage cuts the least harmful means of reducing the government's budget.

According to Burgert and Gomes (2011) using aggregate data for estimating the effects of government spending is problematic. To investigate whether aggregation is misleading, we have identified a shock to total government expenditures which is orthogonal to the TFP, monetary policy and tax shock and induces positive comovements of employment with a lag and the deficit on impact. The output multipliers of increases in total government outlays are mostly insignificant in the medium and long run (see seventh column of Table 3). Unemployment multipliers are insignificant for all countries, but the US one year after the shock (see 12th column of Table 3), while deficit multipliers, apart from Canada, are small and only significant on impact (see last column of Table 3). Our exercise suggests that by summing up the different series a lot of useful information is lost and, therefore, offers an additional motivation for investigating the effects of different spending components separately.

4 Robustness

4.1 Subsample analysis

There are reasons to believe that our sample is likely to be heterogeneous. For example, it is well known that the volatility and the persistence of the US real and nominal variables have fallen after the 1980s (see, Kim and Nelson (1999), McConnell and Perez-Quiros (2000), and Stock and Watson (2003)). There is some evidence that the dynamic effects of fiscal shocks have changed over time (see, e.g., Perotti (2002)). To take sample heterogeneity into account we repeat the analysis for two subsamples, up to 1985 and from 1987 onwards.

In Table 4 we present impact and cumulative output multipliers one, three and five years after the shock for each of the two sub-periods, as well as the difference between the two sub-periods. The structural changes of the 1980s have significantly changed the transmission of government spending shocks. The impact and one-year effects of government vacancy shocks on output have substantially increased in the second subsample for all countries, while the

medium-run output effects of government wage cuts in Canada have reversed sign and in the US have become significantly larger in absolute value on impact, implying stronger expansionary effects of the wage cut in the second sample. After the 80's medium-run deficit multipliers are higher for public wage cuts, while there is no general pattern of changes for unemployment multipliers⁹.

4.2 An alternative identification scheme

For readers who prefer a simple recursive (Cholesky) identification to extract the fiscal shocks from the data to sign restrictions, we have also run four different VARs. Each has the government spending variable ordered first and the rest of the variables are in the following order: real per capita GDP, employment, a variable that alternates between unemployment, real wages and labor force participation, tax revenues and interest rate¹⁰.

Impulse responses of the VAR for the US are in Figure 5. As in our benchmark specification, a public vacancy cut leads to a persistent and pronounced recession and government wage cuts do not imply significant output gains. Although not restricted, total employment reduces significantly some periods after a public employment shock and, as in the benchmark model, unemployment increases and labor force participation falls significantly after the shock. Contrary to the benchmark model, the output effects of government consumption and investment shocks are significant; yet as demonstrated in Table 5, the ranking of the multipliers is similar to the one obtained when we use sign restrictions to recover the shocks.

4.3 Controlling for expectations

Following the work of Ramey (2011) one has to worry about anticipation effects of fiscal consolidations, since the timing of fiscal shocks plays a critical role in identifying the effect of unanticipated fiscal shocks. To control for expectations we add real-time forecasts for US government spending from the Survey of Professional Forecasters (SPF) of the Federal Reserve Bank of Philadelphia in our benchmark specification and add an orthogonality restriction that

⁹In the online Companion Appendix we present impulse responses to the various shocks for the US economy as well as unemployment and deficit multipliers for the two subsample periods.

¹⁰The results of the Cholesky identification have to be taken with caution; first, in these estimations there is no control for movements in other fiscal spending components when extracting the fiscal shocks and second, strictly speaking, in the absence of data on government vacancies, the identified shocks might not be necessarily a cut in public jobs.

ensures that our identified shocks are orthogonal contemporaneously to these series. The ordering of multipliers is unchanged (see last row of Table 5).¹¹

5 Reconciling the evidence with the theory

Summarizing the empirical evidence: (i) government vacancy cuts are typically the most destructive means of fiscal adjustment in terms of output (and unemployment) losses and the least effective in deficit gains and (ii) government wage cuts for most countries in the sample and identification schemes are related to insignificant increases in output and a significant fall in the deficit-to-GDP ratio. In this section, we use the theoretical model of Section 2 to explain our findings. In Figures 6-9 we present the main macroeconomic variable responses to a shock in government consumption, investment, vacancies and wages, respectively. Continuous lines correspond to the benchmark model in which public goods are assumed to be both utility and productivity enhancing (i.e., $\nu = 0.1, z = 0.1$), dotted lines correspond to the case in which the public good is assumed to only enhance private utility (i.e., $\nu = 0, z = 0.1$), dashed dotted lines the case in which the public good is assumed to be only productive (i.e., $\nu = 0.1, z = 0$), and dashed lines the case in which the public good is a complete waste (i.e., $\nu = 0, z = 0$).

As is well known, a government consumption cut induces a wealth effect that decreases labor participation and increases private consumption in Figure 6. The fall in labor force participation is associated with a fall on impact in the fraction of long-term unemployed jobseekers in both sectors, given that it is more difficult for them to find a job. This is combined with a negative demand effect due to price rigidities, which decreases labor demand, generating a fall in private vacancies and, consequently, in private employment. Jobseekers shift from the private to the public sector increasing short-term unemployment in this sector. The fall in long-term unemployment implies also a fall in total unemployment on impact, while the upward movement of short-term unemployment, which adjusts one period after the shock, causes a similar movement in total unemployment. The combined shifts of labor supply and demand in the private sector induce an increase in the private wage after the shock, which leads subsequently to an increase in the public wage. Public employment increases, since the tightness of the public job market decreases, and as a result, public output increases as well. Total output falls one period after the shock due to the drop in private output. Responses for the different model specifications look similar since public consumption is assumed to be a waste and does

¹¹The responses of the macro variables for the US are presented in the online appendix.

not affect labor supply decisions.

In Figure 7, the assumption on the productivity of the public good now matters for the results. When the public good is a waste (dashed lines), or utility enhancing only (dotted lines), the responses of the economy to a cut in public investment are very similar qualitatively with the responses to a government consumption shock in Figure 6, with the exception of public output, which falls persistently since the negative investment shock reduces future public capital persistently. When the public good is productive, the wealth and demand effects are combined with a negative effect of the shock on future private production. The contemporaneous responses are qualitatively similar to the ones produced by a government consumption shock, but the lagged effects are quite different: private and, hence, total output fall persistently.

Like the other two austerity measures, public job cuts induce a fall in the labor force participation and, unlike the other two shocks, a reallocation of jobseekers from the public to the private sector (see Figure 8). Yet, the fall in labor force participation is relatively stronger, leading to a fall in private employment and an increase in the real wage a period after the shock. This is because the cut in public vacancies reduces the probability that an unemployed household member will be matched next period and, as a result, strengthens the reaction of long-term unemployed to exit labor force, decreasing significantly the private labor supply¹². Assuming that the public good is productive does not change the main propagation mechanism, but adds persistence to the responses through the accumulation of public employment, which increases the future public good. In terms of output losses, the impact multipliers are not affected significantly by the assumption of public good productivity, but this assumption makes a difference for the cumulative effect of the shock. Hence, it is crucial in order for the model to match the empirical responses.

Again as a reduction in government's absorption a public wage cut is associated with a positive wealth effect that decreases labor force participation. At the same time, this shock triggers a stronger reallocation of both short- and long-term unemployed jobseekers towards the private sector than a public vacancy cut. The different reaction of the long-term unemployed comes from the fact that a public wage cut does not imply for them more adverse prospects of finding a job as is the case of a public vacancy cut. In other words, the cut in the public wage does not decrease the probability of long-term unemployed for finding a job and become more efficient in their matching and for that reason it does not reduce labor force participation by as

¹²The assumption of heterogeneous unemployed is crucial. In exercises available upon request we show that with homogenous unemployed the fall in labor supply is relatively smaller and a government vacancy cut for some calibrations can actually be expansionary in our model.

much as a government vacancy cut. The increase in the relative supply of labor in the private sector leads to increases in private vacancies and employment for a lower wage and private output rises with a lag. This might not seem surprising when government output is assumed to be unproductive (dashed and dotted lines in Figure 9). However, the expansionary effects are limited when public output is productive (continued and dash-dotted lines in Figure 9). The reason behind this result is very simple. A public wage cut reduces the supply of labor in the public sector and, hence, public output. If public output is assumed to be productive, such a fall will imply a decrease in the productive capacity of the economy and, hence, private output will increase less than in the case in which the public good is a waste. Hence, the assumption on the productive nature of public goods is crucial in explaining our empirical findings. The insignificant output and unemployment multipliers can be perfectly rationalized if one is willing to accept that public goods enhance to some degree private productivity.

Looking through Figures 6-9, and the multipliers depicted with continuous lines for the benchmark model in Figure 10, it is apparent that the model can replicate qualitatively the empirical evidence. When the public good is assumed to be productive, government vacancy cuts do generate the highest output and unemployment losses and insignificant deficit gains in the model, while government wage cuts generate the lowest losses in terms of output and unemployment and the highest gains in terms of deficit reductions. Since wage cuts lead to moderate expansions in the model it is not surprising that they generate the highest deficit gains. On the other hand, the fall in private consumption and investment and in labor force participation after a vacancy cut limit the deficit gains after the fiscal contraction.

Moreover, the model predicts that government wage cuts reallocate jobseekers from the public to the private sector, increasing private employment and, instead, in response to vacancy cuts both private and public employment fall due to a fall in labor force participation. Figure 3 confirms that labor force participation falls significantly in the US in the benchmark empirical model after government employment cuts. In Figure 11 we present the responses of private employment in response to the two fiscal shocks from a VAR in which we use restrictions on output rather than employment to identify the government employment shock and we use private rather than total employment series. Notice that the responses of private employment are left unrestricted for both shocks. The first column on Figure 11 reconfirms our intuition, the fall in labor force participation is significant, as in the benchmark model, and leads to a significant fall in private employment. When we look at government wage cuts, according to our theoretical predictions, private employment increases.

5.1 Sensitivity analysis

It is important to study the sensitivity of our results to changes in the parameterization of the model. In Figure 10 we present how theoretical cumulative output, unemployment and deficit multipliers, which are computed in accordance with their empirical counterparts, vary when we change some key parameters of the model.

The size of replacement rates affects the propagation of government vacancy shocks significantly. A higher replacement rate ($b/w^p = 0.45$) decreases substantially the wealth effect from government vacancy shocks since when unemployment benefits are high agents have fewer incentives to leave the labor market and labor force participation is not reduced so strongly. Hence, output multipliers are smaller. The public job destruction rate also affects the persistence of the cut in public jobs and, hence, the probability of finding a job for long term unemployed. The dotted lines in Figure 10 show that assuming more secure public jobs ($\sigma^g = 0.03$) implies an increase in the output multiplier for public vacancies, and hence bigger output losses from a vacancy cut, since safer public jobs imply lower job creation in the public sector in the coming years, which in turn discourages further labor force participation.

The analysis of Erceg and Lindé (2013) suggests that the interactions between monetary and fiscal policy are crucial for determining the size of the output losses of fiscal consolidations. The dashed-circled lines in Figure 10 depict multipliers when we assume a less aggressive monetary policy ($\zeta_\pi = 1.5$). In line with other studies, such a policy substantially increases the effects (i.e. output and unemployment multipliers) of government consumption and investment shocks. Yet a laxer monetary policy seems to reduce the negative output and unemployment effects of government vacancy cuts by limiting the exit of long-term unemployed from the labor market since limited movements in the interest rate limit the wealth effect that induces an increase in consumption and a fall in labor force participation.

There are several other parameters that might affect the output multiplier for government spending shocks. We examine the sensitivity of our results to changes in the size of capital adjustment costs ($\omega = 3$) and in the parameter associated with the wealth effect in the utility function ($\gamma = 0.1$). All the parameter changes considered, although they affect the size, do not substantially change the ranking of multipliers for the different spending cuts: cutting government wages is always ranked as the best fiscal consolidation policy in terms of output and unemployment losses, while cutting public vacancies is the worst policy a government can adopt, especially when replacement rates are low and public jobs are of a more temporary nature.

6 Conclusions

To identify deficit-financed expenditure shocks we use sign restrictions that hold for many variants and parameterizations of a very general DSGE model with real and nominal frictions. Output losses from government employment cuts are the largest, while they are the smallest for government wage cuts for all countries, identification schemes and samples considered. Government wage cuts are also the most effective in reducing deficits in the medium run.

Determining whether these facts have a common underlying explanation is a challenging task. We employ our model to highlight which features are necessary to justify the empirical responses: government employment cuts are the most detrimental austerity measure because, apart from generating the standard wealth and demand effects after decreases in government absorption, they have an additional effect on the labor participation decision of the household: it discourages long-term unemployed from participating in the labor market. This latter effect depends crucially on the size of the unemployment benefits and on the monetary policy stance. Since the empirical results point to a significant increase in the output effects of government employment shocks in the post-1980s period, our model predictions suggest that the reforms in replacement rates and the change in the monetary policy stance in the countries considered could be a possible explanation for this pattern.

Finally, we have abstracted from analyzing cuts in government transfers as an alternative austerity measure. In our theoretical model such cuts could be modeled as shocks to the lump-sum transfers, or the unemployment benefits. We have decided to exclude cuts in transfers from the current analysis for the following reasons. First, transfers typically involve many additional items, such as subsidies to firms, or energy support for poor households, so it would be restrictive to consider as transfer cuts, only cuts to unemployment benefits, or lump-sum transfers. Second, it would be much more difficult to apply our empirical methodology, since the identification of shocks in the data becomes more cumbersome, given that it is practically difficult to make so many shocks orthogonal to each other and at the same time to satisfy many sign restrictions. For these reasons, we leave the exploration of transfer cuts and their macroeconomic consequences in our top priorities for future research.

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Tables

Table 1: Parameter ranges and values					
Varying parameters	Ranges	Values	Varying parameters	Ranges	Values
η	[0.5,6]	1.0	vacancy cost - wage ratio	[0.035,0.065]	0.045
z	[0,0.5]	0.1	unemployment rate	[0.04,0.1]	0.065
$\frac{1}{\psi}$	[0.1,10]	0.25	public employment share	[0.12,0.2]	0.16
ν	[0,0.5]	0.1	long-term unemployed allocation	[0.25,0.35]	0.3
γ	[0.05,0.95]	0.8	priv. vacancy filling probability	[0.4,0.9]	0.5
$\frac{C^g}{Y}$	[0.05,0.2]	0.08	private hiring probability	[0.4,0.9]	0.9
$\frac{K^g}{K^p}$	[0.27,0.35]	0.31	short- vs. long-term unemployed	[1.005,1.02]	1.015
δ^j	[0.02,0.03]	0.025	hiring probability		
φ, μ	[0.3,0.4]	0.36	replacement rates	[0.0,0.5]	0.4
ω	[0,10]	5.5	steady-state wage ratio	[0.95,1.25]	1.03
τ^n	[0,0.4]	0.2	public wage elasticity to w^p	[0.9,1.2]	0.94
τ^k	[0,0.4]	0.2	long-term unemployment share	[0.1,0.2]	0.18
τ^c	[0,0.1]	0.045	firms bargaining power	[0.3,0.6]	0.4
$\bar{\beta}$	[0.4,0.8]	0.6	labor participation rate	[0.6,0.7]	0.65
ζ_β	[1,4]	2.0	public separation rate	[0.02,0.06]	0.04
ζ_π	[1,5]	2.5	private separation rate	[0.02,0.06]	0.05
ζ_y	[0,1]	0.0	steady-state markup	[1.09,1.16]	1.1
ϱ, ϱ_g^ψ	[0.0,0.95]	0.85	price stickiness	[0.4,0.8]	0.75
$\varrho_g^{\psi b}$	[-0.5,0.0]	0.0			
$\varrho_g^{\psi y}$	[-0.05,0.05]	-0.05			

Notes: $j = p, g$ and $\psi = c^g, i^g, v^g, \tau^n$

Table 2: Identifying restrictions

<i>restricted variables</i>	<i>shocks</i>						
	ε_t^{cg}	ε_t^{ig}	ε_t^{vg}	ε_t^{wg}	ε_t^A	ε_t^R	$\varepsilon_t^{\tau n}$
<i>output</i>					+	-	
					$k = 0$	$k = 1$	
<i>interest rate</i>					-	+	
					$k = 0$	$k = 0$	
<i>employment</i>	+	+	+				
	$k = 1, 2$	$k = 1, 2$	$k = 1, 2$				
<i>deficits</i>	+	+	+	+			-
	$k = 0$	$k = 0$	$k = 0$	$k = 0$			$k = 0$
<i>gov.wage bill</i>			+	+		-	+
			$k = 1, 2$	$k = 1, 2$		$k = 1, 2$	$k = 1, 2$
<i>tax revenues</i>							+
							$k = 0$
<i>gov. consumption</i>	+	0	0	0			
	$k = 0$	$k = 0$	$k = 0$	$k = 0$			
<i>gov. investment</i>	0	+	0	0			
	$k = 0$	$k = 0$	$k = 0$	$k = 0$			
<i>gov. employment</i>	0	0	+	0			
	$k = 1, 2$	$k = 1, 2$	$k = 1, 2$	$k = 1, 2$			
<i>gov. wages</i>	0	0	0	+			
	$k = 0$	$k = 0$	$k = 0$	$k = 0$			

Notes: k refers to the horizon of the restrictions

ε_t^{cg} : government consumption shock, ε_t^{ig} : government investment shock, ε_t^{vg} : government employment shock
 ε_t^{wg} : government wage shock, ε_t^A : TFP shock, ε_t^R : interest rate shock, $\varepsilon_t^{\tau n}$: labor income tax shock

		output multipliers associated with shocks to:				unemployment multipliers associated with shocks to:				deficit/GDP multipliers associated with shocks to:						
		c^g	i^g	v^g	w^g	G	c^g	i^g	v^g	w^g	G	c^g	i^g	v^g	w^g	G
Canada	0	1.48*	1.97*	1.40*	-0.83	1.75*	-0.20	-0.10	-0.49	0.06	-0.46	1.05*	1.18*	1.13	1.18*	1.96*
	4	1.48	1.76	2.31*	-2.25	1.71	-0.28	-0.24	-0.52	0.03	-0.43	0.88*	0.97	0.88	1.49*	1.87*
	12	1.50	0.94	2.39	0.62	1.45	-0.16	-0.38	-0.40	-0.28	-0.19	0.99*	0.86	0.64	1.68*	1.91*
	20	1.37	0.55	2.07	2.14	1.30	-0.13	-0.48	-0.23	-0.50	-0.10	1.06	0.66	0.66	1.53*	1.85*
Japan	0	1.49	1.37	2.54*	0.90	1.66	-0.04	-0.04	-0.10	0.03	-0.12	0.89*	0.91*	0.66*	0.82*	0.86*
	4	2.26	2.71	3.22	1.34	1.88*	-0.03	-0.04	-0.20	-0.02	-0.18	0.51*	0.45*	0.22	0.81	0.73
	12	2.95	3.39	3.15	-0.67	2.42*	-0.06	-0.08	-0.29	-0.12	-0.13	0.03	-0.29	0.04	0.87	1.04
	20	3.85	3.45	3.27	-2.10	3.07	-0.16	-0.10	-0.21	-0.13	-0.19	-0.41	-0.33	-0.21	0.48	0.74
UK	0	2.00*	0.75	3.95*	0.44	1.17	0.17	-0.08	-0.64*	0.02	-0.11	1.30*	1.05*	1.11*	1.39*	1.06*
	4	1.59*	1.00	2.98*	0.41	1.19*	0.16	0.04	-0.73*	0.03	-0.23	0.81	0.71	0.71	1.52*	0.80
	12	1.15	1.08	2.06*	0.85	0.92	-0.48	-0.19	-0.60	-0.22	-0.01	0.73	0.55	0.40	1.22*	0.73
	20	1.13	1.23	1.64	1.01	0.70	-0.64	-0.51	-0.17	-0.23	-0.10	0.62	0.43	0.33	0.95	0.87
US	0	2.27	2.62*	3.58*	-0.38	2.24*	-0.43	-0.62	-0.88*	1.33	-0.56	1.42*	1.32*	1.10*	3.80*	1.47*
	4	2.56*	1.87*	3.50*	-0.83	2.10*	-0.74	-0.64	-1.11*	1.34	-0.71*	0.52	0.99	0.75	3.10*	0.87
	12	1.82*	1.22	2.74*	0.76	1.24	-0.33	-0.44	-0.66	0.19	-0.18	0.51	1.09*	0.64	2.14*	0.88
	20	1.43	1.09	2.33*	1.44	1.22	-0.15	-0.34	-0.19	0.06	-0.15	0.74	1.06*	0.81	1.46	0.77

Note: $G = c^g + i^g + w^g n^g$, An * indicates multipliers that are significantly different from zero at one standard deviation.

shock	Canada			Japan			UK			US							
	0	4	12	20	0	4	12	20	0	4	12	20					
c^g	pre	0.92	0.80	2.62	2.96	1.55	0.01	-0.01	-0.28	2.78*	1.45	0.41	0.03	0.90	0.96	0.90	0.86
	post	1.19	-0.87	3.57	3.95	2.26*	2.67	2.68	2.67	1.21	0.75	0.36	0.69	3.37*	1.97	0.62	0.24
	dif.	0.27	-1.66	0.95	0.99	0.71	2.66	2.69	2.94	-1.57*	-0.70	-0.05	0.67	2.47*	1.01	-0.28	-0.62
i^g	pre	-0.01	1.41*	2.58	2.99	0.93	0.76	0.42	0.00	3.42	2.94	0.74	0.14	1.54*	1.39*	1.09*	0.93
	post	1.08	1.86	4.24	3.17	1.92	2.48	2.52	2.08	0.19	0.28	0.34	1.14	3.37	2.06*	0.97	0.49
	dif.	1.09	0.45	1.66	0.18	0.98	1.72	2.10	2.07	-3.22	-2.66	-0.41	1.00	1.83	0.66*	-0.13*	-0.44
v^g	pre	1.19*	1.71*	2.85*	2.63	1.67*	1.05	0.00	-0.27	1.60	0.96	0.52	0.27	2.52*	2.24*	1.74	1.18
	post	2.16*	2.23*	1.67	0.92	3.95*	3.38*	2.52	2.26	3.18*	1.76*	1.30*	1.09	3.88*	3.12*	1.51	1.26
	dif.	0.97*	0.52*	-1.18	-1.71	2.29*	2.33*	2.52	2.53	1.57*	0.81*	0.79*	0.82	1.36*	0.88*	-0.23	0.07
w^g	pre	-0.14	-0.79	3.44	3.13	1.09	0.51	0.01	-0.16	-0.24	-0.22	-0.14	-0.12	-0.07	0.09	0.97	1.23
	post	-0.07	-1.04	-1.72*	-0.72	-0.15	0.46	1.77	3.48	-0.30	-0.63	-0.60	0.19	-3.36*	1.05	1.25	0.57
	dif.	0.07	-0.25	-5.15*	-3.84	-1.24	-0.05	1.76	3.64	-0.07	-0.40	-0.46	0.31	-3.29*	0.95	0.28	-0.66

Note: An * indicates multipliers that are significantly different from zero at one standard deviation.

Table 5: Robustness analysis

		output multipliers associated with shocks to:					unemployment multipliers associated with shocks to:				
		c^g	i^g	v^g	w^g	G	c^g	i^g	v^g	w^g	G
Canada (Cholesky)	0	0.76*	0.44	1.27*	-0.67*	0.32*	0.06	-0.32*	-0.45*	0.39*	0.08*
	4	0.84*	0.25	2.05*	-2.85*	-0.05	0.09	-0.23	-0.59*	1.33*	0.16*
	12	1.40*	-0.71	1.66*	0.48	-0.03	0.10	-0.28	0.00	0.16	0.12
	20	0.94	-1.22	1.75*	1.77	-0.08	0.34	-0.16	0.24	-0.03	0.17
Japan (Cholesky)	0	0.62*	0.93*	4.42	1.01	0.81*	0.02	-0.03	0.02	-0.05	-0.23
	4	2.02	1.56*	0.79	1.28	1.22*	-0.01	-0.04	0.13	-0.03	0.23
	12	3.50	1.52*	0.52	1.15	1.47*	-0.05	-0.06	0.32*	-0.01	2.71
	20	3.68	0.57	2.60	1.34	1.32	-0.04	0.01	0.33	0.01	3.99*
UK (Cholesky)	0	0.45*	0.05	1.82*	0.48*	0.31*	-0.02	0.03	-0.11	0.01	0.02
	4	0.16	0.01	1.20*	0.61*	0.23*	0.07	0.11	-0.08	-0.02	0.08*
	12	0.25	0.37	1.56*	0.91	0.37*	0.15	0.08	0.02	-0.30*	0.10
	20	0.65	0.77	1.16	0.78	0.47	0.03	-0.05	0.27	-0.44*	0.11
US (Cholesky)	0	1.40*	1.85*	3.66*	-0.92*	1.48*	-0.02	-0.07	0.04	0.19	-0.05
	4	1.73*	1.10*	3.37*	-1.28	1.05*	-0.13	0.01	-0.27	0.62	-0.06
	12	1.63*	0.94	3.43*	0.32	1.27*	-0.20	-0.23	-0.50*	0.07	-0.17*
	20	1.34*	1.09*	2.95*	1.72	1.45*	-0.07	-0.24	-0.18	-0.21	-0.17
US (Expectations)	0	2.82*	2.36	3.44*	-2.87	2.35*	-0.72	-0.44	-0.25	1.04	-0.52*
	4	1.93	1.81	2.74	0.16	2.29*	-0.41	-0.21	-0.09	-0.01	-0.55*
	12	1.44	1.09	1.79	0.97	0.68	-0.08	-0.31	-0.06	-0.23	0.08
	20	0.61	0.49	1.38	0.66	0.07	0.07	-0.17	0.05	0.14	0.07

Note: An * indicates multipliers that are significantly different from zero at one standard deviation.

Figures

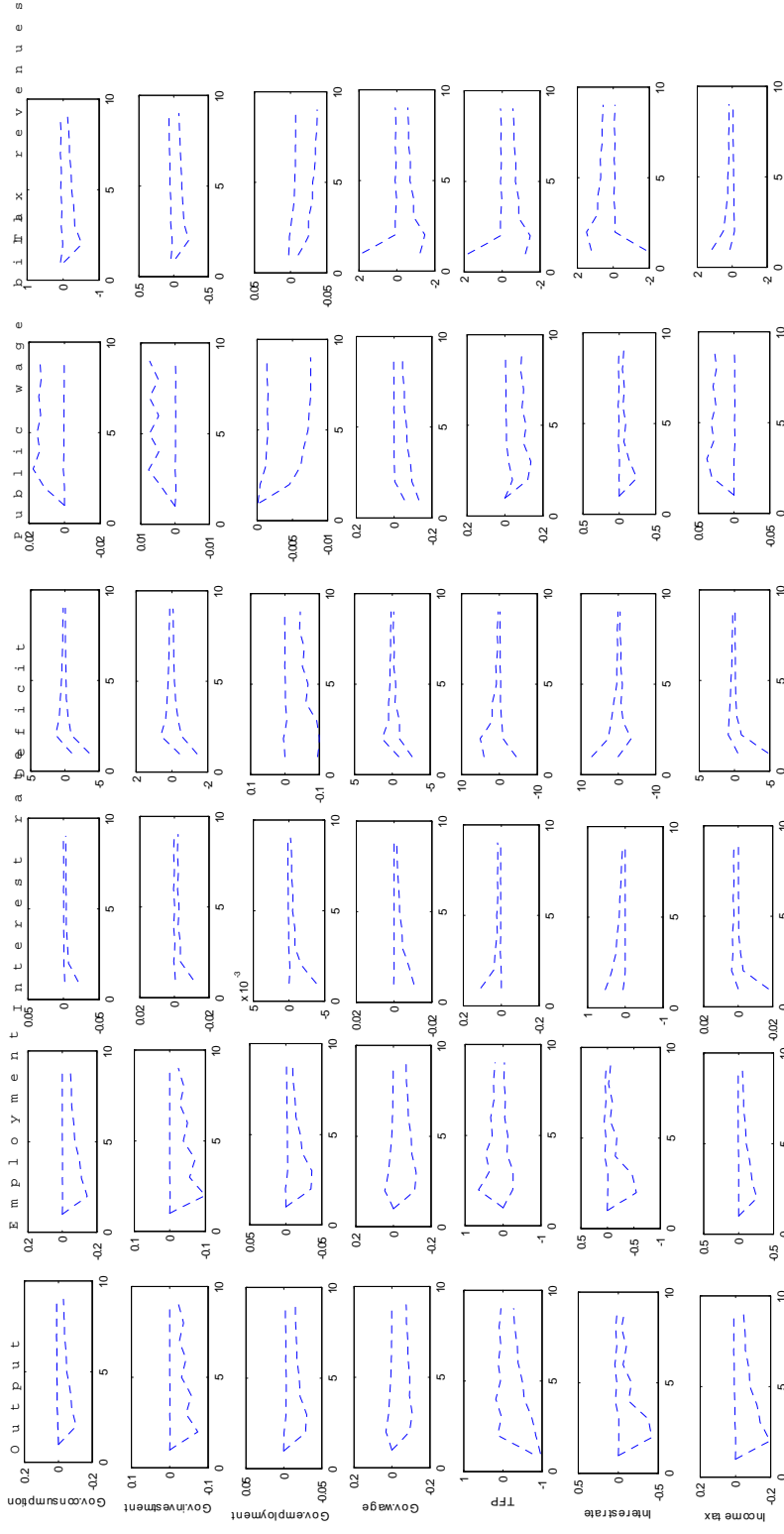


Figure 1: Robust sign restrictions, theoretical responses to negative shocks

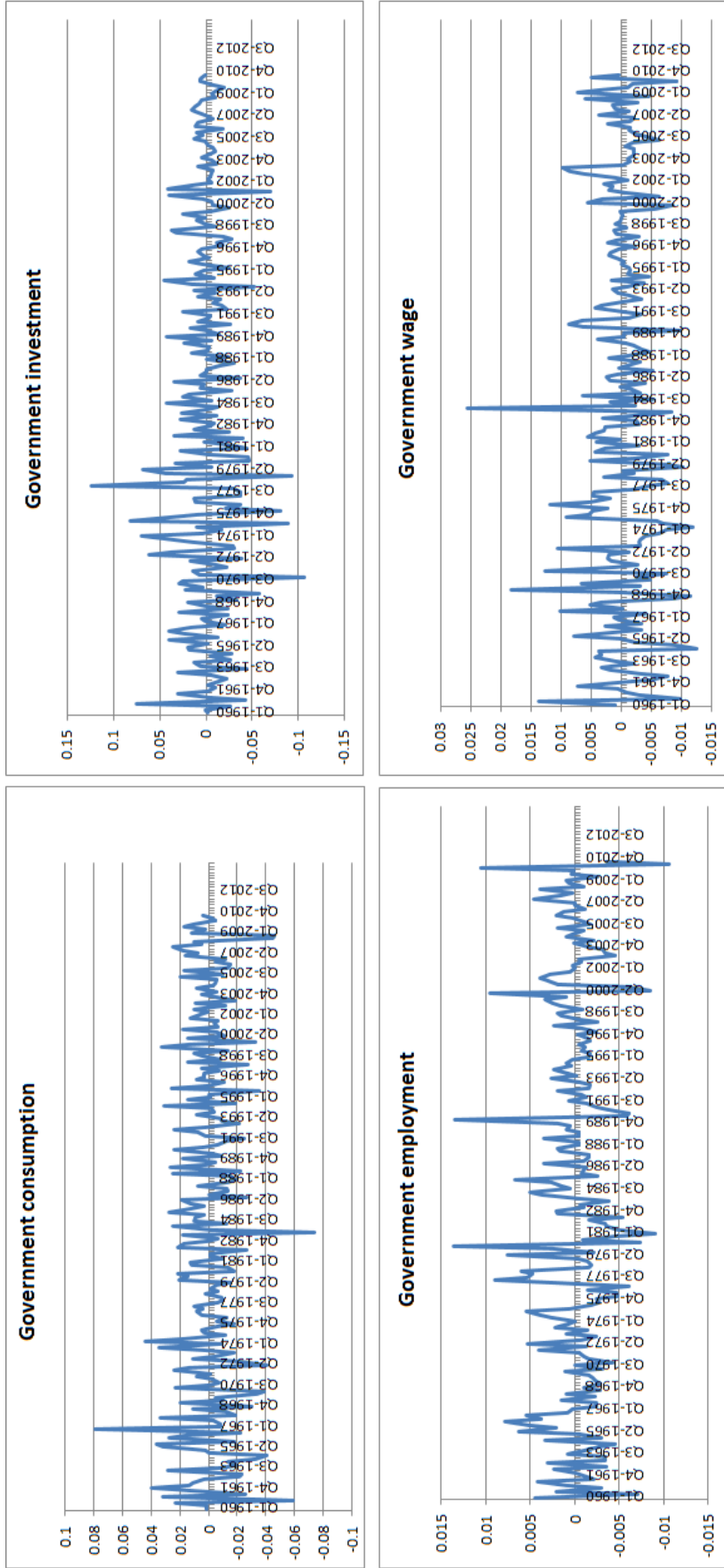


Figure 2: The cyclical component of the quarterly growth changes in the US fiscal variables

consumption cut investment cut vacancy cut wage cut

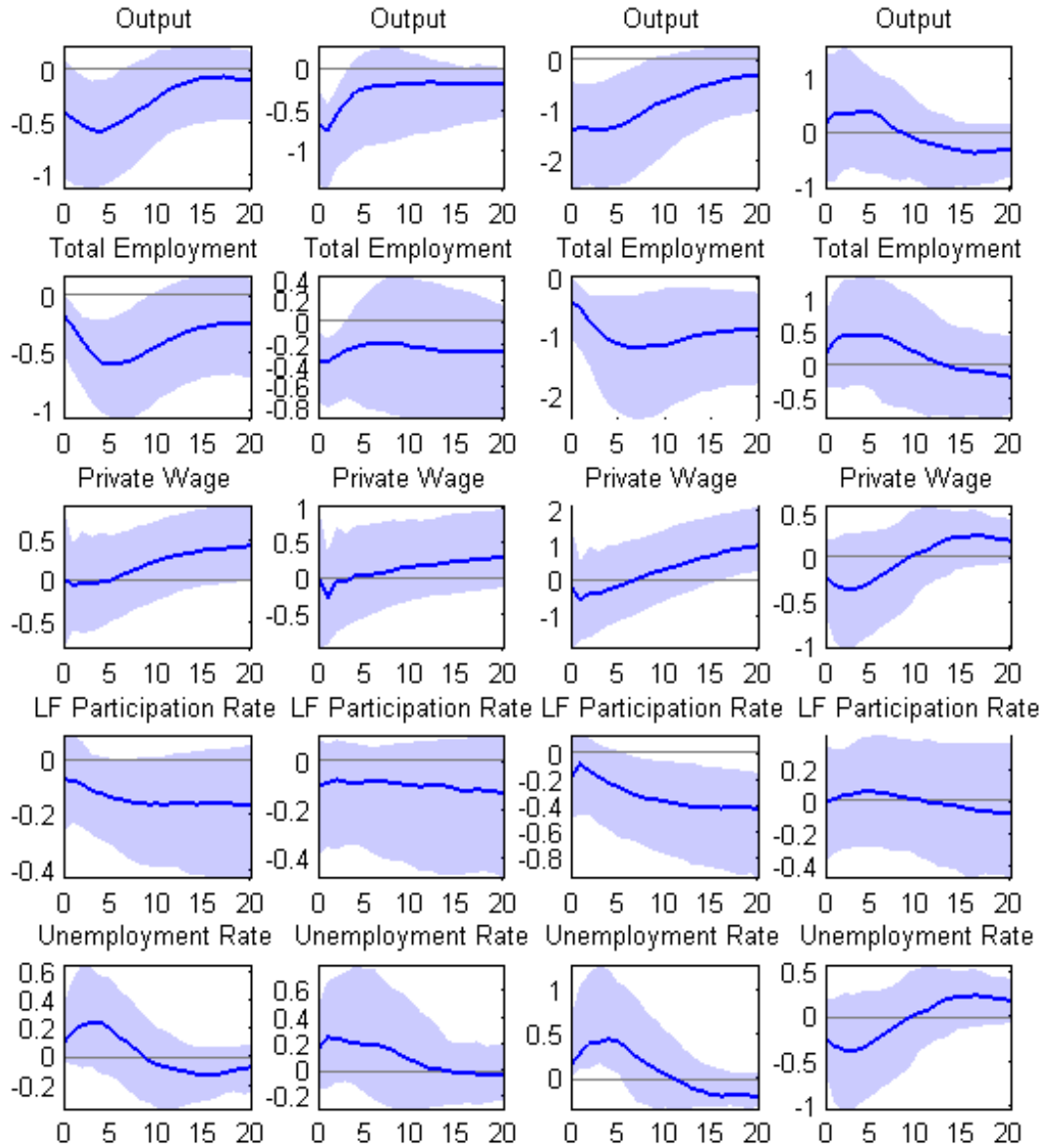


Figure 3: Impulse responses to fiscal shocks in the US

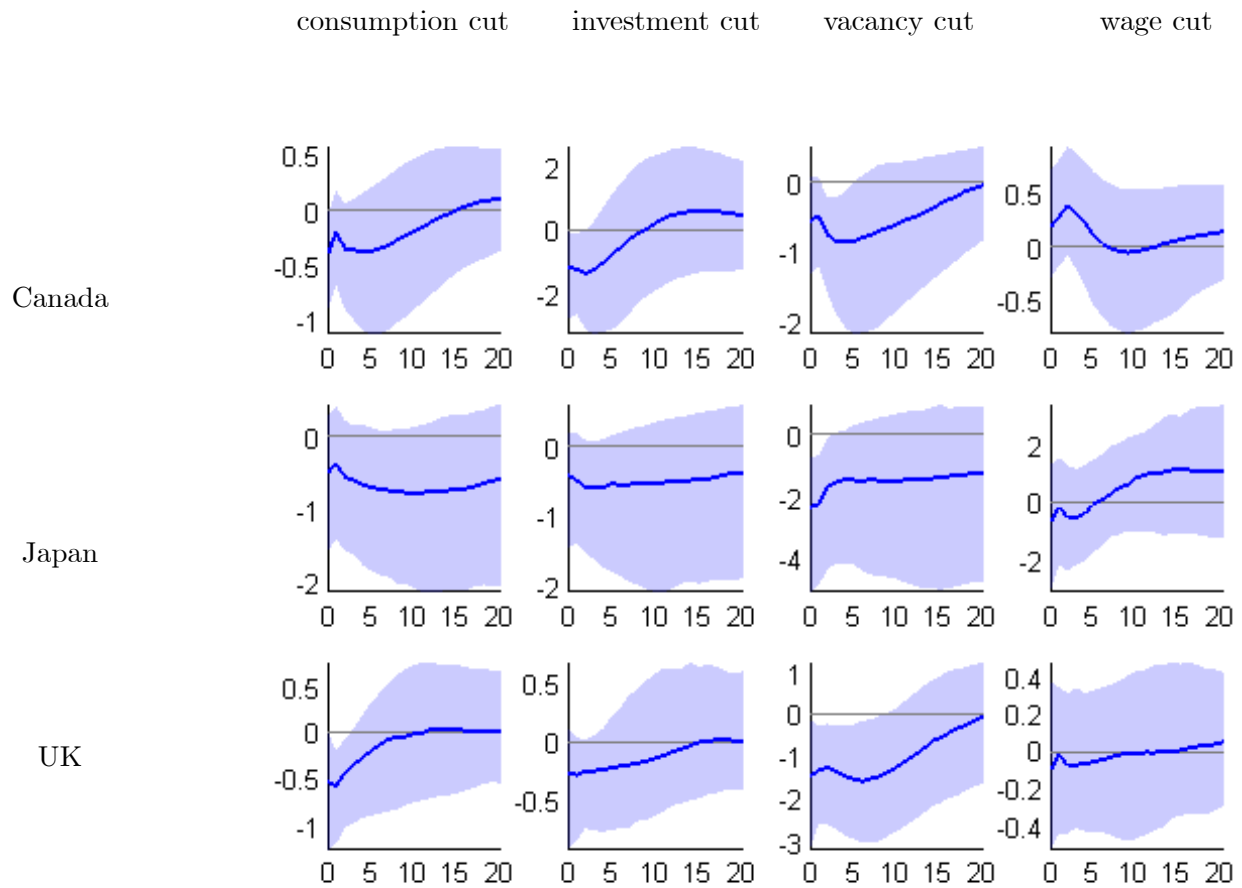


Figure 4: Output responses to fiscal shocks in other OECD countries

consumption cut investment cut vacancy cut wage cut

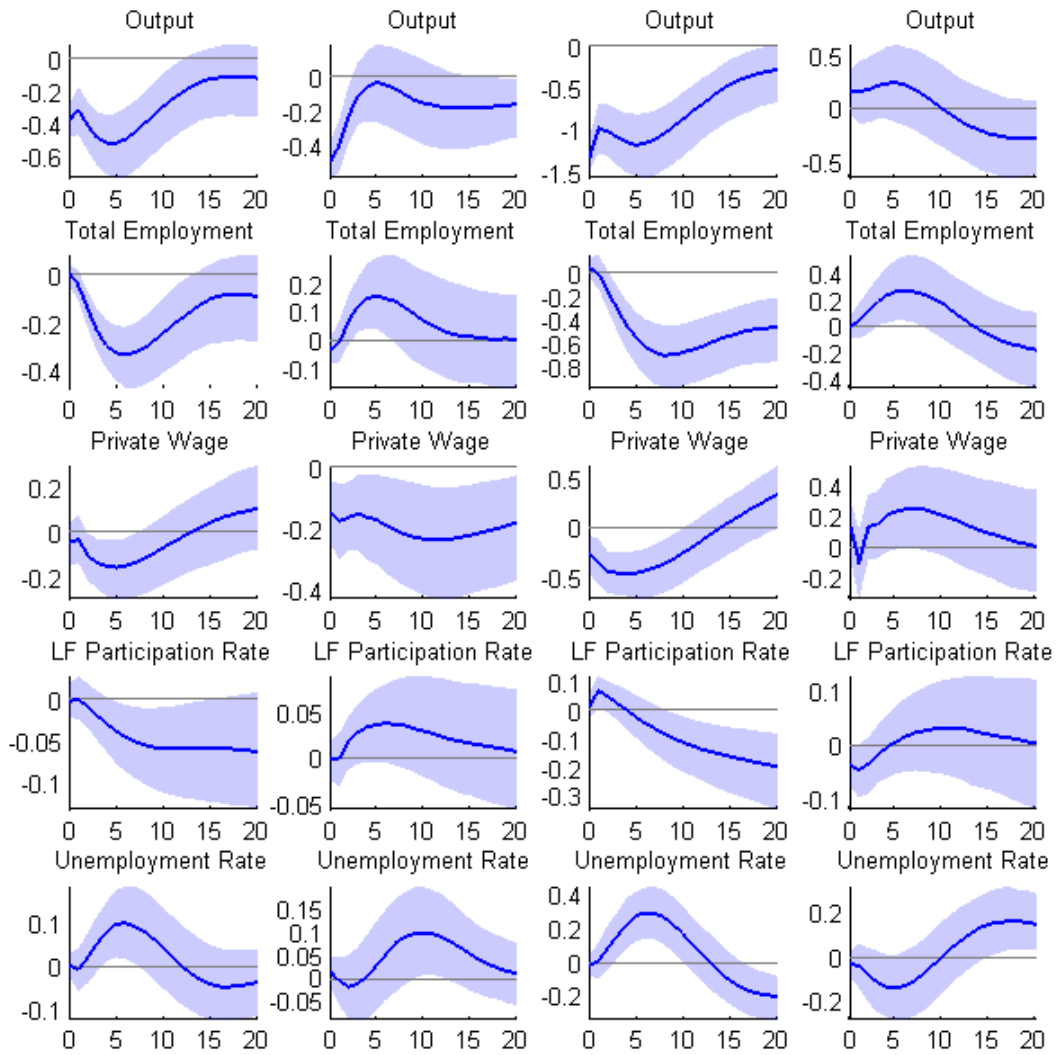


Figure 5: Impulse responses to fiscal shocks in the US, Cholesky identification

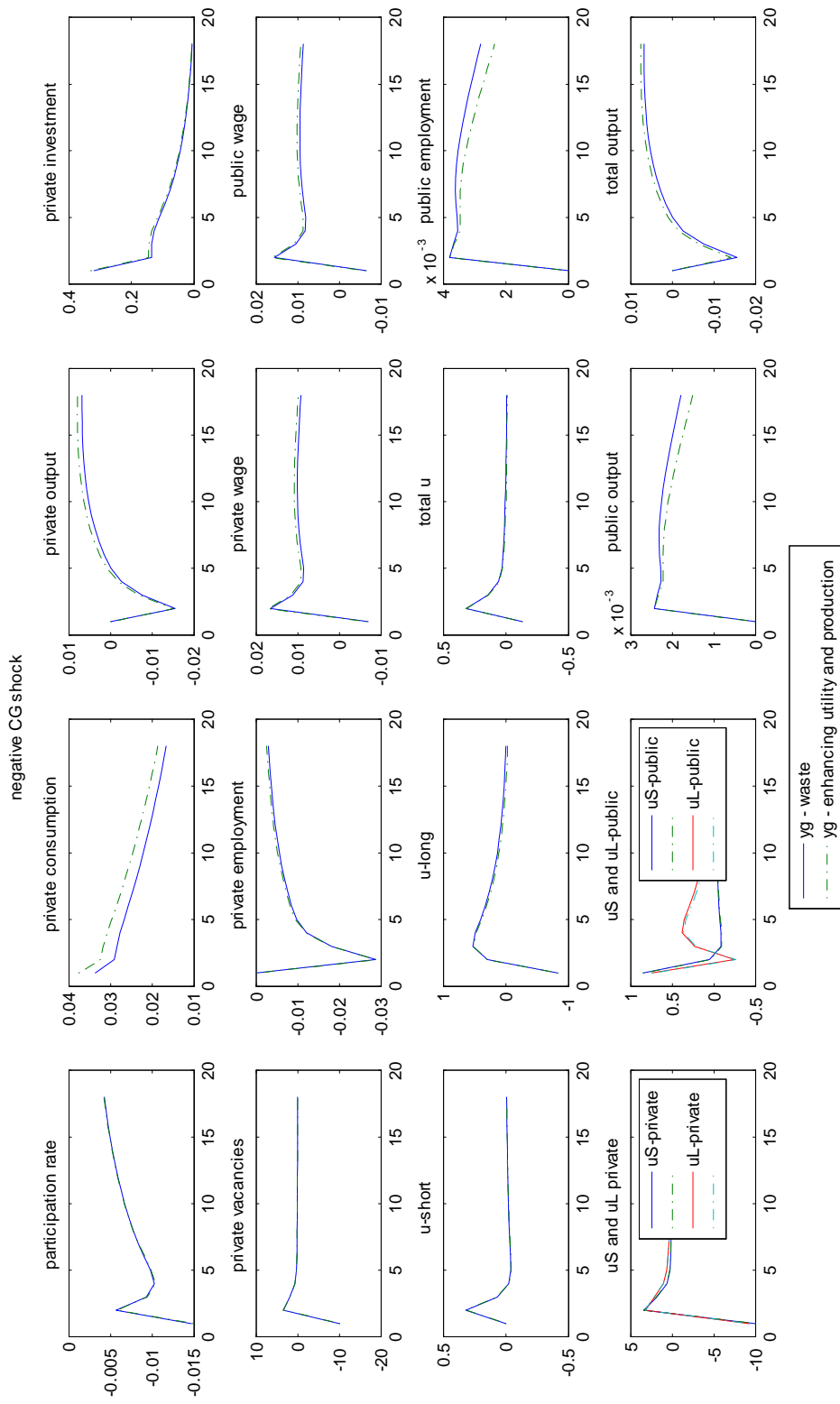


Figure 6: Theoretical impulse responses to a government consumption cut

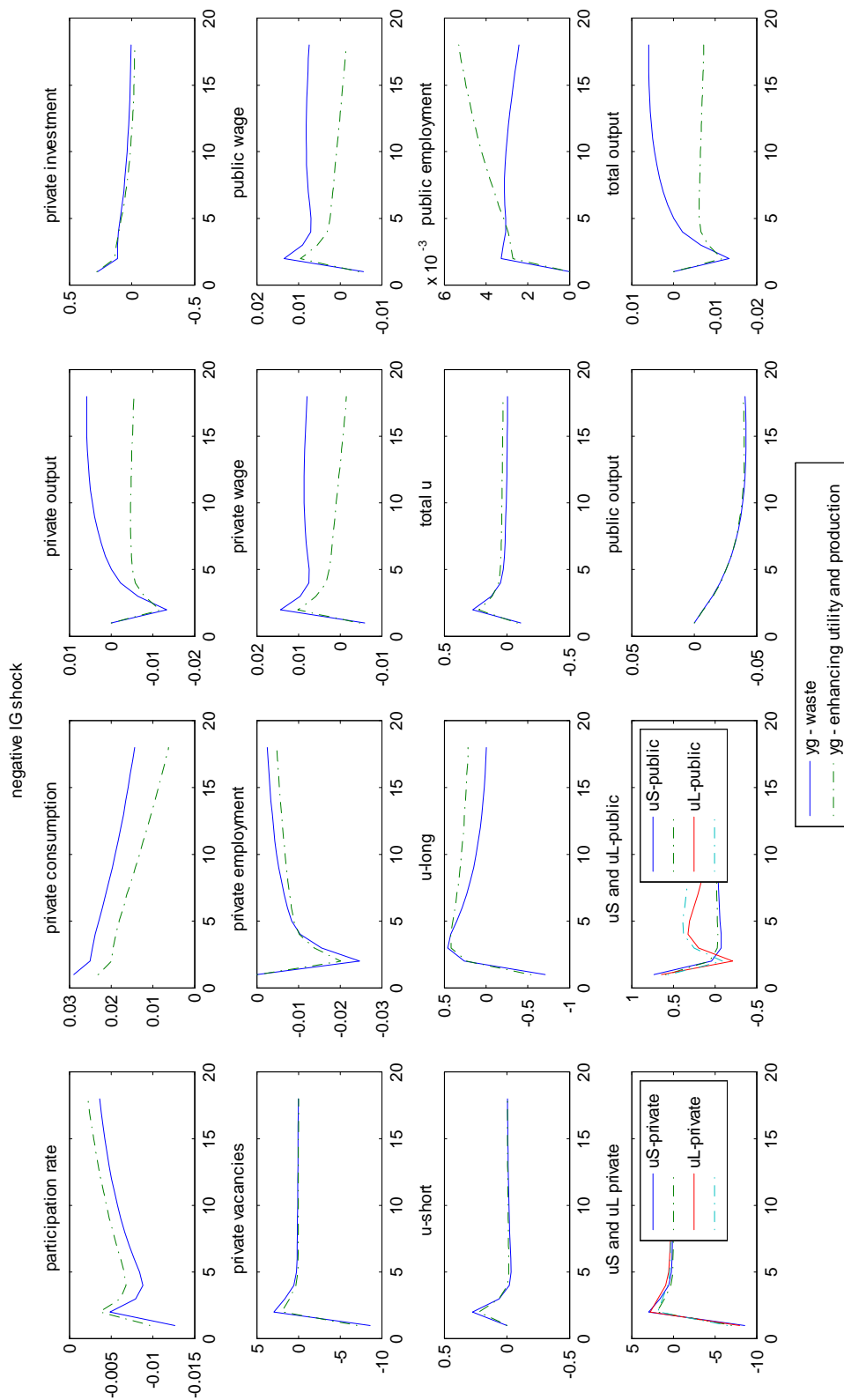


Figure 7: Theoretical impulse responses to a government investment cut

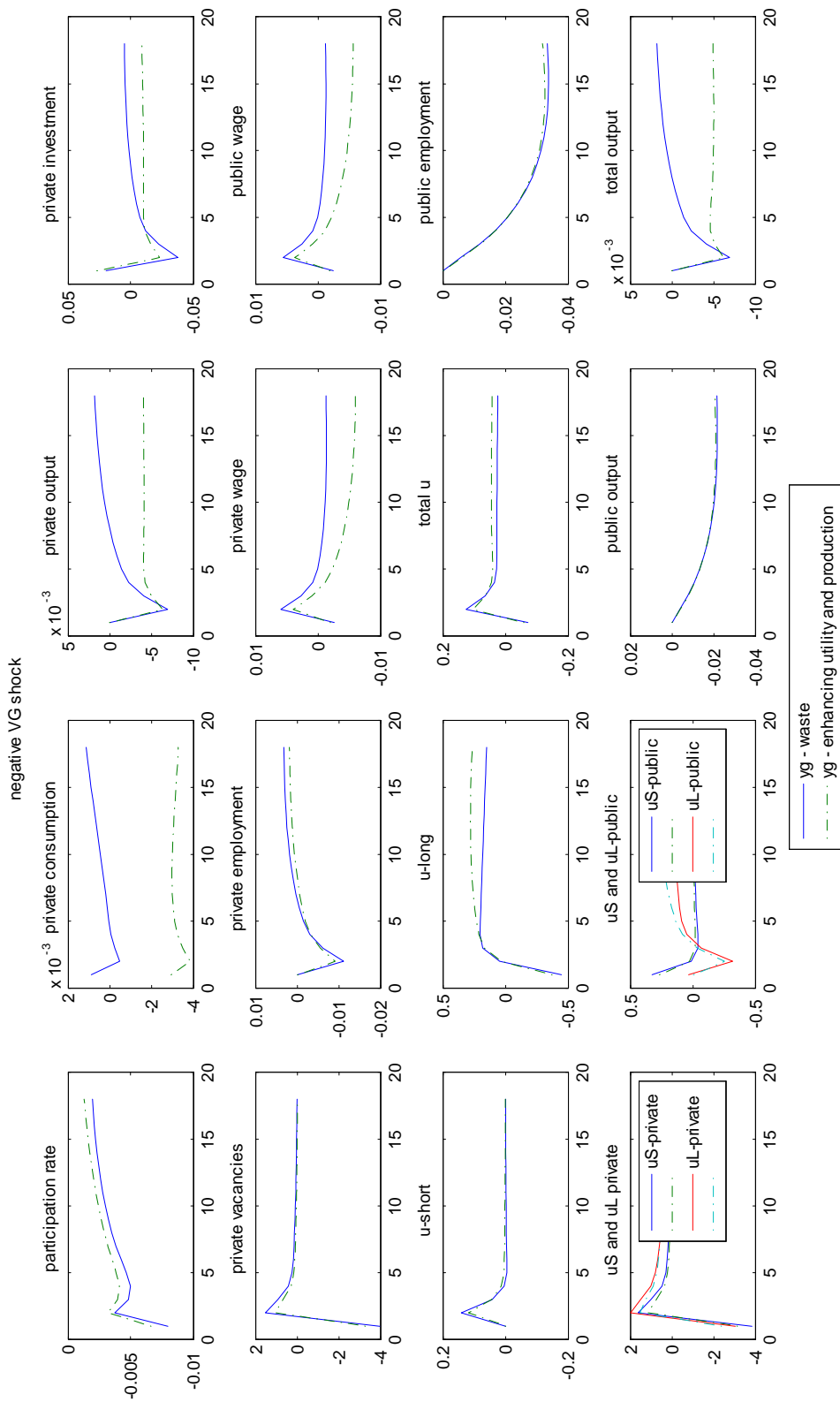


Figure 8: Theoretical impulse responses to a government vacancy cut

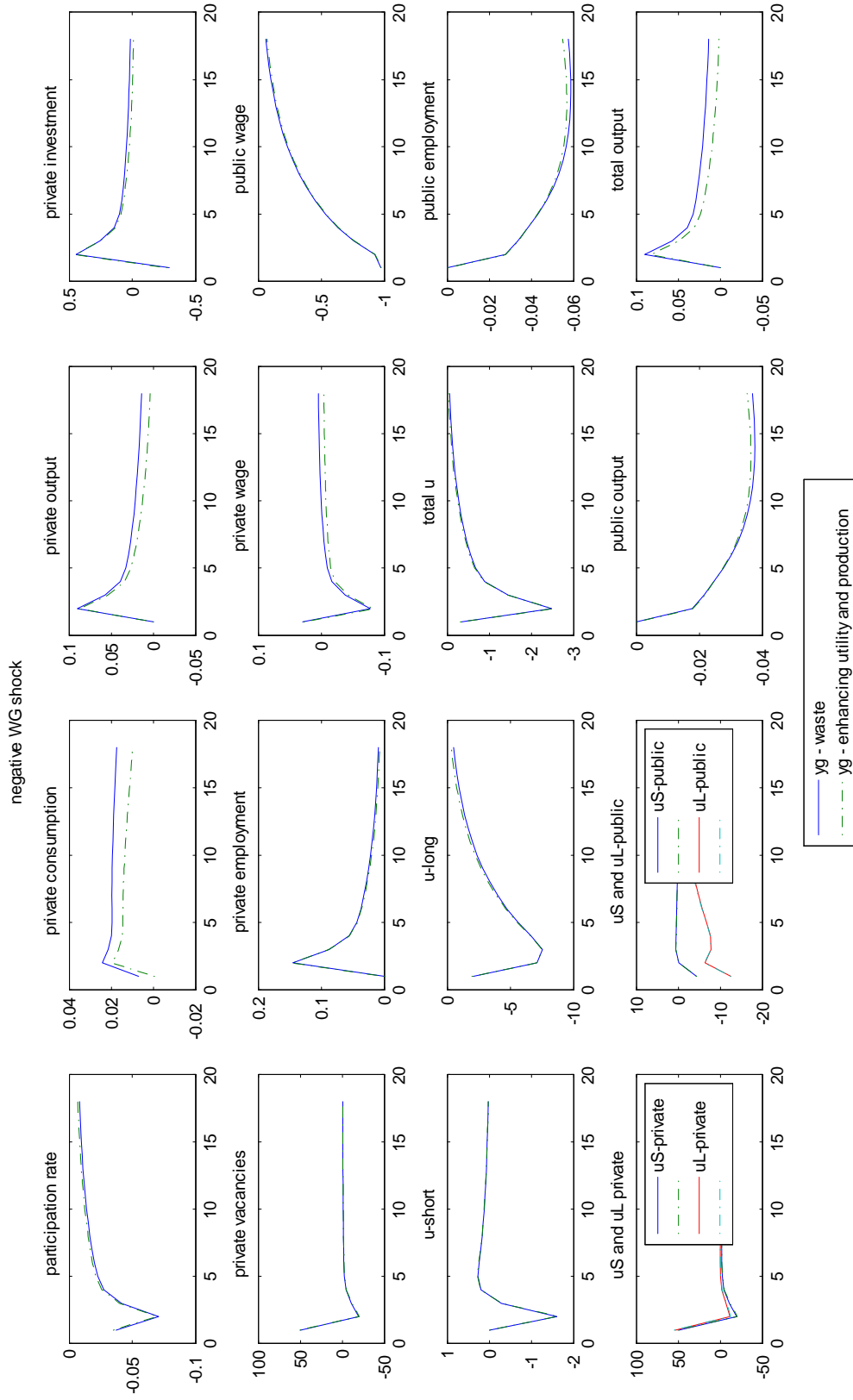


Figure 9: Theoretical impulse responses to a government wage cut

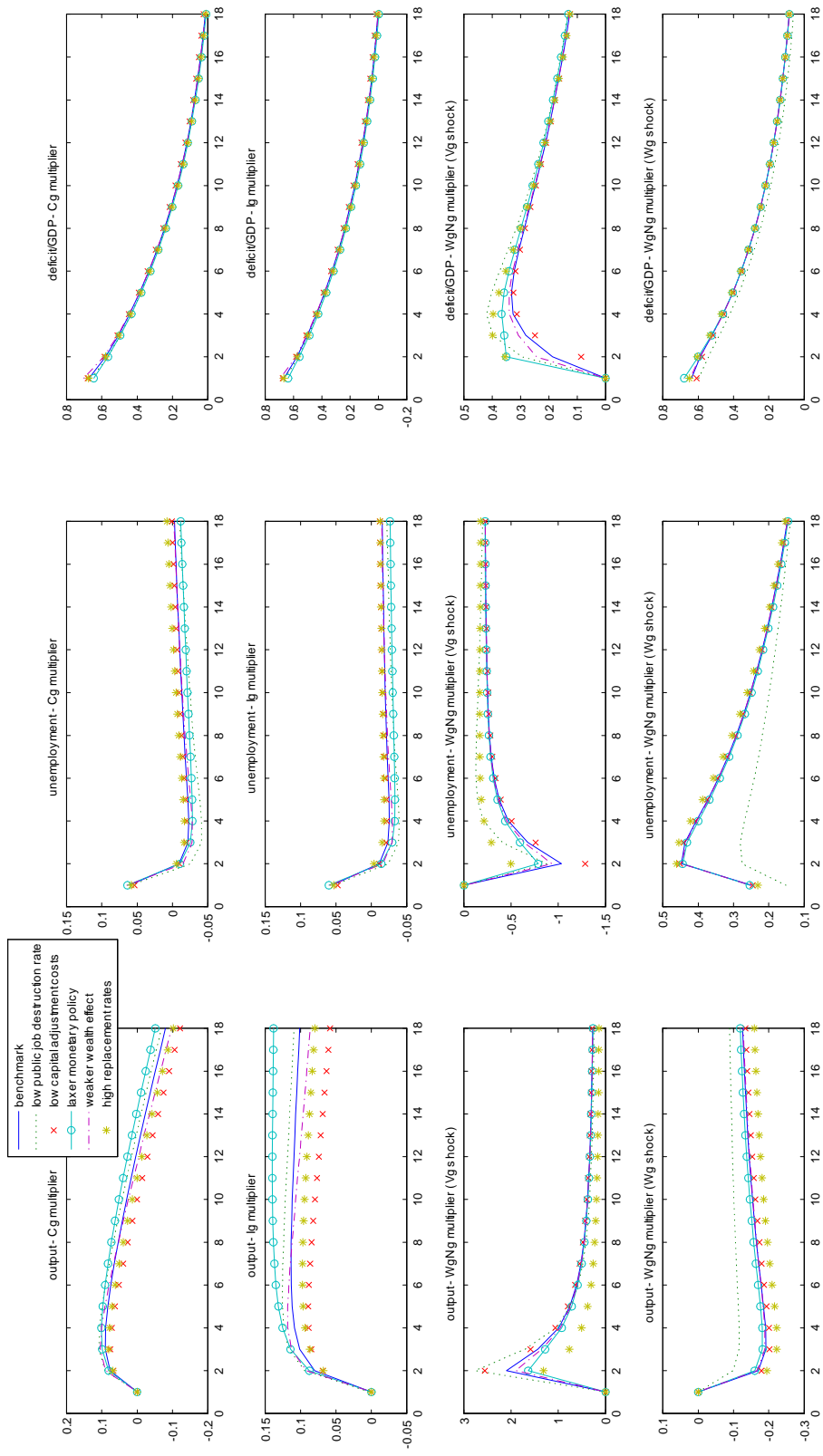


Figure 10: Sensitivity analysis for output, unemployment and deficit-to-GDP multipliers



Figure 11: Impulse responses to fiscal shocks in the US
from a VAR with private employment