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ABSTRACT

Spending-based austerity measures and their effects on output and unemployment

We compare the output and unemployment 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, vacancies and government wages in a SVAR using sign restrictions extracted from a New-Keynesian model with matching frictions in the private and public sector, endogenous labor force participation and heterogeneous unemployed jobseekers. Government vacancy cuts are associated with the highest output losses and the lowest gains in terms of deficit reductions. This is because such shocks generate an additional wealth effect: they induce a fall in the number of working members of the household that leads to a fall in private consumption and investment demand. On the other hand, government wage cuts are the least destructive device for cutting the budget.

JEL Classification: C11, E12, E32 and E62
Keywords: austerity, NK model, output and unemployment multipliers, search and matching frictions, sign restrictions and VARs

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1 Introduction

How does an economy react to austerity measures? This question has become central in academic and policy circles over the last years. The recovery from the financial distress has been rather slow and fragile in many regions of the world economy. Growth in the industrial countries was throttled by the excessive government debt and the financial failure transformed into a fiscal crisis in many countries. The rise in government debt and the higher risk perception by financial markets have triggered a crisis of public budgets. The fiscal stimulation measures during the offset of the crisis have raised government debt and many countries were obliged to cut spending items from their budget and increase the tax rates so as to decrease government deficits.

Austerity measures are usually expected to imply short-term contractionary effects on output, given the Keynesian positive fiscal spending multiplier. In the empirical literature the effects of fiscal shocks typically depend on the methodology used to extract them from the data and on the identification restrictions employed. Studies using the 'Dummy Variable' approach, which consider 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), find that a positive shock to spending for national defense makes private consumption and the real wage fall, while employment and nonresidential investments increase, generating multipliers lower than one. The strand of literature employing the Structural Vector Autoregression (SVAR) methodology, which identifies fiscal shocks by 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), concludes that private consumption, output, employment and the real wage positively comove with the spending shock and estimated multipliers usually vary in the range of (0.8, 1.2).[1] Furthermore, Monacelli et al. (2010) have estimated an unemployment multiplier for the US of 0.6 at peak (in absolute percentage points). 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. The evidence that this literature produces is somewhat mixed, but a reconciliation offered by Caldara and Kamps (2008) suggests that positive shocks to government expenditure tend to increase employment and real wages and to generate output multipliers larger than one, while tax shocks are associated with higher multipliers.

[1] Perotti (2007) reconciles the results in the two strands of literature.

Theoretical models have hard time to generate significant aggregate demand effects after government spending expansions. Hall (2009) and Woodford (2011) use simple analytical frameworks within the mainstream New-Keynesian paradigm to understand the effects of government spending and the assumptions necessary to generate high output multipliers.[2] Coenen et al. (2012) perform similar exercises in seven large-scale models used by policy institutions in the developed world. Finally, Christiano et al. (2009) focus on the interactions between expansionary fiscal policy and the zero bound constraint on monetary policy as a mechanism for producing considerable demand effects from government spending shocks.

Recently, Alesina et al. (2012) and Leigh et al. (2010) suggest that the output effects of fiscal adjustments depend on how the consolidation occurs. They show that fiscal adjustments based upon spending cuts are less costly in terms of output losses than tax-based ones. Using multi-year fiscal consolidation episodes identified in Devries et al. (2011) for the period 1980-2005 they show that spending-based adjustments have been associated with mild and short-lived recessions and, in many cases with no recession at all, while tax-based adjustments have been followed by prolonged and deep recessions. Batini et al. (2012) find that smooth and gradual consolidations are preferable to frontloaded or aggressive consolidations for economies in recession because sheltering growth is a key factor in these cases. In a similar vein, Hernández de Cos and Moral-Benito (2011) conclude, using Bayesian model averaging techniques, that growth-enhancing policies and cuts in public wages are the most appropriate ingredients of successful fiscal consolidations. On the other hand, Erceg and Lindé (2013) focus on the interactions between fiscal consolidation and monetary policy and using a two-country DSGE model of a monetary union show that the effects of tax-based versus expenditure-based consolidations depend on the degree of monetary accommodation.

All the recent existing analysis considers general cuts in government expenditures. But, are all components equally harmful in reducing demand or is there a lever which is stronger for a given amount cut by the government? With the exception of Pappa (2009) and Hernández de Cos and Moral-Benito (2011), the focus in the literature has so far been on the effects of total government expenditure shocks.[3] Moreover, apart from Leigh et al. (2010), most of the existing analysis concentrates on the output losses from fiscal adjustments and neglects the effects of fiscal consolidations on unemployment. Given the rise in unemployment after the crisis in

[2] See also, Ravn et al. (2006), Cantore et al. (forthcoming), Monacelli and Perotti (2008) among others.

[3] Perotti (1996) provides a good summary of earlier literature on fiscal consolidations when different components of spending are considered. Auerbach and Gorodnichenko (2012) also distinguish between different types of government spending, but do not consider government vacancy and wage shocks.

both the US and Europe, studying the effects of such cuts on unemployment is fundamental. The purpose of this paper is to compare the output and unemployment losses generated by adjustments in different types of government outlays.

We use a structural VAR and identify fiscal shocks via sign restrictions derived from theory. To this end, we build a general Dynamic Stochastic General Equilibrium (DSGE) model with endogenous labor force participation, matching frictions and unemployment that can be either long- or short-term and specific to the private or the public sector. Using sign restrictions we identify shocks to government (a) consumption, (b) investment, (c) vacancies and (d) wages in order to assess which item is the most painless to cut. The analysis focuses on the US, but to robustify inference we also look at other three OECD countries for which we have data (Canada, Japan and the UK).

For a wide range of parameterizations a negative shock to (a), (b) and (c) decreases total output for some periods after the shock and the deficit on impact, while tax revenues have a low or slightly negative correlation with the shock on impact. These restrictions distinguish fiscal shocks from other shocks, such as TFP or interest rate shocks, since those induce a negative correlation between deficits and output on impact. On the other hand, public wage cuts robustly decrease the deficit and the wage bill on impact, but increase output with a lag, while TFP and interest rate shocks increase deficits and decrease both output and the government wage bill. Hence, to identify shocks (a), (b), and (c) in the data, we restrict the contemporaneous response of the deficit and the lagged response of output to positively comove with the fiscal disturbance and we restrict the contemporaneous responses of the deficit and the wage bill to negatively comove with the lagged output response for shock (d). Since tax hikes might also reduce output and deficits, we require a zero or slightly positive correlation between the identified shock and tax revenues on impact. Once shocks are identified, we compute output and unemployment multipliers to quantify the losses associated with the different types of spending cuts. We also compute deficit-to-GDP multipliers to compare the gains in terms of deficit reductions from the different types of spending cuts.

Our methodology gives similar results with the existing literature when we identify fiscal shocks as shocks to total government expenditure. Yet, when we consider shocks in different spending components we find that the associated multipliers differ significantly: cuts in the wage bill component achieved through government vacancy cuts generate the largest output and unemployment losses and the smallest gains in terms of deficit reductions, regardless of the sample and the country, while wage bill cuts coming from reductions in the public wage have expansionary effects and achieve the largest deficit reductions. In particular, a 1% of GDP cut in government consumption, investment, and wage bill expenditures coming from a decrease in public vacancies in the US, decreases output on impact by 0.98%, 1.35%, and 6.24%; raises the unemployment rate by 0.77, 0.78 and 1.79 percentage points; and reduces deficits as a share of GDP by 0.23, 0.25 and 0.10 percentage points, respectively. On the other hand, a 1% of GDP fall in wage bill expenditures stemming from a cut in public wages increases output on impact by 2.92%; reduces unemployment by 0.12 percentage points; and decreases the deficit-to-GDP ratio by 0.55 percentage points.

The fact that cuts in government vacancies are more harmful than cuts in government consumption is intuitive. But, how can one explain the fact that government vacancy cuts can be more contractionary than cuts in government investment? The theoretical model we developed suggests that in addition to the standard wealth effect that decreases the labor supply and the labor demand effect associated with price rigidities, government investment and vacancy cuts also produce a negative wealth effect since they may decrease the productivity of private inputs. This latter effect adds persistence to the responses with respect to both shocks. Furthermore, there is an additional channel at work for government vacancy shocks: public vacancy cuts reduce the number of employed members of the household and generate a negative wealth effect that suppresses demand for both consumption and investment with a delay, propagating the initial restraint.

Our model also predicts that wage cuts are expansionary since they reallocate labor supply from the public to the private sector. As a result, the private real wage falls and private employment increases generating increases in private output and reducing unemployment. The data confirm our theoretical predictions as the identified shocks to the government wage reduce the real wage and increase private employment, reducing substantially the unemployment rate.

We have examined the sensitivity of our results to different identification schemes, different sample periods, and the inclusion of different variables in the VAR and our conclusions hold unchanged. The facts we uncover are useful to policymakers in a number of ways. First, estimating the output losses of total government spending cuts might be misleading since the analysis of specific government spending components cuts reveals that different items of the budget affect differently the macroeconomy. Second, our results highlight that unexpected contractions in government vacancies are the most harmful tool for cutting the budget in terms of output losses and the least effective in terms of deficit reductions. Contrary to the common wisdom, and with the exception of Canada, government investment cuts do not generate stronger output effects at the horizons of interest. However, since they are likely to decrease labor productivity and private investment more than government consumption shocks, they enjoy important long-run implications. Third, government wage cuts is the most preferable austerity measure, since it increases employment and production through workers reallocation from the public to the private sector, it reduces the unemployment rate through the combination of the negative wealth effect that reduces labor force participation and the relative increase in private labor supply, and it generates the largest reductions in the deficit-to-GDP ratio. Fourth, while the evidence is mixed concerning consumption and investment cuts, the contractionary effects of government vacancy cuts and the expansionary effects of government wage cuts have been significantly amplified during the last two decades in all countries. Our model gives some guidance in explaining changes in the transmission of government employment and wage shocks: decreases in public job protection and a more aggressive monetary policy increase the size of the government vacancy and wage multipliers and make government vacancy cuts more destructive and wage cuts more expansionary. First, Japan has experienced significant changes in employment protection (see, Gnocchi and Pappa (2012)) and, second, 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 explain the changing effects of fiscal shocks to the wage component of government 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. Section 3 presents the econometric framework. Results appear in Section 4 and Section 5 studies their robustness. Section 6 investigates how we can reconcile the empirical evidence with our theoretical model and Section 7 concludes.

2 Identifying fiscal shocks: The methodology

The methodology to extract fiscal shocks in the data involves four steps. In the first step, we establish robust restrictions for the comovements of the deficit and lagged output for the shocks we consider. In the second step, we show that the restrictions used to identify fiscal shocks cannot be produced by other shocks and in the third step how model-based restrictions can be used to identify fiscal shocks in the data. In the final step we compute the magnitude of the output, unemployment and deficit 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 that can be used for productive and utility-enhancing purposes (ii) private competitive intermediate firms that use private inputs and the public good to produce a final good; (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 representative household's members consist of employees, unemployed, and labor force non-participants.

2.1.1 Public employment, participation, and heterogeneity of unemployment

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. Recently, Campolmi and Gnocchi (2011) have added a labor force participation choice and Brückner and Pappa (2012) jobseekers' heterogeneity in a New-Keynesian model of equilibrium unemployment. 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 forgoing 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:

$$n_t^p + n_t^g + u_t^S + u_t^L + l_t = 1 \tag{1}$$

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 remainder part, $1 - s_t^S$ ($1 - s_t^L$), are 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:

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

for $j = p, g$, 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, which is a feature that makes public jobs more attractive.

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:

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

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

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

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

where we assume that the matching efficiency is higher for the short rather than the long-term unemployed, i.e. $\rho_m^S > \rho_m^L$, and υ_t^j for $j = g, p$ denotes vacancies in the two sectors. 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}:

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

$$\psi_t^{fj} \equiv \frac{m_t^j}{v_t^j} \tag{7}$$

Finally, market tightness for each sector is defined as:

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

2.1.2 Household's behavior

The representative household is infinitely lived and derives utility from private consumption, c_t^p, the public good, y_t^g, which is supplied free of price by the government, and the fraction of members that are out of the labor force and enjoy leisure, l_t:

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

where $\frac{1}{\eta}$ is the intertemporal elasticity of substitution, $\Phi > 0$ is a preference parameter related to leisure, $z \geq 0$ determines the size of the utility gains from the consumption of the public good and ψ is the inverse of the Frisch elasticity of labor supply.

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

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

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

$$c_t^p + i_t^p + \frac{B_{t+1}}{p_t R_t} \leq \left[r_t^p - \tau_k(r_t^p - \delta^p)\right] k_t^p + (1-\tau_n)(w_t^p n_t^p + w_t^g n_t^g) + bu_t + \frac{B_t}{p_t} + \Pi_t^p - T_t \tag{11}$$

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_k, τ_n and T_t represent taxes on capital income (allowing for depreciation), labor income and lump-sum taxes, respectively.

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 its expected lifetime utility subject to (1), (2), (3), (6), (10), and (11):

$$n_{t+1}^p = (1-\sigma^p)n_t^p + \psi_t^{hpS}(1-s_t^S)u_t^S + \psi_t^{hpL}(1-s_t^L)u_t^L \tag{12}$$

$$n_{t+1}^g = (1-\sigma^g)n_t^g + \psi_t^{hgS}s_t^S u_t^S + \psi_t^{hgL}s_t^L u_t^L \tag{13}$$

$$u_{t+1}^S = \sigma^p n_t^p + \sigma^g n_t^g + (1-\xi)u_t^S - \left[\psi_t^{hpS}(1-s_t^S) + \psi_t^{hgS}s_t^S\right] u_t^S \tag{14}$$

where (12)-(14) correspond to (2)-(3) after using (6). The first-order conditions from the household's maximization problem are presented in the Companion Appendix.[4]

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

$$V_{n^p t}^H = (c_t^p + z y_t^g)^{-\eta}(1-\tau_n)w_t^p - U_{l,t} + (1-\sigma^p)\lambda_{n^p t} + \sigma^p \underbrace{\beta E_t V_{u^S t+1}^H}_{\lambda_{u^S t}} \tag{15}$$

According to (15), $V_{n^p t}^H$ 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.

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

2.1.3 The production side

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

$$y_t^p = (\varepsilon_t^A n_t^p)^{1-\varphi}(k_t^p)^{\varphi}(y_t^g)^{\nu} \tag{16}$$

where ε_t^A is an aggregate technology shock, 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 workers currently employed, n_t^p, is taken as given and the employment decision concerns the number of vacancies posted in the current period, υ_t^p, so as to employ the desired number of workers next period, n_{t+1}^p.[5] 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 υ_t^p to maximize:

$$Q^p(n_t^p, k_t^p) = \max_{k_t^p, \upsilon_t^p} \left\{ x_t(\varepsilon_t^A n_t^p)^{1-\varphi}(k_t^p)^{\varphi}(y_t^g)^{\nu} - w_t^p n_t^p - r_t^p k_t^p - \kappa \upsilon_t^p + E_t\left[\Lambda_{t,t+1} Q^p(n_{t+1}^p, k_{t+1}^p)\right] \right\} \tag{17}$$

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:

$$n_{t+1}^p = (1-\sigma^p)n_t^p + \psi_t^{fp}\upsilon_t^p \tag{18}$$

The first-order conditions are:

$$x_t \varphi \frac{y_t^p}{k_t^p} = r_t^p \tag{19}$$

$$\frac{\kappa}{\psi_t^{fp}} = E_t \Lambda_{t,t+1}\left[x_{t+1}(1-\varphi)\frac{y_{t+1}^p}{n_{t+1}^p} - w_{t+1}^p + \frac{(1-\sigma^p)\kappa}{\psi_{t+1}^{fp}} \right] \tag{20}$$

[5] Firms 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.

According to (19) and (20) the value of the marginal product of private capital should equal 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, $V^F_{n^p t}$ is:

$$V^F_{n^p t} \equiv \frac{\partial Q^p}{\partial n^p_t} = x_t(1-\varphi)\frac{y^p_t}{n^p_t} - w^p_t + \frac{(1-\sigma^p)\kappa}{\psi^{fp}_t} \tag{21}$$

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 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:

$$y^p_t = \left[\int_0^1 (y^p_{it})^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{22}$$

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:

$$y^p_{it} = \left(\frac{p_{it}}{p_t}\right)^{-\varepsilon} y^p_t \tag{23}$$

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:

$$p_t = \left[(1-\chi)(p^*_t)^{1-\varepsilon} + \chi(p_{t-1})^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{24}$$

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

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

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

$$p_{it}^* = \frac{\varepsilon}{\varepsilon - 1} \frac{E_t \sum_{s=0}^{\infty} \chi^s \Lambda_{t+s} x_{t+s} y_{it+s}^p}{E_t \sum_{s=0}^{\infty} \chi^s \Lambda_{t+s} y_{it+s}^p} \tag{25}$$

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 firms' bargaining power, the problem is to maximize the weighted sum of log surpluses:

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

where $V_{n^p t}^H$ and $V_{n^p t}^F$ have been defined in (15) and (21), respectively. The optimization problem leads to:

$$(1-\vartheta)(1-\tau_n) \left(c_t^p + z y_t^g\right)^{-\eta} V_{n^p t}^F = \vartheta V_{n^p t}^H \tag{26}$$

Solving (26) for w_t^p, using the households FOC results in:[6]

$$w_t^p = (1-\vartheta) \left[x_t (1-\varphi) \frac{y_t^p}{n_t^p} + \frac{\kappa}{\psi_t^{fp}} \psi_t^{hpO} \right] + \frac{\vartheta}{(1-\tau_n)} \left[b - \sigma^p \frac{\beta E_t V_{u^I t+1}^H}{\left(c_t^p + z y_t^g\right)^{-\eta}} \right] \tag{27}$$

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 less of those workers with a lower value and more of those 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.

[6] Derivations are presented in the Companion Appendix.

2.1.5 Government

The government sector produces the public good using public capital and labor:

$$y_t^g = (\varepsilon_t^A n_t^g)^{1-\mu}(k_t^g)^\mu \tag{28}$$

where we assume that productivity shocks are not sector specific and μ is the share of public capital in the public production. The public good provides productivity- and utility-enhancing services[7].

The government holds the public capital stock. Similar to the case of private capital, the government capital stock evolves according to:

$$k_{t+1}^g = i_t^g + (1-\delta^g)k_t^g - \frac{\omega}{2}\left(\frac{k_{t+1}^g}{k_t^g} - 1\right)^2 k_t^g \tag{29}$$

Vacancies posted by the government are exogenous and are associated with a vacancy cost κ in terms of the private good. Following Quadrini and Trigari (2007) and Gomes (2012), we assume that the government sets the public wage according to the rule:

$$\log w_t^g = \log w^g + \pi_w(\log w_t^p - \log w^p) + \varepsilon_t^{w_g} \tag{30}$$

where $\varepsilon_t^{w_g}$ is a shock to the public wage. Quadrini and Trigari (2007), using US data over the period 1970-2003, report that public wages comove with private wages with a correlation of 0.75 and an elasticity of 0.94 (see also Gregory and Borland (1999) for evidence on the public-sector wage premium).[8]

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

$$DF_t = c_t^g + i_t^g + w_t^g n_t^g + bu_t + \kappa v_t^g - \tau_k(r_t^p - \delta^p)k_t^p - \tau_n(w_t^p n_t^p + w_t^g n_t^g) - T_t \tag{24}$$

[7]As the public good is not sold, it has no actual price. However, there is an implicit relative price that can be determined either by the firms or the consumers' demand for the public good. In the benchmark model we assumed that the implicit price of the public good is determined by the consumers demand (see the derivations in the Companion Appendix). Results do not change substantially when we determine the relative price of public goods from the demand of private firms.

[8]If the labour market was frictionless, then the wages should be equal across sectors. However, this is not the case with labour market frictions that are not symmetric across sectors.

and the government budget constraint is given by:

$$B_t + P_t DF_t = R_t^{-1} B_{t+1} \tag{31}$$

where B_t denotes government bonds. In order 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:

$$T_t = \overline{T} \exp(\zeta_{ß}(ß_t - \overline{ß})) \tag{32}$$

where $\overline{ß}$ is the steady state level of debt to GDP ratio, $ß_t = \frac{B_t}{y_t}$.

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

$$\Psi_t^g = \overline{\Psi}^g \left(\Psi_{t-1}^g\right)^{\varrho_g^{\psi}} \exp(\varrho_g^{\psi y} \Delta y_t - \varepsilon_t^{\psi g}) \tag{33}$$

where Δy_t is total output growth and $\varepsilon_t^{\psi g}$ is a zero-mean, white noise disturbance.[9] So that ρ_g^{ψ} determines the persistence of the different government components processes and $\varrho_g^{\psi y}$ the degree of procyclicality of government spending.

2.1.6 Monetary policy

There is an independent monetary authority that sets the nominal interest rate as a function of current inflation according to the rule:

$$R_t = \bar{R} \exp(\zeta_\pi \pi_t + \varepsilon_t^R) \tag{34}$$

where ϵ_t^R is a monetary policy shock and π_t measures inflation in deviation from the steady state.

2.1.7 Closing the model

Private output must equal private and public demand. The resource constraint is given by:

$$y_t^p = c_t^p + i_t^p + c_t^g + i_t^g + \kappa(\upsilon_t^p + \upsilon_t^g) \tag{35}$$

[9] Total output, y_t, is given by $y_t = y_t^p + \frac{p_t^g}{p_t} y_t^g$, where $\frac{p_t^g}{p_t}$ is the implicit relative price of public goods determined by the consumers' demand for public goods.

The model features six exogenous disturbances. The shocks to public vacancies and fiscal spending components, as described (33), 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:

$$\log(S_t) = (I - \rho)\log(\bar{S}) + \rho\log(S_{t-1}) + V_t \tag{36}$$

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-stohastic 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.

2.2 Robust restrictions

This step is designed to tackle the intrinsic uncertainty implicit in calibration procedures. An implication is called robust if it holds independently of the specific parameterization and the functional forms for the primitives used. Robustness is not generic since many dynamic properties are sensitive to the exact parameterization employed and to specific features added, or subtracted to the model. What we are looking for here is to establish that there are common restrictions for the four types of shocks of interest that are representative of a general DSGE model and, thus, can be used for the identification of fiscal shocks.

Formally speaking, let $h(y_t(\theta|x_t)))$ be a $J \times 1$ vector of functions of the data y_t produced by the model, when the $N \times 1$ vector of structural parameters θ is employed, conditional on the shock x_t. We let θ be uniformly distributed over Θ, where $\Theta = \prod_i \Theta_i$ is the set of (a-priori) admissible parameter values and Θ_i is an interval for each parameter i. We draw $\theta_i^l, i = 1, \ldots, N$ from each Θ_i, construct $h(y_t(\theta^l|x_t))$ for each draw $l = 1, \ldots, 10000$ and order them increasingly. Then $h_j(y_t(\theta|x_t))$, $j = 1, \ldots J$ is robust if $sgn[(h_j^U(y_t(\theta|x_t))] = sgn[h_j^L(y_t(\theta|x_t))]$, where h^U and h^L are the 84 and 16 percentiles of the simulated distribution of $h(y_t(\theta|x_t))$.

Since we restrict the range of Θ_i on the basis of theoretical and practical considerations and draw uniformly, our approach is intermediate between calibrating the parameters to a point and assuming informative subjective priors. Our approach also formalizes, via Monte Carlo methods, standard sensitivity analysis conducted in calibration exercises (see also Canova and Paustian (2011)).

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, either to avoid indeterminacies or because of steady state considerations, while θ_2 are the parameters which are allowed to vary. In the first set of parameters we have the discount factor, which is set so that the annual real interest rate equals 4%, the labor force participation rate which is set equal to 0.64, the unemployment rate set equal to 6%, the share of public labor in total employment set equal to 16%, the separation rates for public and private jobs, the private hiring probability rate, the ratio of short to long term unemployment hiring probability rates, and the private vacancy filling probability (See Table 1).

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. 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. 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, deficit, the government wage bill to a 1% decrease in government consumption (first row), government investment (second row) public vacancies (third row), public wages (fourth row), TFP (fifth row) and interest rate (last row) when parameters vary over the ranges reported in Table 1.

All the fiscal shocks, except for government wage shocks, robustly decrease total output one or more periods after the shock and the deficit on impact. A contractionary monetary policy and a negative technology shock move deficits in the opposite direction relative to the three fiscal disturbances. Hence, the correlation between deficit and output responses can be used to distinguish monetary policy and technology shocks from shocks to government consumption, investment and vacancy since in the former case the output contraction results in higher deficits on impact. Therefore, in order to identify a shock in those components we restrict the responses of each component, total output and deficit to positively correlate for two periods after the shock and on impact, respectively.

Public wage shocks are distinguished from technology and monetary policy shocks by the correlation of the output and the wage bill which is negative for public wage shocks and positive for the other two shocks. Next, output increases robustly after a negative public wage shock. On the other hand, the public wage bill, $w^g n^g$, robustly increases one period after a shock in public consumption and investment and decreases after a shock to public vacancies and wages. To distinguish the two types of shocks to the government wage bill it is enough to impose that output and the government wage bill move in the same direction for government vacancy shocks and in the opposite direction for government wage shocks. Hence, by adopting those restrictions the shock in government wages cannot be confused with a productivity or an interest rate shock, since for these shocks output and the government wage bill comove. Notice that we are imposing government wage shocks to be expansionary in the data and this is a strong assumption. We enforce it since our theoretical model suggests that it is robust. If it is unrealistic, we should not be able to recover government wage shocks with such characteristics, or detect a significant expansionary effect of government wage cuts. Moreover, in what follows we check the sensitivity of our results using other identifying assumptions.

Since tax hikes might also contract output and deficits, we require a zero or slightly positive correlation between the identified shock and tax revenues on impact, so as to exclude the possibility that the identified shocks are combinations of government spending cuts and tax hike shocks. Finally, to account for possible correlation among the four fiscal components, we shut the responses of the unshocked government spending variables on impact.[10]

Table 2 summarizes our robust restrictions and reports the probability that at least one of the four sign restrictions we used to identify shocks is violated for the six shocks considered. The probability of adopting false restrictions is very low for all identified shocks.

[10] Notice that the shock in government wages cannot be confused with a shock in the price level that would reduce the real wage in the private sector and subsequently the public wage, leading possibly to a deficit reduction, as such as shock should reduce output and not increase it.

3 The econometric framework

3.1 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 eight endogenous variables: The log of real per capita GDP, the log of real per-capita net tax revenues, the log of real per capita government expenditure in (a) goods purchases, defined as government expenditures minus government wage expenditures, (b) 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 log of total employment, (ii) the unemployment rate, (iii) the labor force participation rate, or (iv) 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.[11]

We set the lag length of the VAR to two. We have also examined other variants of the model (e.g. a VAR with revenues and expenditures in percentage of GDP and a model where variables are expressed in growth rates). The results are unaffected by all of these changes. Finally, we use flat prior Bayesian techniques to compute the point estimates and the credible intervals of the responses.

3.2 Identifying the shocks

To identify the shocks we employ the sign restrictions presented in Table 2. Besides making the link between the model and the data tighter, the use of robust sign restrictions avoids, in principle, typical problems associated with the identification of economically meaningful fiscal shocks. In particular, problems concerning the endogeneity of fiscal variables, the delays between planning, approval and implementation of fiscal policies, which may give rise to predictability problems and the scarceness of reasonable zero-identifying restrictions are to a large extent avoided. Furthermore, since theory defines the features of the fiscal disturbances we are

[11] In the online appendix we present results of a more parsimonious exercise with five endogenous variables when we consider one spending component at the time in the VAR specification. In other exercises that we do not present for economy of space we have tried also to include more than one labor market variables in the system. Results are not significantly affected in both cases.

looking for and the timing of the responses of the endogenous variables is largely unrestricted, the other two problems are also considerably eased. Sign restrictions resolve to some extent the problem of predictability of fiscal shocks since it is possible to design restrictions which will capture it. Finally, since monetary policy and fiscal shocks move deficits in opposite directions (see Table 2), the question of fiscal and monetary policy interaction does not arise when identifying fiscal disturbances.

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 is 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 $\lambda's$ and $H's$.

4 Empirical results

We present in Figure 2 the responses of output, total employment, the real wage, the labor force participation and the unemployment rate to a 1% decrease in government spending on consumption, investment, and the government wage bill originating from either a government vacancy or a government wage cut in the US. 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, as was imposed by our restrictions, output increases significantly and persistently with respect to government wage cuts. Total employment decreases significantly in response to consumption and vacancy shocks, but increases according to our theoretical predictions with respect to government wage cuts (although not significantly). The real wage and labor force participation responses are not significant for any of the shocks considered and the unemployment rate responses mirror the output ones. Although responses are similar qualitatively, there are striking quantitative differences: output is largely reduced after a public vacancy shock, but not after a government consumption or investment shock. A similar pattern arises in other OECD countries. In Figure 3 we present the output responses after a government consumption (first column), investment (second column), vacancy (third column) and wage (last column) shock in Canada, Japan, and the UK. The first three fiscal spending cuts contract significantly output and the most contractionary adjustment is always associated with the public vacancy reductions, while cuts in the government wage increase output significantly.[12]

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 multipliers and the long-run cumulative multipliers one and three years after the shock for the sample countries. Impact output multipliers are computed by dividing the output response, normalized to the response of the corresponding endogenous fiscal component, by the sample mean of the GDP share of each fiscal component. Long-run multipliers are computed by dividing the cumulative sum of the output response by the product of the cumulative sum of the government spending response and the sample mean of the GDP share of government spending. Similarly, unemployment multipliers measure what is the percentage-point change in the unemployment rate when government spending increases by 1% of GDP. Finally, the deficit multipliers express the change in the deficit in percentage points of GDP. That is they report how much the deficit-to-GDP ratio will change when government spending increases by 1% of GDP. Values for which corresponding 68% intervals do not include zero are indicated with an asterisk.[13]

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 consumption, investment and wage bill expenditures implies a fall in output on impact by 0.98%, 1.35% and 6.24%, respectively. Three years after the government consumption and vacancy shock the cumulative effect on output is 1.79% and 2.46%, respectively. The results for Japan and the UK are similar; the output multipliers of the government vacancy shocks are always higher. For Canada, government investment multipliers are the highest for all horizons considered; however, this result in not robust to the methodology used to extract the fiscal shocks as we shall see later. In contrast, government wage cuts generate positive, considerable, and, often, significant output effects in all countries in the sample.

The size of the output multipliers for the different government shocks reported in Table 3 is much higher than the estimates reported in the existing SVAR literature. Typically, the output

[12] The complete set of impulse response functions for all countries are provided in the Companion Appendix.

[13] Notice that for government vacancy and wage shocks, the output and unemployment multipliers of the wage bill expenditures account for induced changes in public employment and in public wages, respectively.

multiplier for total government expenditures in the US in normal times varies between 0.6 in Barro and Redlick (2011) to 3 in Romer and Bernstein (2009). To understand whether the size of our estimated multipliers is driven by the specification we adopted, or the data we used, we have identified a shock to total government expenditures by using our theoretical restrictions for the first three components of spending. Results from this exercise appear in the seventh column of Table 3. The multipliers we generate are comparable with the ones in the existing literature. We conjecture that this is due to aggregation, since by summing up the different series a lot of useful information is lost. The results in Table 3 give an additional motivation for investigating separately the effects of different spending components.

Unemployment multipliers in the US are considerable and significant for government consumption and government vacancy shocks, with government vacancy cuts generating higher losses in terms of unemployment on impact and one year after the shock. Naturally, in Canada it is government investment shocks that induce the higher unemployment multipliers on impact, while for the other countries unemployment multipliers are mostly significant for government investment shocks. Finally, government wage cuts tend to induce a fall in unemployment, but results are not significant. Again, investigating the effects of a shock in total expenditures might be misleading. Unemployment multipliers for total expenditure shocks are not comparable with those computed for different components of spending.

In terms of deficit responses, government wage cuts generate the largest fall in the deficit-to-GDP ratio both on impact and in the long run, while government vacancy cuts do not generate significant gains in terms of deficit reductions in the US and Japan and reverse (significantly) sign in Canada and the UK one year after the shock. We also document reversions in the deficit multipliers associated with government consumption shocks in Japan and the US and with government investment shocks in the UK. In general, government consumption and investment cuts reduce significantly the deficit-to-GDP ratio on impact for all countries. Relatively speaking, government vacancy cuts even in terms of deficit reductions are the least efficient way for consolidating the budget, while government wage cuts appear to be the most effective.

5 Robustness

5.1 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 1980 (see, Kim and Nelson (1999), McConell and Perez-Quiros (2000), and Stock and Watson (2003)). There is some evidence that the dynamics effects of fiscal shocks have changed over time (see, e.g., Perotti (2002)). To take into account sample heterogeneity we repeat the analysis for two subsamples, from the starting date up to 1980 and from 1982 to the end of the sample.

In Table 4 we present impact and cumulative output and unemployment multipliers one and three years after the shock for each of the two sub-periods, as well as the difference between the two sub-periods.[14] The results indicate that the structural change of the 1980s has changed significantly the transmission of government spending shocks. The effect of government consumption shocks on output is weakened significantly in the post-1980s for Canada and the UK. On the other hand, the output effects of investment shocks have been strengthened significantly in Canada and the US. The impact and one year effects of government vacancy shocks on output have substantially increased in the second subsample for all countries but the UK, while the output effects of government wage cuts have also been enhanced for most countries and time horizons considered.

However, unemployment effects of government spending disturbances changes in the two sub-periods do not have a uniform pattern across countries. Unemployment multipliers for government investment shocks are significant for the US, Canada and the UK in the first subsample and for Canada and Japan in the second subsample. In the US, and in accordance to the output multipliers, the unemployment multiplier of government consumption shocks decreases and the ones for government vacancies and investment shocks become weaker in the post-1980s period, while wage cuts generate higher negative unemployment effects in the second subsample. This is a common feature across countries: government wage shocks have stronger effects on unemployment in the second subsample. In the UK we fail to detect significant

[14]In the online Companion Appendix we present a complete set of the corresponding impulse responses for the US economy as well as impact and cumulative deficit multipliers for all countries for the two sub-periods. The general pattern is that after the 80's long-run deficit multipliers are higher for public wage shocks and weaker for consumption and investment shocks. Especially, deficit multipliers after a public wage shock remain significantly above one for all countries, all horizons and all subsamples, while deficit multipliers for the other shocks rarely exceed unity.

changes in the unemployment multipliers. In Canada negative government consumption shocks tend to decrease unemployment in the long run in the post-1980s period (see also Brückner and Pappa (2012)), while the unemployment effects of government vacancy shocks become stronger and the long run effects of government investment shocks weaker in the post-1980s period.

5.2 An alternative identification scheme

For readers who prefer a simple recursive (Choleski) identification to extract the fiscal shocks from the data to sign restrictions, we have also run four different VARs with each government spending variable ordered first and the rest of the variables included in the following order: real per capita GDP, the unemployment rate, tax revenues and interest rate.

Impulse responses of the VAR for the US variables are presented in Figure 4. The public vacancy cut leads to a persistent and pronounced recession, while the effects of the other two contractionary fiscal shocks on spending die out quicker. Public vacancy cuts are also more contractionary in the labor market. Total employment is significantly and persistently decreased and unemployment increases significantly. The wage cut results to a (non significant) reduction in output, confirming our theoretical predictions, an increase in employment and, accordingly, a fall in the unemployment rate.

For this identification scheme, the ranking of the multipliers (see Table 5) is similar with the one obtained by sign restrictions, with government vacancy cuts generating the biggest output losses for all the horizons considered. Using zero restrictions changes the ranking of multipliers in Canada and government vacancy shocks when extracted using the Choleski scheme are associated with the highest output multipliers. Also, for Canada government wage cuts generate significant positive output responses and reductions in unemployment, while for the UK and Japan results using zero restrictions contradict the theoretical predictions for the effects of wage cuts: output, not restricted in this identification scheme, decreases significantly after a wage cut. We do not take this as evidence of flaws in our benchmark empirical model, because the results of the Choleski identification have to be taken with caution since 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 government vacancy shocks but shocks to the destruction rate of public jobs that reduce government employment. Finally, public vacancy cuts are associated with the highest unemployment losses in Canada and Japan on impact and in the US at a one- and three-year horizon.[15]

5.3 Controlling for expectations

Ramey (2011) argues that 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 the US government spending and output from the Survey of Professional Forecasters (SPF) of the Federal Reserve Bank of Philadelphia. The VAR we consider includes the log of real per capita GDP, the log of real per capita government expenditure in goods purchases, gross fixed investment, government employment, the log of real average wage per public job, the log of real per-capita net tax revenues, the total public spending and the output forecasts, a measure of a short-term interest rate and one of the labor market variables. We use the same sign restrictions as in the benchmark model to identify the fiscal shocks. The responses of the macro variables for the US are depicted in Figure 5. The ordering of multipliers is unchanged (see last row of Table 5). We do not find significant changes because the output forecast does not react significantly on impact after the identified shocks.

6 Reconciling the evidence with the theory

Summarizing the empirical evidence: (i) government vacancy cuts are the most destructive mean of fiscal adjustment in terms of output and unemployment losses and the least efficient in terms of deficit reductions; (ii) government investment cuts are also costly in terms of unemployment and less so in terms of output losses except for Canada; and (iii) government wage cuts for most countries in the sample and identification schemes are related with significant increases in output and employment, a fall in the unemployment rate 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.

6.1 Fiscal multipliers: public spending as a waste

We start by assuming that the public good is unproductive ($\nu = 0$) and yields no utility to households ($z = 0$). The values for the other parameters of the model appear in Table 1.

[15] In the online Companion Appendix we also report the impact and cumulative deficit multipliers for all countries under this identification scheme.

In Figure 6 we plot with continuous lines the responses of the economy to a negative government consumption shock.[16] As it is well known, a government consumption cut induces a wealth effect that decreases labor participation and increases private consumption. The presence of long-term unemployed magnifies the size of the wealth effect, since for those agents looking for a job when the economy is contracting has a lower payoff because during such times it is difficult to find a job that would help them move away from long-term unemployment and increase their matching efficiency. This effect 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. Output decreases, but private investment increases after the negative shock. The combined shifts of labor supply and demand produce a decrease in the private wage, which leads subsequently to a fall in the public wage. The decrease in labor demand increases short-term unemployment, while the decrease in labor force participation decreases long-term unemployment, and depending on the share of the latter in total unemployment total unemployment can go down or up. In our benchmark parameterization unemployment decreases initially and rises when firms reduce employment, decreasing vacancies and increasing short-term unemployment in the periods after the shock. The fall in labor force participation and in labor demand induces a fall on impact in the fraction of unemployed looking for a job in the private sector, while the relative size of job seekers in the public sector increases. Public employment increases slightly since the tightness of the public jobs market decreases. As a result, public output marginally increases.

The continuous lines in Figure 7 depict the responses of the economy to a government investment cut when the public good is unproductive and yields no utility to households. Responses in this case are identical to the case of public consumption shocks, since the two shocks represent decreases in the government's absorption and have no specific feature to distinguish them.

The continuous lines of Figure 8 describe the responses to a negative shock in public vacancies. This shock is different since it directly affects the labor market outcomes in both the private and the public sector. As with the previous shocks, the decrease in government's absorption decreases labor participation, due to the wealth effect, and the labor demand effect is still relevant decreasing private vacancies and private employment. However, the fall in public vacancies alters the dynamics of the other variables substantially. In fact, the supply of labor

[16]Dashed lines correspond to the case in which the public good provides utility- and productivity- enhancing services. Since the properties of the public good affect marginally the responses of the economy to a government consumption shock, the continuous and the dashed lines coincide for most variables in Figure 6.

in both labor markets decreases. The fall in the labor supply comes from the fact that agents have a lower probability to find a job when private demand falls. In addition, the reduction of public vacancies decreases the probability of finding a job in the public sector. Hence, a shock in public vacancies will decrease the probability of the household to employ an additional member in either the private or the public sector. This is why the fall in public vacancies ends up decreasing consumption and investment: with the reduced number of working members, the households cannot afford an increase in consumption and investment when more household members become unemployed, that is, a period after the initial shock.

This property of the public vacancies shock is crucial for understanding the empirical results. In Figure 10 we plot the output, unemployment and deficit (as a share of GDP) multipliers generated by the different types of cuts when government spending is a waste (continuous lines).[17] The output losses associated with government vacancy cuts are the largest and much larger than one in absolute value, because of the induced reductions in consumption and investment. Moreover, deficit multipliers associated with government vacancy shocks, in accordance with our estimates, are very small on impact and turn negative one period after the shock.

In Figure 9 we plot the impulse responses of the economy to a cut in public wages. Again as a reduction in government's absorption this policy is associated with a positive wealth effect that decreases labor force participation and increases consumption and investment. At the same time, the shock reallocates jobseekers from looking for a job in the public to the private sector, since wage rates in the public sector become lower. The increase in demand for consumption and investment coupled with 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 increases in private output with a lag. On the other hand, the reduction in labor force participation and the increase in employment in the private sector reduce both short- and long-term unemployment. As a result, the initial negative shock results to be expansionary, increasing output and reducing unemployment. This might not be surprising if government output is assumed to be unproductive. In the next section we study the sensitivity of our results when we dismiss this assumption.

[17] Theoretical multipliers are computed in accordance with the estimated multipliers of Table 3.

6.2 Fiscal multipliers: productivity- and utility-enhancing public good

The dashed lines in Figure 7 represent the responses of the macro variables to a government investment cut when the public good is productive ($\nu = 0.2$) and utility enhancing ($z = 0.2$). The assumption on the productivity of the public good makes a difference for the responses of the economy to a government investment shock. The wealth and demand effects in this case are combined with a negative effect that the shock has on future production, since lower public investment reduces, through public capital accumulation, future government production, which enhances future private productivity. The contemporaneous responses induced by government investment shocks are qualitatively similar to the ones produced by a government consumption shock (see also Figure 6), but the lagged effects are quite different. Private and, hence, total output persistently fall after a government investment shock, generating a persistent negative effect on wealth that increases long-term unemployment and public employment. The increase of private consumption is smaller than in the case in which government goods are not productive and the fall in the marginal product of labor decreases both private and public wages on impact. The size of the impact multiplier does not change significantly; although cumulative multipliers for government investment shocks are persistently higher when government output is productive (see Figure 10). Of course a rise in the productivity of public good (ν), would reduce further the size of the output losses, both on impact and in subsequent periods (but would not change the ranking relative to the output losses related to public vacancies cuts). According to the empirical results, unemployment losses are also higher and more persistent when government goods are assumed to be productive, although the adjustments in the labor markets occur mostly through wage movements. Introducing wage stickiness would make unemployment losses after a government investment cut even higher in this setting. Finally, deficit multipliers are also more persistent when the public good is assumed to be productive for both government consumption and investment shocks, since the increase in productivity stemming from public goods raises the marginal product of capital and labor and, thus, tax revenues from capital and labor income.

The productive nature of government output also generates a persistent negative wealth effect when we examine the responses of the economy to a government vacancy cut (see the dashed lines in Figure 8). This effect is similar in nature with the one generated by government investment shocks, but the transmission of the two shocks is very different. Consumption decreases more and more persistently after the shock. Private investment reacts less on impact, but its response is more persistent. Hence, the size of the multiplier does not change much on impact, but the effects of the shocks are amplified. Again, output losses are an increasing function of ν, while unemployment losses do not seem to relate strongly to the productive nature of public goods and wages mostly adjust for the differences in productivity induced by the shock. It is important to note that government vacancy cuts cause the highest output losses not because government employment is productive, but because they induce the additional negative wealth effect that the other two shocks do not generate. That is, the government vacancy cut induces a fall in the number of working members in the household inducing a substantial fall in private consumption and investment. Deficit responses are not persistent in the case of government vacancy shocks because, although the increase in public production increases the revenues from income and capital taxation, the rise in public employment increases the wage bill expenses counteracting this positive effect and so deficit responses are not more persistent in this case. Clearly, the size of these effects depends on various parameters of the model. In the next section we try to identify which parameters are crucial for determining its size.

Finally, a public wage cut has less expansionary output effects when the public good is assumed to be productive (see the dashed 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 assumed to be a waste.

6.3 Sensitivity analysis

Shocks related to the government wage bill are associated with very distinct effects on output and unemployment. Government vacancy cuts generate the highest output losses and increases in unemployment, while on the other hand, government wage cuts have expansionary effects. Government consumption and investment imply smaller output and unemployment losses. Nevertheless, it is important to study the sensitivity of our conclusions to changes in the parameterization of the model. This will also help us understand which features are crucial for mapping theoretical and empirical responses.

For example, there are some obvious candidates that determine the magnitude of government vacancy multipliers such as the size of replacement rates, since they affect directly the value to the household of having an additional member working. The dashed lines in Figure 11 demonstrate that indeed high replacement rates ($b/w^p = 0.4$) decrease substantially the wealth effect originating from government vacancy shocks. In fact, with high unemployment benefits, households do not experience a substantial fall in income when a member of the household looses a public job relative to remaining employed in the coming period. High replacement rates also reduce the output and unemployment losses associated with government consumption and investment cuts, since with high replacement rates the positive wealth effects associated with the government contraction is reduced. On the other hand, in an economy with high replacement rates increase in the relative labor supply in the private sector generates larger increases in output.

A change in the job destruction rate of public jobs does not change the dynamics with respect to government consumption and investment cuts, but it affects significantly the output losses associated with government vacancy and wages shocks. The public job destruction rate should also affect the continuation value of the household of having one less public employee among its members. The dashed-dotted lines in Figure 11 depict output losses and unemployment multipliers when $\sigma^g = 0.01$. One should expect that making public jobs more secure would increase the size of the wealth effect associated with a decrease in public vacancies, but this is not the case. A reduction in the public job separation rate has exactly the opposite effect; it reduces substantially output and unemployment losses from government vacancy cuts. This occurs because more permanent public jobs imply longer queues for public jobs. Hence, the reallocation of unemployed jobseekers towards private employment, caused by the decrease in public vacancies, results in a lower recession after the shock and a fall of unemployment on impact. When public jobs are more permanent, government wage cuts are still expansionary and they reduce unemployment but by less than in the case of more temporary public jobs. The longer life of a public job implies that reallocation of jobseekers is more sticky when the government turns to wage cuts for decreasing the government deficits. As a result, the increase in private-sector employment is lower and output expands less, resulting in lower reductions in unemployment.

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 circled lines in Figure 11 depict output and unemployment losses when we decrease the weight on inflation in the monetary policy rule ($\zeta_\pi = 1.1$), which is equivalent with assuming a less aggressive monetary policy. In line with other studies, a laxer monetary policy increases substantially the effects of government consumption and investment shocks: output and unemployment multipliers increase substantially relative to the benchmark case. Yet, a more loose monetary policy in our model seems to reduce the output and unemployment effects of government vacancy and wage cuts. As far as government vacancy shocks are concerned, the fact that monetary policy does not react to the negative fiscal shock implies that the shock to demand is stronger, inducing a bigger fall in labor force participation after the vacancy shock. This implies an increase in the probability of finding a job for the household which, in turn, moderates the size of the negative wealth effect associated with a fall in public vacancies and a more moderate reduction in consumption and investment and, hence in private output. For government wage cuts, the reallocation of workers to the private sector makes private labor cheaper. However the fact that monetary policy does not react to the fall in inflation originating from the fall in government absorption implies that the demand for goods in this case is more limited and, as a result, the output and unemployment multipliers are smaller.

There are several parameters that might affect the output multiplier for the government spending shocks. For example, the size of capital adjustment costs or the flexibility in prices might influence the output losses from government investment cuts. As it is clear from Figure 11, such changes do affect the size of the losses for the four shocks, but do not alter their relative ranking in terms of the recessionary effects that they imply for the economy. High capital adjustments costs increase the output multipliers for government consumption and investment shocks, since they imply higher increases in consumption relative to investment after a fall in the government's absorption and as a result a fall in the productive capacity of the economy. On the other hand, high capital adjustment costs reduce the size of the government vacancy multiplier because the negative wealth effect associated with the increase of unemployed members of the households implies a fall in investment after the negative vacancy shock, but given the adjustment costs this fall is smaller and, as a result, the negative effects of the shocks are restrained. Finally, the expansionary effects of government wage cuts are limited when capital adjustment costs are high, since labor and capital complementarity implies smaller increases in private vacancies after the reallocation of workers towards the private sector. More flexible prices on the other hand, reverse the ordering of multipliers: they make government consumption and investment cuts less contractionary, since they reduce the negative demand effect stemming from sticky prices, and the effects of government vacancy shocks more contractionary, since the negative wealth effect associated with the increase in the households unemployed members reduces substantially consumption and investment in this case. Finally, government wage cuts are more expansionary when prices are more flexible, since the increased output supply originating from the increase in private labor supply is absorbed by a fall in prices.

In sum, all the parameter changes we have considered, although they affect the size, do not change substantially the ranking of the different spending cuts: cutting government wages to decrease debt is always ranked as the best policy response in terms of both output and unemployment losses, while cutting public jobs is the worst policy a government can adopt especially when replacements rate are low and public jobs are of more temporary nature.

7 Conclusions

This paper analyzes the dynamics of transmission of different types of government expenditure cuts engineered to decrease deficits in the US, UK, Canada and Japan. We restrict attention to expenditure shocks for two reasons. First, while the effects of expenditure shocks in the literature are controversial, there is somewhat more agreement on the dynamic effects induced by tax shocks. Second, although not often appreciated in the empirical literature, the qualitative features of the dynamics in response to government shocks crucially depend on the way expenditure is financed (see, e.g., Baxter and King (1993)). Since the implications produced by deficit-financed expenditure cuts are relatively robust across model specifications and across different components of expenditures, while this is not the case for tax-financed expenditure increases, and since robustness gives credibility to our identification methodology, we consider only deficit-financed expenditure shocks in our exercises. A cross-country perspective can help us to understand whether our findings are solely a US phenomenon or if instead are shared in a number of developed economies.

To identify deficit-financed expenditure shocks we use sign restrictions coming from a very general DSGE model with real and nominal frictions and hold for many variants and parameterizations of the model. Government spending cuts in consumption, investment and the wage bill caused by vacancy cuts are all associated with output losses and increases in unemployment; however, for government wage bill cuts through cuts in public vacancies output and unemployment losses are larger and larger than one for all countries and all horizons. Cuts in government wages do not imply output losses; instead, they can be expansionary and reduce unemployment. There are substantial differences in the transmission of fiscal shocks before and after the beginning of the 80s. Government vacancy cuts has significantly stronger effects in the last two decades for all countries but the UK and the output effects of government wage cuts have also been enhanced for most countries and time horizons considered.

Determining whether these facts have a common underlying explanation is a challenging task. We employ the model used for the derivation of restrictions to highlight which features are necessary to justify the empirical responses: government wage bill cuts through cuts in public vacancies is the most detrimental budget component to cut because, apart from generating the standard wealth and demand effects after decreases in government absorption, it has an additional negative effect, since it increases unemployment and induces a negative wealth effect that incentivizes households to consume and invest relatively less. This latter effect depends crucially on the size of the replacement rates and the destruction rate of public jobs. High replacement rates and public job security decrease the output and unemployment losses associated with government vacancy cuts. Since the empirical results point to a significant increase in the effects of shocks to the government wage component of spending; with shocks identified as vacancy shocks generating higher multipliers in the post-1980s period and shocks identified as shocks to government wages having a stronger expansionary effect, we deduce, using our model predictions, that the reforms in employment protection and the change in the monetary policy stance in the countries considered could be possible explanations for this pattern.

8 References

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Tables

Table 1: Parameter ranges and values

Varying parameters		Ranges	Values	Fixed parameters	
η	risk aversion coefficient	[0.5,6]	1.0	β=0.99	discount factor
z	utility from public consumption	[0.0,0.5]	0.2	1-l=0.64	labor participation rate
z	preference parameter for y^g	[0,0.5]	0.2	$\frac{u}{1-l}$=0.06	unemployment rate
$\frac{1}{\psi}$	Frisch elasticity	[0.1,10]	0.25	$\frac{n^g}{n}$=0.16	public employment share
$\frac{u^S}{u}$	short-term unemployment share	[0.1,0.2]	0.16	ψ^{fp}=0.67	priv. vacancy filling probability
σ^g	public separation rate	[0.015,0.025]	0.018	ψ^{hp}=0.83	private hiring probability
σ^p	private separation rate	[0.02,0.03]	0.025	$\frac{\psi^{hjS}}{\psi^{hjL}}$=1.015	short- vs. long-term unemployed
ω	adjustment costs parameter	[0,2]	0.8		hiring probability
δ^j	capital depreciation rate	[0.02,0.03]	0.025		
$\frac{\kappa}{w^p}$	vacancy cost - wage ratio	[0.035,0.055]	0.045		
φ, μ	productivity of capital stocks	[0.3,0.4]	0.36		
ν	productivity of public goods	[0,0.5]	0.2		
τ^l	average labor tax rate	[0,0.4]	0.25		
τ^k	average capital tax rate	[0,0.4]	0.15		
$\frac{b}{w^p}$	replacement rates	[0.0,0.4]	0.3		
$\frac{\varepsilon}{\varepsilon-1}$	steady-state markup	[1.09,1.16]	1.1		
$1-\chi$	probability of price change	[0.4,0.8]	0.75		
ϑ	firms bargaining power	[0.4,0.55]	0.5		
$\frac{C^g}{Y}$	steady-state C^g/Y ratio	[0.1,0.2]	0.165		
$\frac{K^g}{K^p}$	steady-state K^g/K^p ratio	[0.27,0.31]	0.31		
π_ω	public wage elasticity to w^p	[0.95,1.25]	1.16		
ζ_π	Taylor's coefficient	[1,2.5]	1.5		
$\zeta_{\text{ß}}$	debt coefficient	[1.5,4]	2.0		
$\overline{\text{ß}}$	debt to GDP ratio	[0.4,0.8]	0.6		
ϱ	persistence of non-fiscal shocks	[0.0,0.95]	0.95,0.65		
ϱ_g^{ψ}	persistence of fiscal shock	[0.0,0.95]	0.8		
$\varrho_g^{\psi y}$	output stabilization in fiscal rule	[-0.05,0.05]	0.0		

Notes: $j = p, g$ and $\psi = c^g, i^g, \upsilon^g$

Table 2: Identifying restrictions									
shocks	$y_k,\ k=2,3$	DF	c^g	i^g	υ_k^g	w_k^g	$w_k^g n_k^g,\ k=2,3$	tax revenues	probability of false restriction
$\varepsilon_t^{c^g}$	<0	<0	<0	$=0$	$=0$	$=0$	>0	≤ 0	7%
$\varepsilon_t^{i^g}$	<0	<0	$=0$	<0	$=0$	$=0$	>0	≤ 0	8.5%
$\varepsilon_t^{\upsilon^g}$	<0	<0	$=0$	$=0$	<0	$=0$	<0	≤ 0	16%
$\varepsilon_t^{w_g}$	>0	<0	$=0$	$=0$	$=0$	<0	<0	≥ 0	7%
ε_t^{A}	<0	>0					<0	≤ 0	13%
ε_t^{R}	<0	>0					<0	≤ 0	2%

Table 3: Benchmark VAR

		output multipliers					unemployment multipliers					deficit/GDP multipliers				
		associated with shocks to:					associated with shocks to:					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	1	2.39*	5.97*	2.81*	-1.31	1.76*	-0.63*	-1.36*	-0.19	-0.17	-0.21	0.58*	0.91*	0.33*	0.51*	0.90*
	4	5.55*	4.49*	3.55*	-2.37*	1.77*	-2.32*	-1.69*	-0.55	-0.33	-0.38*	0.85	1.08	-0.23*	1.85*	0.98*
	12	1.99	2.32	0.75	-0.99	0.89	-2.08*	-1.63*	-0.21	-0.42	-0.19	1.46	2.29*	0.58	2.32*	1.01*
Japan	1	0.76*	1.13*	6.74*	-2.63*	1.83*	-0.05	-0.13	-0.53	-0.92	-0.04	0.25*	0.43*	0.05	0.47*	0.87*
	4	3.03*	1.64*	4.38*	-2.13*	2.06*	-1.02	-0.20*	-0.28	-1.04	-0.03	-1.52*	0.00	0.63	1.82*	0.80*
	12	6.73	2.21*	2.29*	-1.91*	1.97*	-1.76	-0.31*	0.15	-1.51	0.00	-2.38	-0.67	1.51	3.59*	0.78
UK	1	0.94	0.62*	5.70*	-0.88*	1.24*	-0.32	-0.12	-0.29	0.24	-0.06	0.18*	0.38*	0.51*	0.60*	0.94*
	4	2.45*	1.10*	2.68*	-1.15*	1.18*	-0.79	-0.38	-0.39	0.70*	-0.15	0.51	-0.14	-0.92*	1.47*	0.88*
	12	1.10	1.20	2.74*	-0.42	1.14	-0.35	-0.70	-0.74	0.74	-0.23	3.51	-0.42	-1.62	2.52*	0.90*
US	1	0.98*	1.35*	6.24*	-2.92*	2.79*	-0.77*	-0.78	-1.79*	0.12	-0.23	0.23*	0.25*	0.10	0.55*	0.87*
	4	2.30*	1.50*	4.80*	-3.51*	2.56*	-1.92*	-1.00	-2.09*	0.03	-0.45*	-0.95	0.07	-0.31	3.03*	0.59
	12	1.79*	0.84	2.46*	-2.18	2.25*	-1.74*	-0.55	-1.15	-0.98	-0.48*	-0.69	1.20	-0.15	2.23*	0.55

Note: $G = c^g + i^g + w^g n^g$

Table 4: Subsample analysis: pre- and post-1980s

shock		Canada 1	Canada 4	Canada 12	Japan 1	Japan 4	Japan 12	UK 1	UK 4	UK 12	US 1	US 4	US 12
output multipliers													
c^g	pre	3.93*	1.79	-3.46	1.50*	1.47	0.05	2.55*	2.92*	1.10	0.32	2.03*	2.78
	post	0.52*	1.21*	2.67*	1.05*	2.66*	6.66*	0.43	1.07*	3.77	1.53*	1.77*	1.59
	dif.	-3.40*	-0.58	6.13	-0.44	1.19	6.61*	-2.12*	-1.85*	2.67	1.21	-0.26	-1.18
i^g	pre	1.35*	2.17*	5.14*	1.09*	2.03*	0.55	2.12*	1.48*	-0.64	1.22	2.40*	2.23*
	post	2.05*	4.00*	4.87	0.58*	0.62*	0.68*	0.58*	2.01*	1.31	2.54*	3.47*	4.77
	dif.	1.04	2.74*	-0.41	-0.52	-1.41*	0.13	-1.54	0.53	1.95	1.32*	1.08*	2.54*
υ^g	pre	0.21	1.00*	1.38*	5.08*	2.90*	1.57	6.56*	2.57*	1.37	5.83*	4.04*	2.05*
	post	4.85*	3.73*	1.87	5.87*	5.28*	3.34*	3.55*	2.28*	1.95*	6.78*	3.80*	0.82
	dif.	4.65*	2.73*	0.49	0.79	2.38*	1.77*	-3.01*	-0.28	0.58	0.95*	-0.25	-1.23
w^g	pre	-0.27	-1.06*	0.11	-2.54*	-2.69*	-3.65*	-0.52	-1.00*	-0.17	0.16	-3.10*	-2.96
	post	-0.96	-2.71*	-5.03*	-2.05*	-2.62*	-6.80*	-0.87*	-1.59*	-2.25	-2.51	-2.78*	-2.57*
	dif.	-0.69	-1.65*	-5.14*	0.50	0.07	-3.15*	-0.35	-0.59	-2.08*	-2.67*	0.32	0.39
unemployment multipliers													
shock		Canada 1	Canada 4	Canada 12	Japan 1	Japan 4	Japan 12	UK 1	UK 4	UK 12	US 1	US 4	US 12
c^g	pre	-0.35*	-0.27	2.16	-0.18	0.39	0.35	-0.07	-0.38	-1.61	-0.81	-1.48*	-2.01*
	post	0.61*	0.46	-0.07	-0.03	-0.41*	-1.77*	0.17	0.09	-0.41	-0.40	-1.03	-0.65
	dif.	0.97	0.73	-2.23*	0.14	-0.80	-2.13*	0.24	0.47	1.20	0.41	0.44	1.35*
i^g	pre	-0.46*	-1.04*	-2.28*	-0.12	-0.16	-0.02	-0.29	-1.22*	-0.98	-0.40	-1.03*	-1.57*
	post	-0.49*	-1.16*	-1.92*	-0.16	-0.35*	-0.42*	0.01	-0.31	-0.12	-0.38	0.47	0.42
	dif.	-0.03	-0.12	0.36*	-0.04	-0.19	-0.41	0.30	0.91	0.87	0.02	1.50*	1.99*
υ^g	pre	0.17	0.50	0.61	-0.22*	-0.20*	0.04	-1.57*	-0.70*	-0.29	-1.20	-1.43*	-0.82
	post	-0.87*	-0.95*	-0.53	0.11	0.57	0.54	0.12	0.08	0.11	-0.93	-0.22	0.97
	dif.	-1.05	-1.45*	-1.13	0.33	0.77	0.51	1.69*	0.78	0.40	0.27	1.21*	1.79*
w^g	pre	0.63*	1.29*	1.15*	0.60	0.64*	0.70*	0.21*	0.49*	0.57	0.47	1.50*	2.18*
	post	0.62	1.41*	2.35*	0.54	1.58*	2.79*	0.31	1.12*	1.70*	1.76	2.16	2.38*
	dif.	-0.02	0.12	1.20*	-0.06	0.94	2.08*	0.10	0.63	1.13	1.29*	0.66	0.20

Table 5: Robustness analysis		output multipliers				unemployment multipliers			
		associated with shocks to:				associated with shocks to:			
		c^g	i^g	υ^g	w^g	c^g	i^g	υ^g	w^g
Canada - Choleski	1	1.33*	0.68*	3.34*	-0.40	0.07	-0.16*	-0.66*	0.39*
	4	1.03*	0.58*	3.12*	-1.51*	0.05	-0.13	-1.21*	1.29*
	12	-0.04	0.30	0.04	-0.60	0.48	-0.21	-0.13	1.12*
Japan - Choleski	1	0.50*	1.12*	1.50	0.76	0.03	-0.03	-2.56*	0.64*
	4	-0.72	0.91*	-3.26	1.29*	0.10	0.02	-0.17*	0.36
	12	-2.82	0.32	-6.63	3.66*	0.21	0.14*	2.56	-0.52
UK - Choleski	1	0.59*	0.01	3.77*	0.58*	0.02	0.01	-0.26	0.01
	4	1.29*	0.00	1.73*	0.50*	0.11	0.04	-0.10	0.09
	12	2.11*	0.04	3.45*	1.16*	0.29	0.02	-0.14	-0.25
US - Choleski	1	1.68*	1.26*	5.61*	-1.14	-0.07	-0.11*	0.13	0.08
	4	1.46*	1.44*	4.54*	-1.78	-0.17	-0.21*	-0.67*	0.46
	12	1.75*	1.16*	4.17*	-0.80	-0.57*	-0.32*	-1.08*	0.23
US - Expectations	1	1.19*	1.64*	6.37*	-2.22	-0.36	-0.40	-0.30	1.43
	4	1.84*	1.74*	5.21*	-2.61*	-1.18	-0.57	-0.70	2.34
	12	1.60*	1.52*	3.56*	-1.78	-1.71*	-0.87	-0.87	2.01*

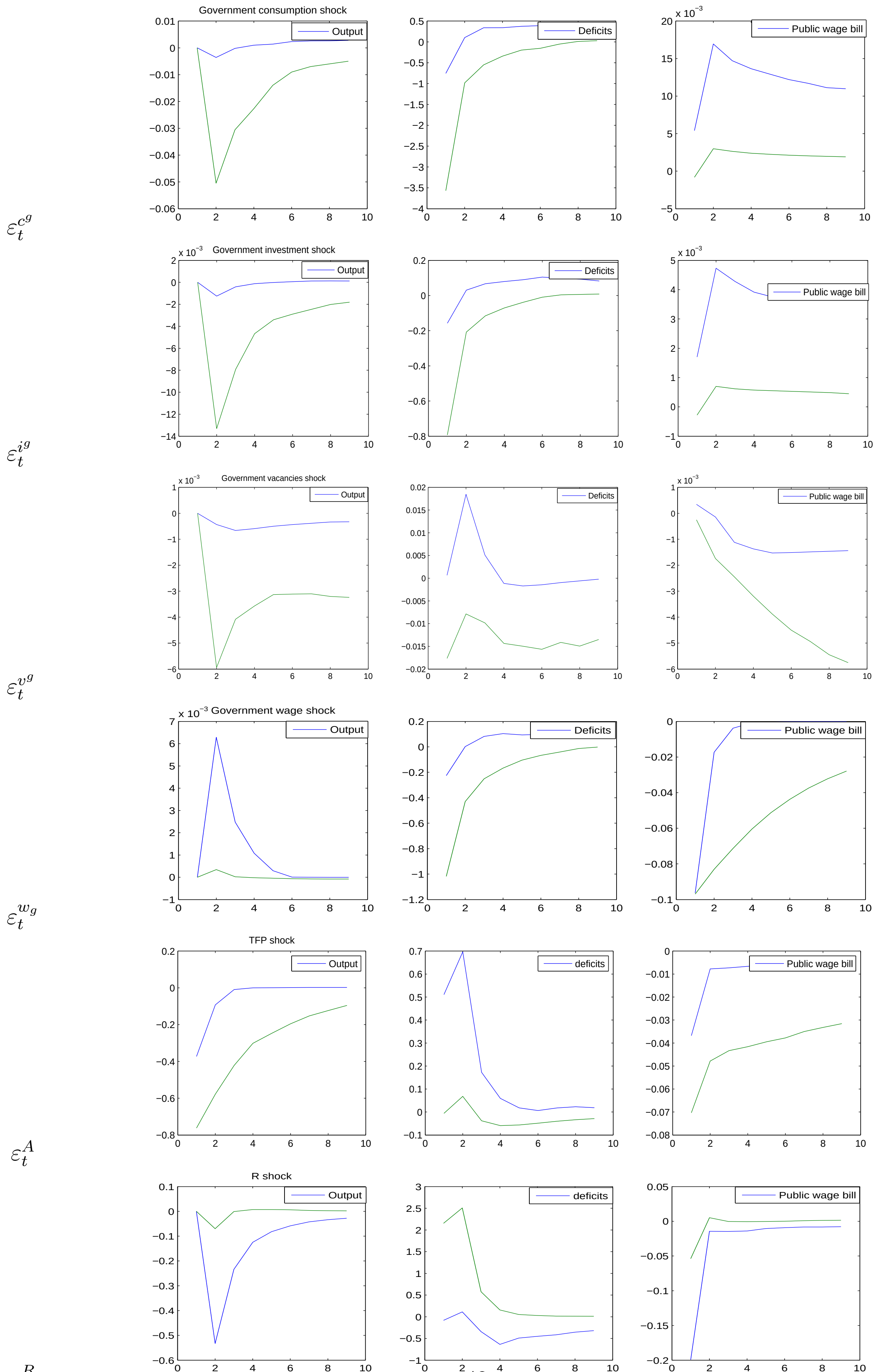

Figure 1: Robust sign restrictions, theoretical responses to negative shocks

public consumption cut	public investment cut	public vacancy cut	public wage cut

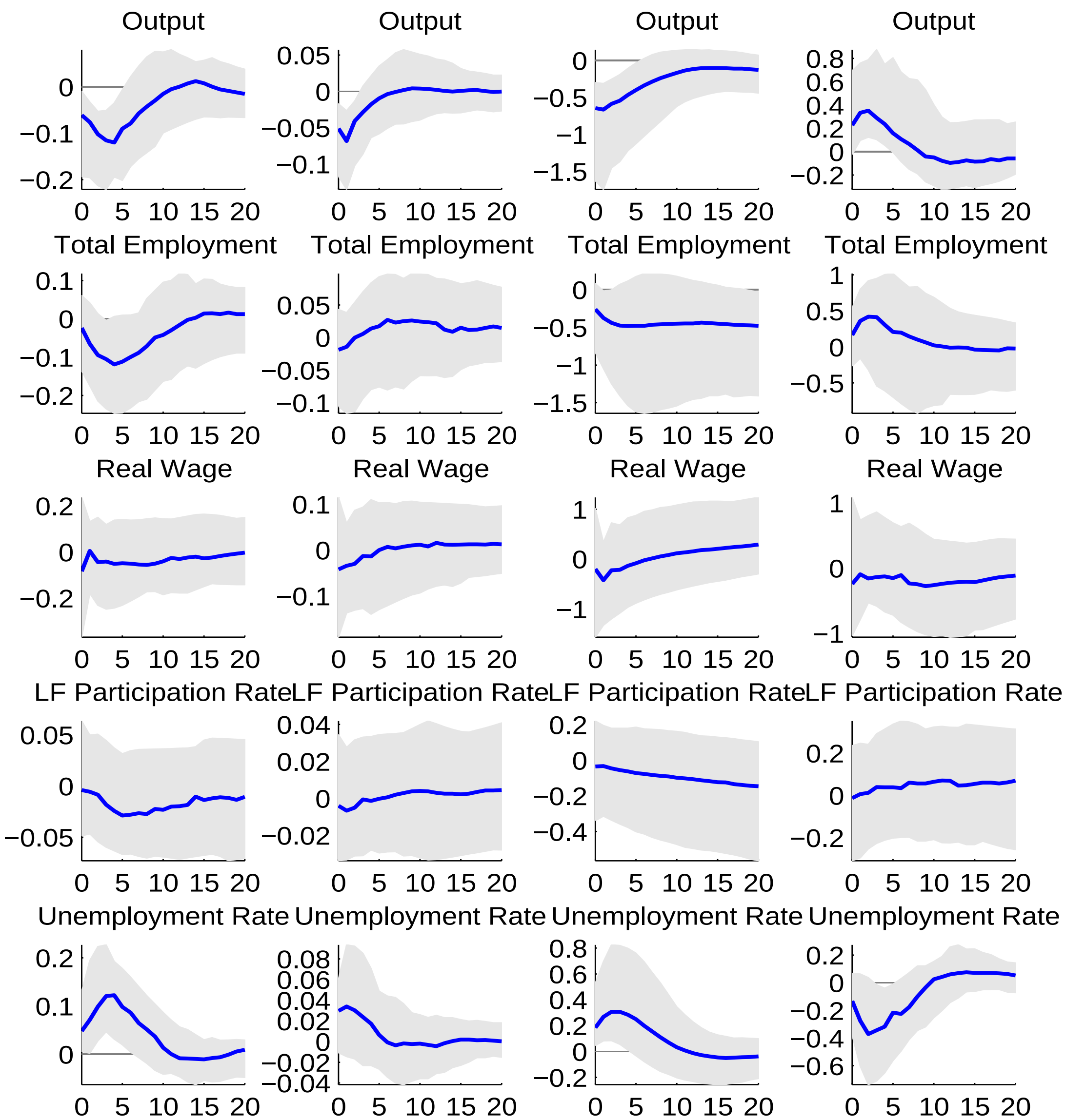

Figure 2: Impulse responses to different fiscal shocks in the US

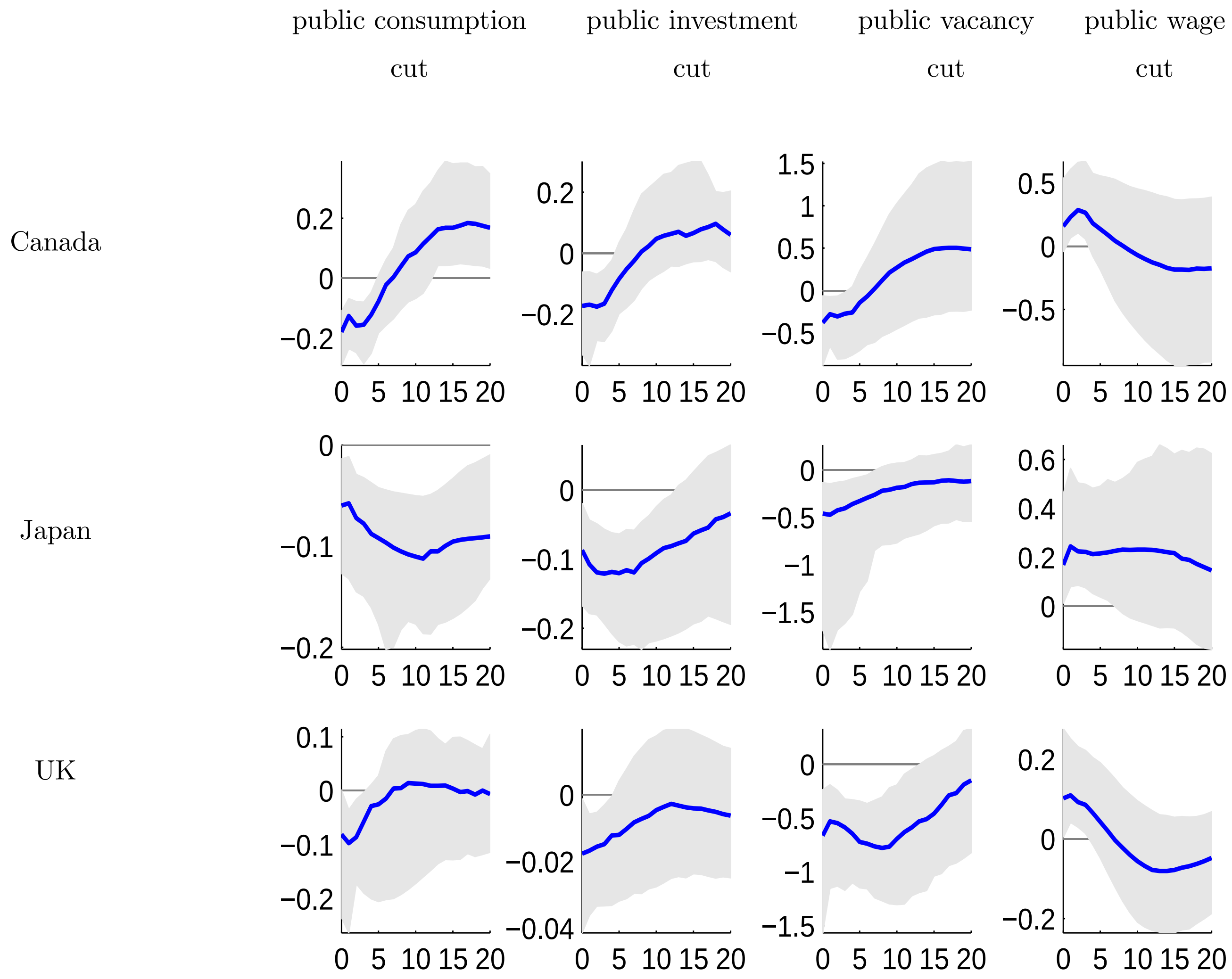

Figure 3: Output responses to fiscal disturbances in other OECD countries

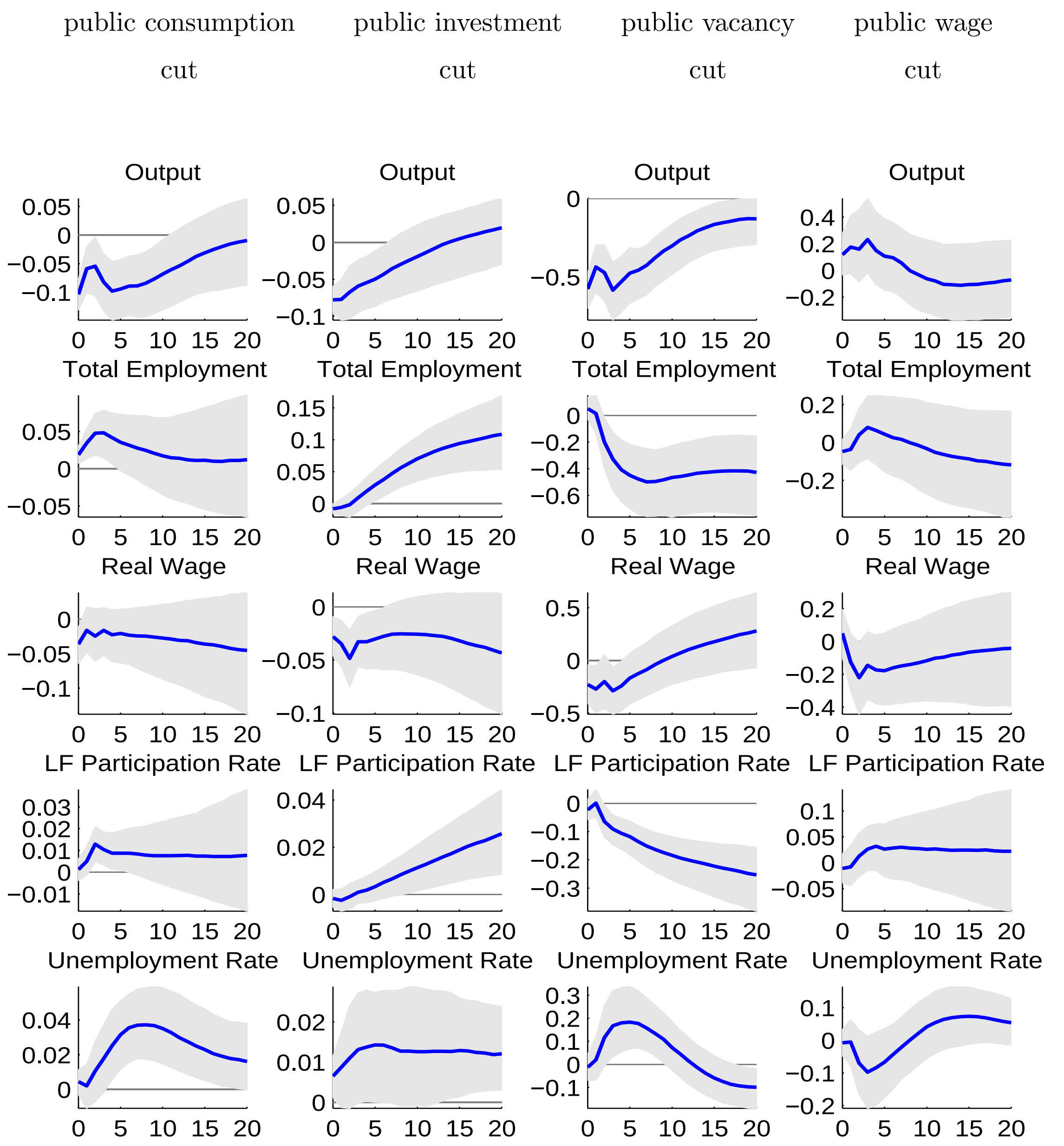

Figure 4: Impulse responses to different fiscal shocks in the US, Choleski identification

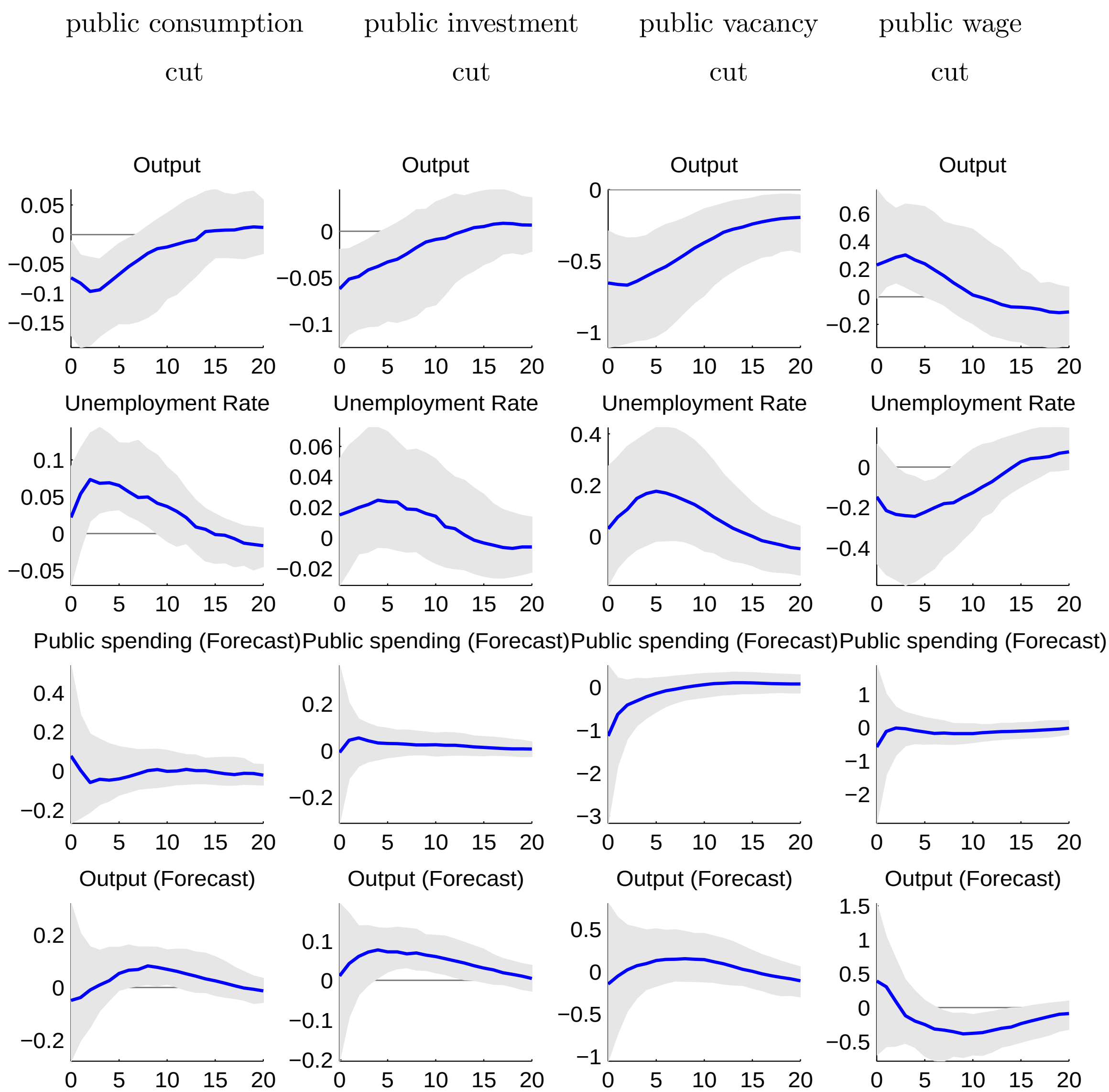

Figure 5: Impulse responses to different fiscal shocks in the US, controlling for expectations

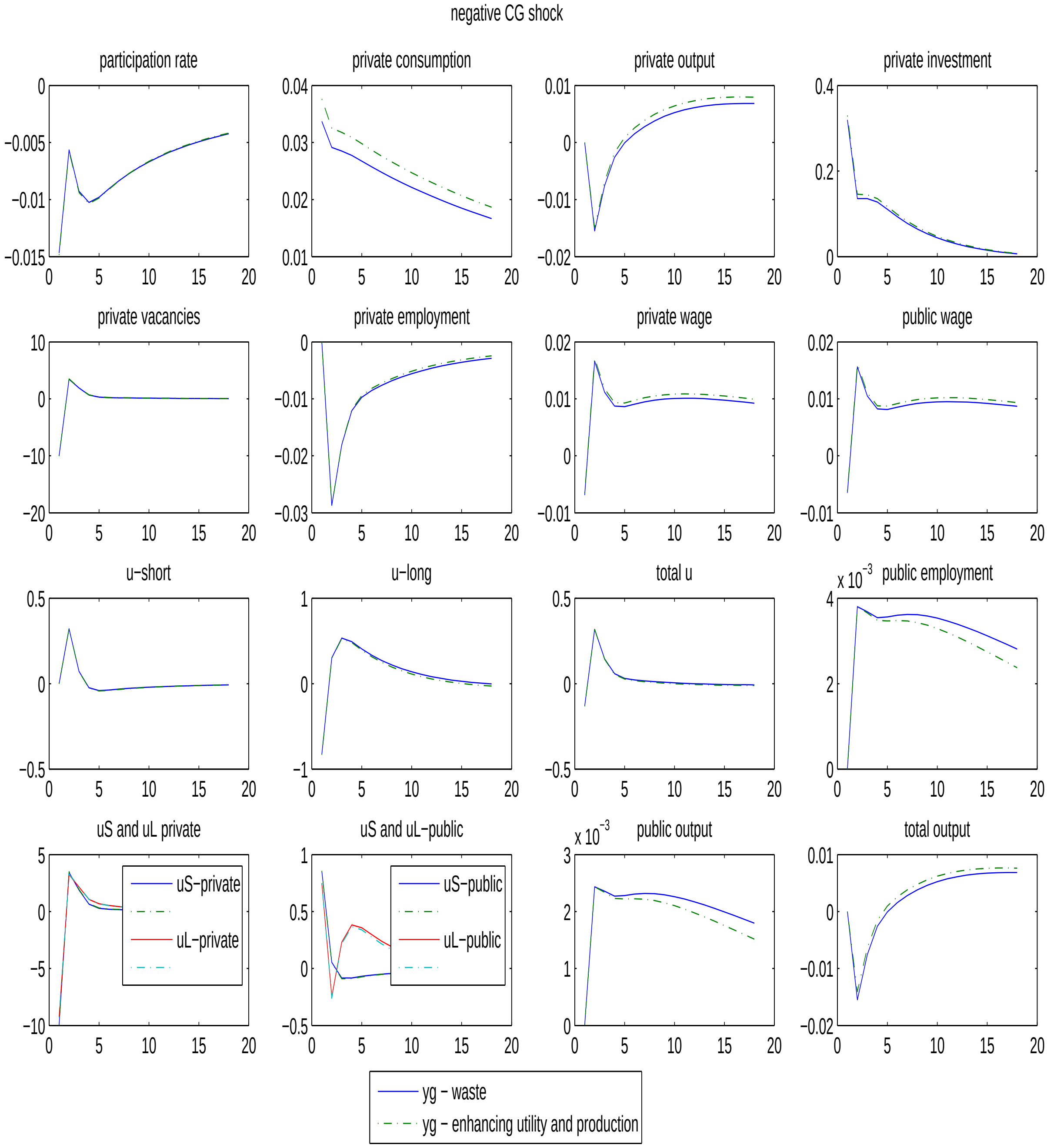

Figure 6: Theoretical impulse responses to a government consumption cut

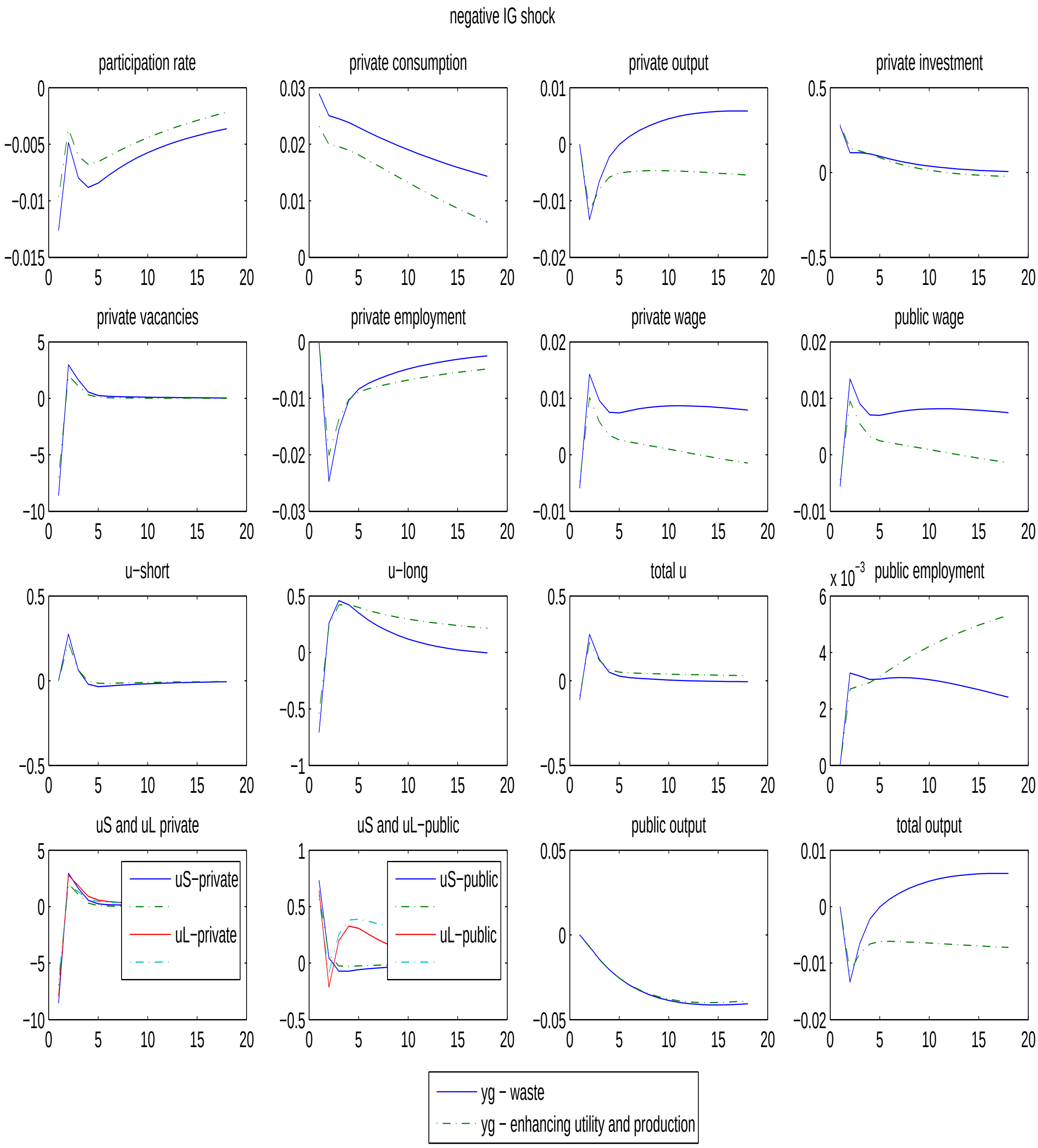

Figure 7: Theoretical impulse responses to a government investment cut

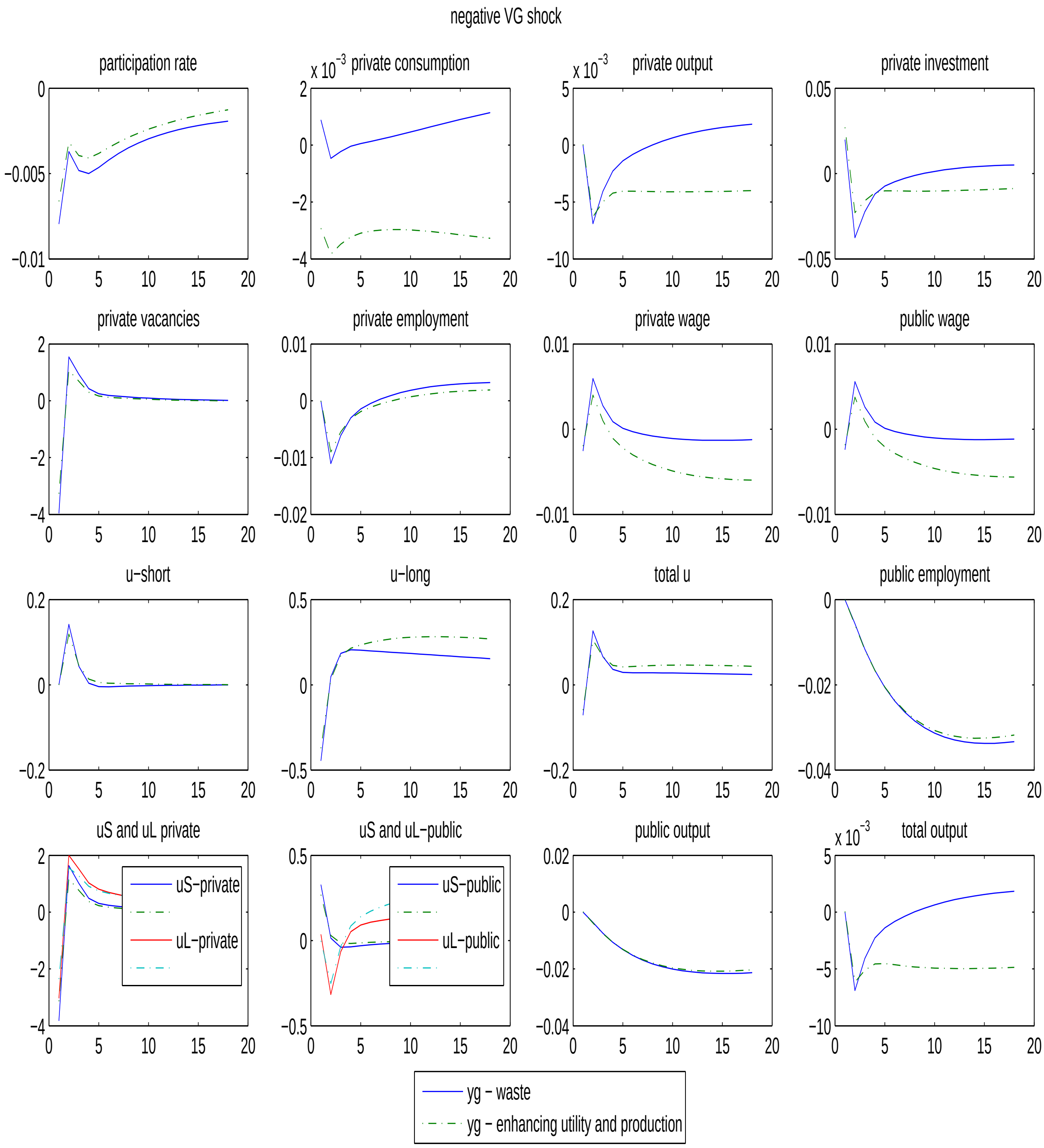

Figure 8: Theoretical impulse responses to a government vacancy cut

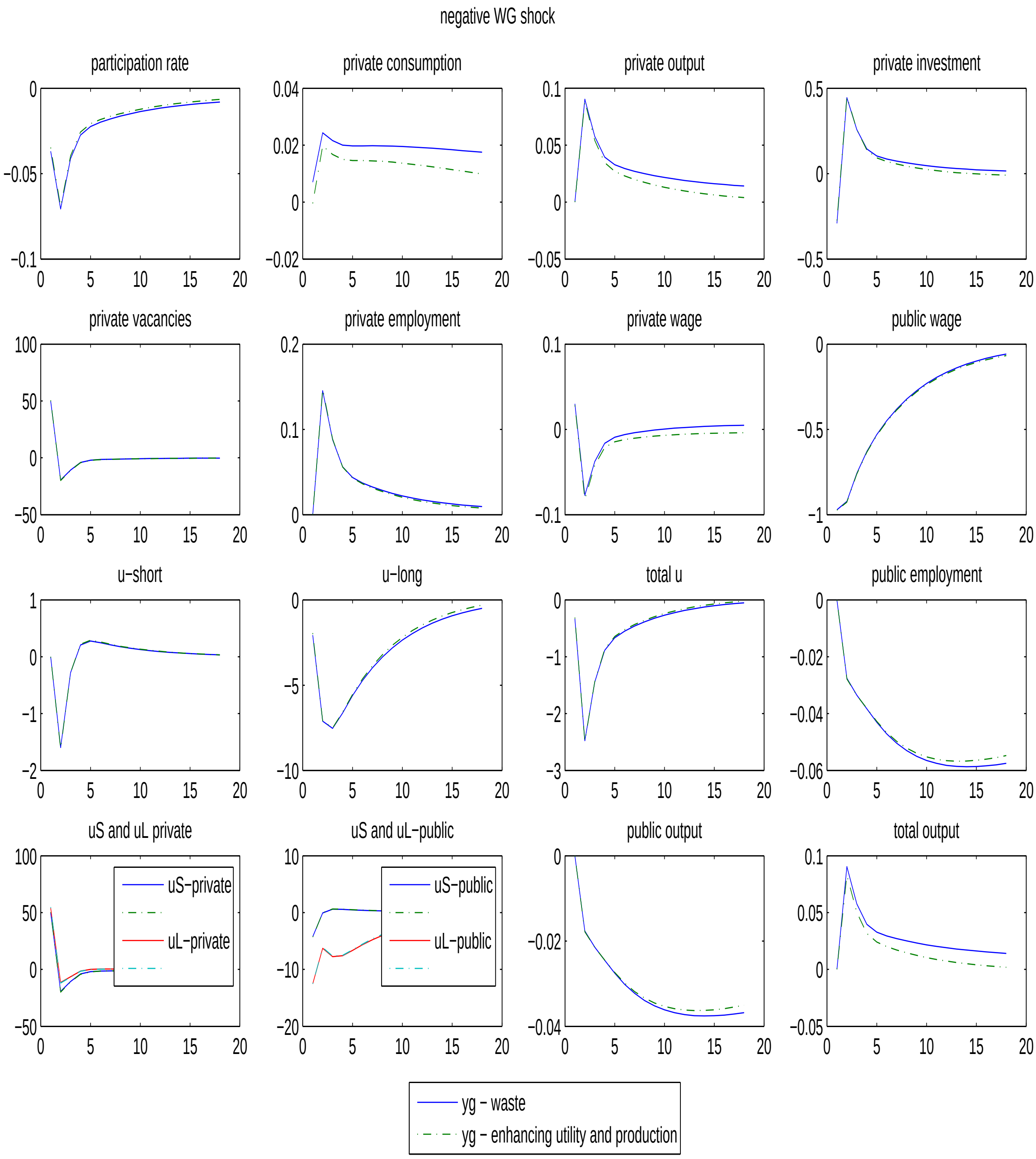

Figure 9: Theoretical impulse responses to a government wage cut

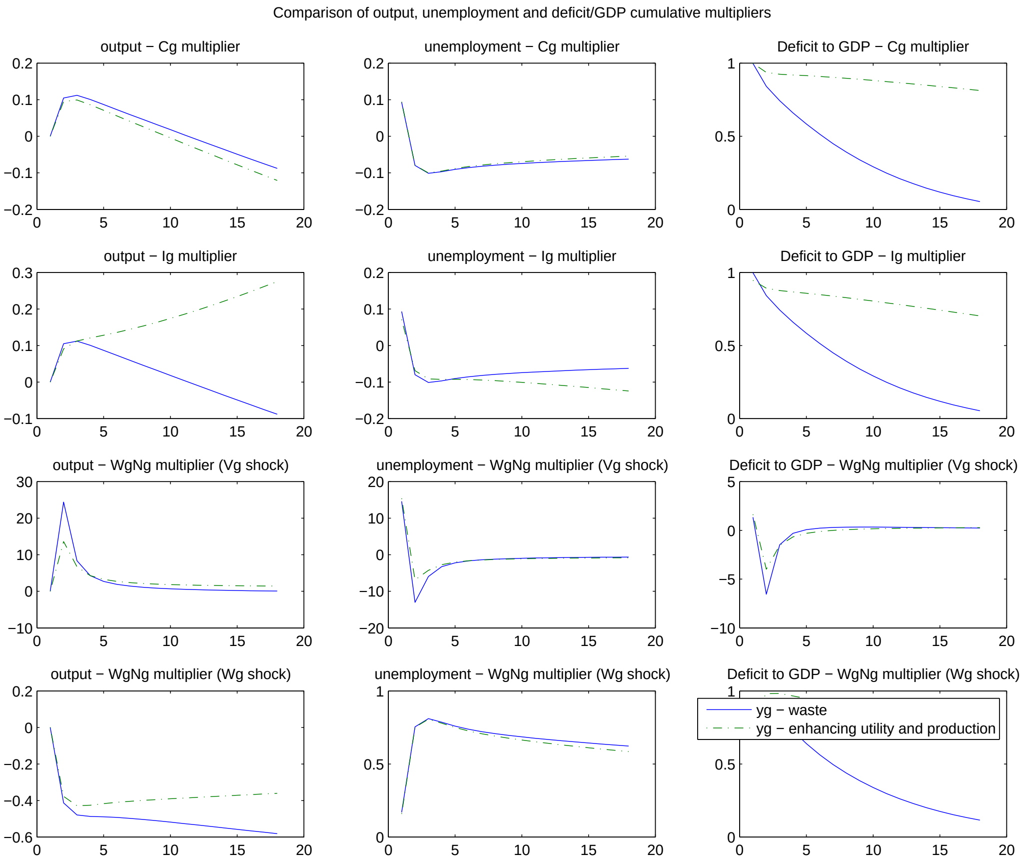

Figure 1: Comparison of output, unemployment and deficit-to-GDP multipliers

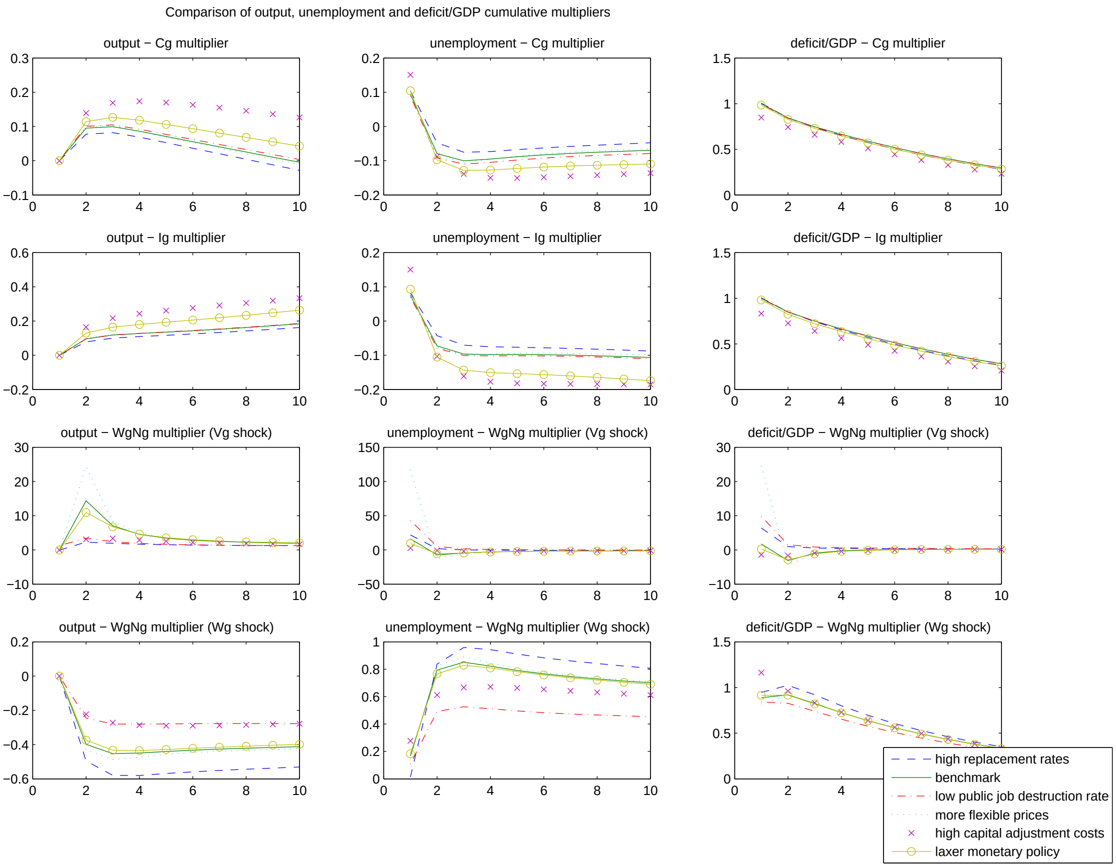

Figure 2: Figure 11: Sensitivity analysis for output, unemployment and deficit-to-GDP multipliers