

Burgert, Matthias; Gomes, Pedro

**Conference Paper**

## The Effects of Government Spending: A Disaggregated Approach

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2011: Die Ordnung der Weltwirtschaft: Lektionen aus der Krise - Session: Fiscal Stimulus, No. G2-V3

**Provided in Cooperation with:**

Verein für Socialpolitik / German Economic Association

Suggested Citation: Burgert, Matthias; Gomes, Pedro (2011) : The Effects of Government Spending: A Disaggregated Approach, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2011: Die Ordnung der Weltwirtschaft: Lektionen aus der Krise - Session: Fiscal Stimulus, No. G2-V3, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft

This Version is available at:

<http://hdl.handle.net/10419/48690>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# THE EFFECTS OF GOVERNMENT SPENDING: A DISAGGREGATED APPROACH\*

Matthias Burgert

Pedro Gomes<sup>†</sup>

Goethe University Frankfurt University Carlos III de Madrid

March 1, 2011

PRELIMINARY DRAFT

DO NOT QUOTE OR CIRCULATE WITHOUT PERMISSION

## Abstract

We disaggregate government spending into five macroeconomic-relevant components: average wage, employment, purchases of intermediate goods and services, investment and transfers. We set up a simple RBC model with only search and matching frictions in the labour market to show that these components have different, quantitative and sometimes qualitative, effects on output, private wages and employment, the unemployment rate and private consumption. Using simulated data we show that a VAR with aggregate government spending and output does not identify any type of fiscal shock. We then use the several identification strategies proposed in the literature to understand the effects of different components, for the United States. We find that both the average wage and employment have larger multipliers than purchases of intermediate goods, investment and transfers. They also have distinct effects on private wages and private consumption.

**JEL Classification:** E62 .

**Keywords:** Government spending.

---

\*We would like to thank participants at the European Central Bank Fiscal Policies seminar. We want to give particular thanks to Jacopo Cimadomo for valuable comments.

<sup>†</sup>Corresponding author. University Carlos III de Madrid, C/ Madrid 126, 28903 Getafe, Spain. Tel:+34916245732, Email: pgomes@eco.uc3m.es.

# 1 Introduction

During the current economic crisis, one of the most relevant questions posed by policy makers was how much can government spending stimulate output. Economists find it hard to answer this question. On the one hand, theoretical models often predict different, and sometimes opposite, effects of government spending on several macroeconomic variables such as real wages, private employment or private consumption. On the other hand, the empirical literature has not been able to shed much light on the debate. Most studies disagree on the size of the fiscal multipliers and on the effects of government spending on the key macroeconomic variables (Perotti (2008)).<sup>1</sup>

The source of this disagreement has usually been attributed to the methodology of the identification of fiscal shocks. Blanchard and Perotti (2002) impose a restriction on the timing of the response of government spending to shocks on output. Mountford and Uhlig (2009) impose sign restrictions to identify monetary policy, business cycles, government spending and tax shocks. Ramey and Shapiro (1998) follow a narrative approach, isolating the dates of exogenous events that lead to military buildups in the United States. More recently, following Ramey (2009), the research has focussed on the timing and anticipation of fiscal shocks.

We believe that the identification strategy is not the only explanation for this mixed evidence. Government spending includes several components, such as government investment, transfers or government consumption. Within government consumption, the biggest share is the compensation to government employees but the more volatile component is the purchases of intermediate goods and services. If the components of fiscal policy have different macroeconomic effects, by including all components together, some in particular or using different samples in which the composition of spending has changed, we cannot expect to identify properly any type of fiscal shocks.

Even in the absence of nominal rigidities, there are good theoretical reasons to expect that different types of expenditure have distinct macroeconomic effects. Baxter and King (1993) find that government investment has different quantitative and qualitative effects than government consumption. Because it affects the marginal productivity of factors in

---

<sup>1</sup>The empirical literature is, in fact, extensive. Rotemberg and Woodford (1992) find that after a military expenditure shock (government military purchases and military employment) real wages go up but Edelberg, Eichenbaum, and Fisher (1999) and Ramey and Shapiro (1998) find that after a government military purchases shock real wages go down. Blanchard and Perotti (2002), Fatás and Mihov (2001) find that private consumption increases after a government consumption shock but Mountford and Uhlig (2009), Ramey (2009) and Tenhofen and Wolff (2007) report a negative or zero response.

the private sector, it can, for instance, crowd in private investment. Two early references like Rotemberg and Woodford (1992) or Finn (1998) find that, contrary to government purchases of goods and services, the purchase of hours raises real wages and reduces private employment. Pappa (2009) finds similar results in a New Keynesian model.

Beside the theory, there is also empirical evidence. Lane (2003) measures the cyclicity of different spending categories across OECD countries using regression based approach and finds that they are very heterogeneous. Alesina and Perotti (1995) and Perotti (1996) examine episodes of fiscal adjustments in OECD countries and find that the most successful episodes were based on spending cuts on transfers and on the wage bill. These ones were also more likely to foster growth and private investment. There are also findings that the wage component of government consumption causes much stronger contractions in exports (Lane and Perotti (1998)), as well as in private investment and profits (Alesina, Ardagna, Perotti, and Schiantarelli (2002)). Perotti (2008) in one exercise, distinguishes between government employment and a goods spending shock and find that both GDP and private consumption respond much more to the employment component of government spending.

Our objective is to do a deeper study of the effects of the different types of spending. We disaggregate government spending into macroeconomically relevant components: the wage bill (product of government employment and the average wage), purchases of intermediate goods, investment, transfers and interest payments. Using quarterly data for the United States, we examine the properties of each component, such as: the size, volatility, persistence and comovement. The correlation among the components is not high. Wages and employment are less volatile, more persistent and more procyclical than the other components. The weight of each component in total spending changes throughout the sample, as well as the volatilities and their correlation with total spending and with real GDP.

We then set up an RBC model with only search and matching frictions in the labour market. As we are going to focus particularly on examining the effects of government employment and wages compared to consumption or investment, we think it is important to have a more realistic approach of the labour market. The purpose of the model is twofold. First we want to show that, even in a very basic setting, the components of spending have different, quantitative and sometimes qualitative, effects on output, private wages and employment, the unemployment rate and private consumption. The model allows us to understand the fundamental differences between components, even in the absence of any demand effects. The second objective is to highlight the potential problems of using aggregate data of government spending to estimate its effects of output and other variables. To do so, we simulate data

from the model with technology shocks and government spending shocks (wages, employment, consumption and investment). We then estimate a VAR with aggregate government spending and output and show that we cannot identify any type of shock.

This last result motivates our empirical study. We use a VAR approach to identify the effects of the different types of expenditure. First we reproduce the studies by Blanchard and Perotti (2002) and Mountford and Uhlig (2009) and Perotti (2008), by substituting government spending for its different components. Then, we generalize the identification approach by Blanchard and Perotti (2002), to include all the different types of spending, to capture possible complementarities and substitutabilities between them. To relate to the literature using the narrative approach in the spirit of Ramey and Shapiro (1998), we then include dummy variables at the onset of military buildups, to find how the composition of spending evolved in each episode.

We find that expenditure in wages and employment is stronger in stimulating the economy than purchases of intermediate goods and transfers. These results are quite robust to different identification strategies. We also find that each of the military buildups consisted of a very specific combination of types of spending and that the effects on output were very different. Furthermore, the components of spending also affect other variables differently: private wages and private consumption tend to increase after government wages and employment shocks as opposed to other shocks.

The paper continues as follows. In section 2 we describe the data and show some basic facts about the components of spending. Section 3 presents the model and Section 4 studies the effects of the components of spending and the VAR estimation with simulated data. In Section 5 we reproduce the main studies in the empirical literature, substituting total spending by each of its components. In section 6 we estimate a VAR including all the different components and we use it to relate to the event-study identification. Section 7 concludes the paper.

## 2 The composition of government spending

### 2.1 Preliminary concepts

Our definition of total spending is the sum of the five components: the public sector wage bill which can be decomposed into the product between the average wage ( $\omega_t^g$ ) and employment ( $l_t^g$ ), purchases of intermediate goods and services ( $c_t^g$ ), investment ( $i_t^g$ ), transfers ( $t_t^g$ ) and

interest payments ( $r_t^g$ ).

$$Gov_t^1 = \omega_t^g l_t^g + c_t^g + i_t^g + t_t^g + r_t^g. \quad (1)$$

All data are taken from the National Income and Product Accounts of the Bureau of Economic Analysis: Government purchases of intermediate goods and services, Gross Government Investment, Government transfers, Government Interest payments and Compensation of General Government Employees. The average wage is calculate by dividing total compensation by *All Employees: Government*. When we add these categories, our measure of total government spending is slightly above the official definition from the Bureau of Economic Analysis. This is so because on top of the current expenditures and gross government investment, they include capital transfer payments and deduce the sale of goods and services to the private sector.<sup>2</sup> On top of spending, we also use data on taxes, defined as *Total government receipts*.

Many of the empirical studies of the macroeconomic effects of government spending, focus simply on government consumption. In theoretical papers, government consumption usually refers to goods and services bought from the private sector. However, the official definition of government consumption includes the public sector wage bill, purchases of intermediate goods and services minus goods and services sold to the private sector and the consumption of fixed capital (depreciation). This last category is purely an accounting value, and it is not an actual expenditure. Throughout the paper we are going to refer purchases of intermediate goods and services ( $c_t^g$ ) as consumption. This component is the one consistent with the theoretical models when referring to government consumption. In occasions, we also consider measures of total government spending excluding interest payments ( $Gov^2$ ) and excluding interest payments and transfers ( $Gov^3$ ):

$$Gov_t^2 = \omega_t^g l_t^g + c_t^g + i_t^g + t_t^g, \quad (2)$$

$$Gov_t^3 = \omega_t^g l_t^g + c_t^g + i_t^g. \quad (3)$$

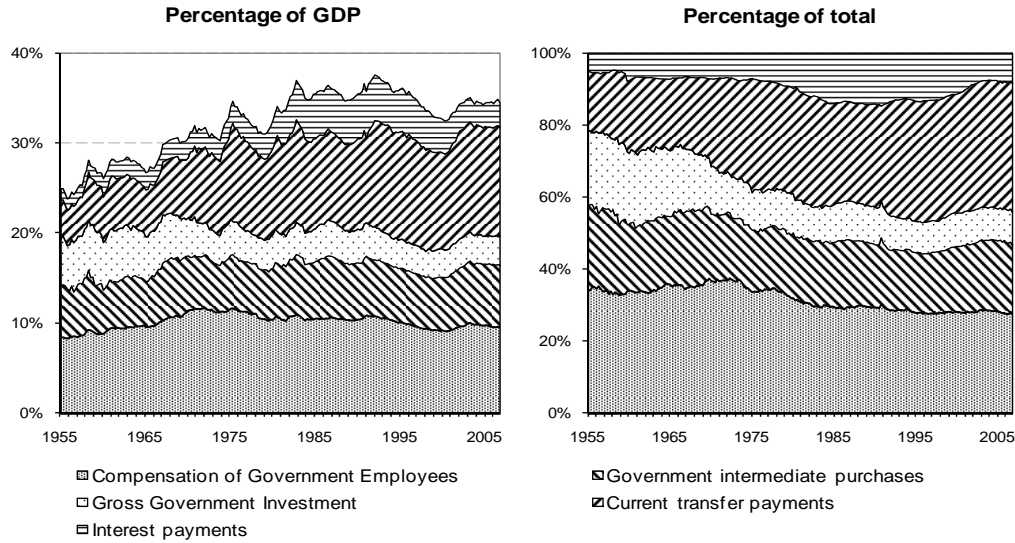
## 2.2 Size

Figure 1 shows the evolution of government spending with its several components. All the five components of government spending are important. On average, the public sector wage

---

<sup>2</sup>On average, our variable is 5 percent above the official value. See appendices A and B for a comparison between the two, as well as all the details of the calculations.

Figure 1: Evolution of government expenditure and its components



bill and transfers correspond to 30 percent of total spending, purchases of intermediate goods and services is 20 percent of spending, investment corresponds to 13 percent while interest payments are close to 10 percent. Total government spending as a share of GDP has increased throughout the sample from 20 to 35 percent of GDP (and to 40 percent of GDP in 2010 due to the economic crisis). This was mostly driven by the increase in transfers and of purchases of intermediate goods. The weight of the public sector wage bill and investment on total spending diminished around 6 and 10 percentage points, while transfers have increased by almost 20 percentage points.<sup>3</sup>

### 2.3 Volatility, persistence and comovement

To analyse the properties of the different types of spending, we first detrend the data using an HP-filter.<sup>4</sup> Table 1 shows the correlation between each component of spending, as well as with aggregate measures of government spending and economic activity. The last two columns show the standard deviation and the first-order autocorrelation coefficient of the series. The volatility of the series are quite different. Consumption and investment are the most volatile components with standard deviations around 0.04, followed closely by transfers. The wage and employment are less volatile with standard deviations around 0.01. Wages and employment are also more persistent with an autocorrelation coefficient close to 0.9, while for investment it is 0.7 and for consumption 0.6.

<sup>3</sup>Figure 8 in Appendix B plots each component of spending, in real terms. The public sector wage bill is disaggregated into the average wage and employment.

<sup>4</sup>The variables are shown in Figure 9 in Appendix B.

Table 1: Correlations and standard deviations on the 1955:2006 sample

<b>Correlations</b>	Wage	Employment	Consumption	Investment	Transfers	Interest	<b>Stddev</b>	<b>AR(1)</b>
Wage	1						0.011	0.87
Employment	-0.44	1					0.008	0.89
Consumption	0.02	0.38	1				0.037	0.61
Investment	-0.06	0.50	0.41	1			0.043	0.70
Transfers	0.15	0.03	0.20	0.17	1		0.033	0.65
Interest	-0.01	-0.06	-0.24	0.04	-0.20	1	0.044	0.74
Gov. Spending (1)	0.22	0.39	0.71	0.69	0.64	-0.02	0.017	0.84
Gov. Spending (2)	0.22	0.41	0.73	0.66	0.67	-0.21	0.019	0.83
Gov. Spending (3)	0.21	0.52	0.83	0.78	0.25	-0.14	0.019	0.83
Wage bill	0.72	0.31	0.31	0.33	0.19	-0.05	0.010	0.88
Unemp.Rate	0.19	-0.23	0.08	-0.08	0.59	-0.34	0.116	0.89
GDP	0.00	0.15	-0.10	0.08	-0.45	0.16	0.016	0.85
GDP lead(4)	-0.39	0.52	0.09	0.25	-0.33	0.22		
GDP lead(1)	-0.11	0.24	-0.06	0.06	-0.53	0.26		
GDP lag(1)	0.09	0.07	-0.16	0.01	-0.31	-0.02		
GDP lag(4)	0.26	-0.22	-0.11	-0.16	-0.02	-0.30		

*Notes: variables in logs were previously detrended using an HP filter with parameter 1600. Gov. Spending (1) includes all components while (2) excludes interest payments and (3) excludes interest payments and transfers. AR(1) corresponds to the autocorrelation coefficient of order 1.*

Another important conclusion is that the correlation among the different types of expenditures is not very high. All correlations are below 0.5 with the exception of employment and investment. Interest payments have a negative correlation with all other components. All components, with the exception of interest payments, are positively correlated with total spending. The correlation of any measure of total spending with consumption or investment is high (around 0.7) but far from perfect. On the other hand, it is much lower for wages (0.2) and employment (0.4 to 0.5).

Finally, we can relate each component with two measures of economic activity: unemployment rate and real GDP growth. Wage, employment and investment are slightly procyclical but with very low correlation. On the other hand, transfers have a correlation of -0.5 with real GDP growth and of 0.59 with unemployment. Government wage is more correlated with the lags of GDP, while employment has a correlation of 0.52 with the 1 year lead of GDP.

## 2.4 Stability

These properties, however, change throughout the sample.<sup>5</sup> For instance, the standard deviation of consumption and investment has fallen significantly throughout the sample. During the first years of the sample the two components had a standard deviation as high as 0.06, but it gradually came down to 0.02. By the end of the sample, these components

<sup>5</sup>Shown in Figures 10, 11 and 12 in Appendix B.



are not more than twice as volatile as wages or employment. Also, government spending seems driven by different expenditures over different periods. It was positively correlated with the average wage at the beginning and at the end of the sample but in the 70s and 80s it had a correlation of -0.5. The correlation between investment and government spending has declined from close to 0.9 to 0.4 at the end of the sample. The cyclicity of each component also varies substantially throughout the sample. Transfers is the component that is consistently countercyclical. All other components vary from slightly procyclical at some stages to slightly countercyclical during other periods.

## 2.5 Specific Episodes in Components

Table 2 shows the periods of abnormal fiscal events, defined as a percentage change higher than three standard deviations. While there is only three dates of large swings in total government spending, there has been 16 episodes within the different components.<sup>6</sup>

Table 2: Large changes in government spending components in the 1955:2006 sample

Wage		Employment		Investment		Consumption		Transfers		Gov. Spending (2)	
sd $\Delta w^g=0.006$		sd $\Delta l^g=0.005$		sd $\Delta i^g=0.034$		sd $\Delta c^g=0.033$		sd $\Delta t^g=0.028$		sd $\Delta g=0.011$	
69q3	0.020	66q2	0.017	71q1	-0.102	56q3	-0.145	59q1	0.087	58q2	0.039
74q3	-0.021			78q2	0.132	56q4	0.100	70q2	0.129	65q3	0.034
						58q3	-0.109	80q3	0.091	67q1	0.046
						59q1	-0.122	91q1	-0.109		
						60q1	-0.123	91q2	0.106		
						67q1	0.102				

Notes:  $\Delta x^g$  are quarter-on-quarter changes of the log of real variables (employment not in real terms) normalized by the size of the population. Episodes selected are the ones where the change in absolute levels is bigger than three standard deviations ( $|\frac{\Delta x^g}{sd}| \geq 3$ ). Gov. Spending (2) corresponds to equation (2) which excludes interest payments.

## 3 Model

### 3.1 General setting

The model is a dynamic stochastic general equilibrium model with public and private sectors. The only rigidities present are due to search and matching frictions. It is an extension of Gomes (2010) to include not only government employment and wages, but also government

<sup>6</sup>In Appendix B we show the dates of changes above 2 standard deviations. While there are 11 quarters where the change in total government spending was above 2 standard deviations, there are 66 episodes for the different components.

consumption and investment.<sup>7</sup> Public sector variables are denoted by the superscript  $g$  while private sector variables are denoted by  $p$ . Time is denoted by  $t = 0, 1, 2, \dots$

The labour force consists of many individuals  $j \in [0, 1]$ . Part of them are unemployed ( $u_t$ ), while the remaining are working either in the public ( $l_t^g$ ) or in the private ( $l_t^p$ ) sectors.

$$1 = l_t^p + l_t^g + u_t. \quad (4)$$

Total employment is denoted by  $l_t$ . The presence of search and matching frictions in the labour market prevents some unemployed from finding jobs. The evolution of employment in both sectors depends on the number of new matches  $m_t^p$  and  $m_t^g$  and on the separations. In each period, jobs are destroyed at constant fraction  $\lambda^i$ , potentially different across sectors.

$$l_{t+1}^i = (1 - \lambda^i)l_t^i + m_t^i, \quad i = p, g. \quad (5)$$

The new matches are determined by two Cobb-Douglas matching functions:

$$m_t^i = \mu^i (u_t^i)^{\eta^i} (v_t^i)^{1-\eta^i}, \quad i = p, g. \quad (6)$$

We assume the unemployed choose which sector they want to search in, so  $u_t^i$  represents the number of unemployed searching in sector  $i$ . The vacancies in each sector are denoted by  $v_t^i$ . The parameter  $\eta^i$  is the matching elasticity with respect to unemployment and  $\mu^i$  the matching efficiency. A fraction  $s_t = \frac{u_t^g}{u_t}$  of unemployed search for public sector jobs. From the matching functions we can define the probabilities of vacancies being filled  $q_t^i$ , the job-finding rates conditional on searching in a particular sector  $p_t^i$ , and the unconditional job-finding rates  $f_t^i$ :

$$q_t^i = \frac{m_t^i}{v_t^i}, \quad p_t^i = \frac{m_t^i}{u_t^i}, \quad f_t^i = \frac{m_t^i}{u_t}, \quad i = p, g.$$

## 3.2 Households

Following Merz (1995), I assume all the income of the members is pooled so the private consumption is equalised across members. The household is infinitely-lived and has preferences over private consumption goods,  $c_t$ , and public goods  $g_t$ . It also has utility from unemployment  $\nu(u_t)$ , which captures leisure and home production.

$$E_t \sum_{t=0}^{\infty} \beta^t [u(c_t, g_t) + \nu(u_t)], \quad (7)$$

---

<sup>7</sup>For the model, we are going to abstract from transfers.

where  $\beta \in (0, 1)$  is the discount factor. The budget constraint in period  $t$  is given by:

$$c_t + B_t = (1 + r_{t-1})B_{t-1} + w_t^p l_t^p + w_t^g l_t^g + \Pi_t, \quad (8)$$

where  $r_{t-1}$  is the real interest rate from period  $t - 1$  to  $t$  and  $B_{t-1}$  are the holdings of one period bonds.  $w_t^i l_t^i$  is the total wage income from the members working in sector  $i$ . Finally,  $\Pi_t$  encompasses the lump sum taxes that finance the government's wage bill and possible transfers from the private sector firms. We assume there are no unemployment benefits.

The household chooses  $c_t$  to maximize the expected utility subject to the sequence of budget constraints, taking the public goods as given. The solution is the Euler equation:

$$u_c(c_t, g_t) = \beta(1 + r_t)E_t[u_c(c_{t+1}, g_{t+1})]. \quad (9)$$

### 3.3 Workers

The value of each member to the household depends on their current state. The value of being employed in sector  $i$  is given by:

$$W_t^i = w_t^i + E_t \beta_{t,t+1} [(1 - \lambda^i)W_{t+1}^i + \lambda^i U_{t+1}], \quad i = p, g, \quad (10)$$

where  $\beta_{t,t+k} = \beta^k \frac{u_c(c_{t+k}, g_{t+k})}{u_c(c_t, g_t)}$  is the stochastic discount factor. The value of being employed in a sector depends on the current wage, as well as, the continuation value of the job that depends on the separation probability. Under the assumption of directed search, the unemployed are searching for a job either in the private or in the public sector, with value functions given by:

$$U_t^i = \frac{\nu_u(u_t)}{u_c(c_t, g_t)} + E_t \beta_{t,t+1} [p_t^i W_{t+1}^i + (1 - p_t^i)U_{t+1}], \quad i = p, g. \quad (11)$$

Beside the marginal utility from unemployment, the value of being unemployed and searching in a particular sector, depends on the probabilities of finding a job and the value of working in that sector. Optimality implies that there are movements between the two segments that guarantee that there is no additional gain of searching in one sector *vis-à-vis* the other:

$$U_t^p = U_t^g = U_t. \quad (12)$$

This equality determines the optimal share of unemployed searching in each sector. We

can re-write it as:

$$\frac{m_t^p E_t[W_{t+1}^p - U_{t+1}]}{(1 - s_t^*)} = \frac{m_t^g E_t[W_{t+1}^g - U_{t+1}]}{s_t^*}, \quad (13)$$

which implicitly defines  $s_t^*$ . An increase in the value of being employed in the public sector, driven either by an increase in the wage or by a decrease in the separation rate, raises  $s_t^*$ , until there is no extra gain from searching in that sector. Gomes (2010) estimates the model and finds that the share of the unemployment searching in each sector fluctuates less than what is predicted by the model. This might be due to frictions in changing sector. In order to be more general, the actual share of unemployed searching in the public sector is:

$$s_t = \alpha s_t^* + (1 - \alpha)s_{t-1}. \quad (14)$$

### 3.4 Private sector firms

The representative firm hires labour to produce the private consumption goods. The production function is linear in labour, but part of the resources produced have to be used to pay the cost of posting vacancies  $\varsigma^p v_t^p$ .

$$y_t = a_t^p l_t^p - \varsigma^p v_t^p, \quad (15)$$

where  $a_t^p$  is the productivity of the private sector which is taken as given for the firms. We assume it depends on the amount of public capital with an elasticity of  $\theta$  and a productivity shock  $\epsilon_t^a$ .

$$\ln(a_t^p) = \ln(\epsilon_t^a) + \theta \ln(k_t^g), \quad (16)$$

At time  $t$ , the level of employment is predetermined and the firm can only control the number of vacancies it posts. The value of opening a vacancy is given by:

$$V_t = E_t \beta_{t,t+1} [q_t^p J_{t+1} + (1 - q_t^p) V_{t+1}] - \varsigma^p, \quad (17)$$

where  $J_t$  is the value of a job for the firm, given by:

$$J_t = a_t^p - w_t^p + E_t \beta_{t,t+1} [(1 - \lambda^p) J_{t+1}]. \quad (18)$$

Free entry guarantees that the value of posting a vacancy is zero ( $V_t = 0$ ), so we can combine the two equations into:

$$\frac{\varsigma^p}{q_t^p} = E_t \beta_{t,t+1} [a_{t+1}^p - w_{t+1}^p + (1 - \lambda^p) \frac{\varsigma^p}{q_{t+1}^p}]. \quad (19)$$

The condition states that the expected cost of hiring a worker must equal its expected return. The benefit of hiring an extra worker is the discounted value of the expected difference between its marginal productivity and its wage, plus the continuation value, knowing that with a probability  $\lambda^p$  the match is destroyed.

Finally, we consider the private sector wage is the outcome of a Nash bargaining between workers and firms. The sharing rule is given by:

$$(1 - b)(W_t^p - U_t) = bJ_t. \quad (20)$$

### 3.5 Government

The government produces its good using workers and a consumption good purchased from the private sector ( $c_t^g$ ). The costs of posting vacancies are deducted from production. Unless there is a particular interdependence in the utility function between public and private goods, the production function turns out to be irrelevant.

$$g_t = g(l_t^g, c_t^g) - \varsigma^g v_t^g. \quad (21)$$

Additionally the government also buys from the private sector investment goods ( $i_t^g$ ), which are used to build up the level of public capital.

$$k_{t+1}^g = (1 - \delta)k_t^g + i_t^g. \quad (22)$$

The government collects lump sum taxes to finance the wage bill, consumption and investment:

$$\tau_t = w_t^g l_t^g + c_t^g + i_t^g. \quad (23)$$

The numeraire of this economy is the private consumption good. As in reality, as the public good is not sold, it has no actual price. The value added of the public sector is going to be measure using the production cost ( $w_t^g l_t^g + c_t^g + i_t^g$ ).

Finally, the government sets a policy for the sequence of vacancies and wage  $\{v_t^g, w_t^g\}_{t=0}^\infty$ , consumption  $\{c_t^g\}_{t=0}^\infty$  and investment  $\{i_t^g\}_{t=0}^\infty$ . We are going to focus on exogenous policies to help us understand the functioning of the model and the transmission mechanisms of fiscal

policy:

$$w_t^g = \bar{w}^g + \epsilon_t^w, \quad (24)$$

$$l_{t+1}^g = \bar{l}^g + \epsilon_{t+1}^l, \quad (25)$$

$$c_t^g = \bar{c}^g + \epsilon_t^c, \quad (26)$$

$$i_t^g = \bar{i}^g + \epsilon_t^i. \quad (27)$$

Where the steady-state variables are represented with a bar, and  $\epsilon^i$  are the shocks to each component. In the baseline setting, we consider that an employment shock is achieved through hirings but can only be put in place in period  $t + 1$ . An alternative would be to consider a shock to vacancies. As there is a one-to-one mapping between a sequence of vacancies and a sequence of employment, the distinction is not relevant.

### 3.6 Market clearing

To close the model, we need the market clearing condition for the private goods market:

$$y_t = c_t + c_t^g + i_t^g, \quad (28)$$

Notice however that to have a comparable measure to GDP, we need to add the government wage bill:

$$Output_t = c_t + c_t^g + i_t^g + w_t^g l_t^g, \quad (29)$$

### 3.7 Calibration

To solve the model, we assume a that the utility function is separable in the private and public good and that the utility of unemployment is linear.

$$u(c_t, g_t) = \frac{c_t^{(1-\gamma)} - 1}{(1-\gamma)} + \zeta \ln(g_t), \quad \nu(u_t) = \chi u_t.$$

The model is calibrated to match the US economy at a quarterly frequency. The steady-state vacancies in the public sector are such that public sector employment corresponds to 13.6 percent of the labour force (average from 1955 to 2006). The steady-state levels of government consumption and investment are set to 7 and 4 percent of output. We choose a steady-state public sector wage gap of 2 percent ( $\pi = \frac{\bar{w}^g}{w^p}$ ) which implies a total government wage bill of 14 percent of output.

Most of the labour market parameters follow Gomes (2010). We fix the separation rate in the private and public sectors at 0.06 and 0.03. We set the public sector matching elasticity with respect to unemployment,  $\eta^g$ , at 0.2 and  $\eta^p$  at 0.5. We calibrate the matching efficiency  $\mu^i$  to such that the duration of a vacancy is 50 days for the government and 20 days for the private sector ( $\bar{q}^p = 4.7$  and  $\bar{q}^g = 1.8$ ). We consider the cost of posting a vacancy  $\zeta^i$  to be 2 in the private sector and 1.1 in the public sector. Under this calibration, the sum of recruitment costs is close to 2.5 percent of the total labour costs. For the model to satisfy the Hosios condition in the private sector, the worker's share in the Nash bargaining is set at 0.5. The value of leisure in the utility function is calibrated, such that the unemployment rate in steady state is 0.063 and implies an outside option equivalent to 63 percent of the average wage. Technology in the private sector is normalised to 1 and the discount factor is set at 0.99.

We have four additional variables to calibrate. The productivity of public capital,  $\theta$  is set at 0.05, following Baxter and King (1993) and the depreciation of public capital is set to 0.02. This implies that the steady-state level of public capital is around 50 percent of annual output. We consider a log utility of private consumption ( $\gamma = 1$ ). The parameter reflecting the frictions in changing sector,  $\alpha$  is set to 0.4, Table 3 summarises the baseline calibration and the implied steady-state values for some of the variables.

Table 3: Baseline calibration

Parameters													
$\gamma$	1	$\eta^p$	0.5	$\zeta^p$	2.0	$\mu^p$	1.71	$\lambda^p$	0.06	$\chi$	0.46	$\alpha$	0.1
$\beta$	0.99	$\eta^g$	0.2	$\zeta^g$	1.1	$\mu^g$	1.97	$\lambda^g$	0.03	$b$	0.5	$\theta$	0.99
$\delta$	0.02	$\pi$	0.98	$\bar{l}^g$	0.136	$\bar{c}^g$	0.065	$\bar{i}^g$	0.037				
Steady-state variables													
$\bar{u}$	0.062	$\bar{q}^g$	1.8	$\bar{f}^g$	0.065	$\bar{p}^g$	1.45	$\bar{s}$	0.05	$\frac{\zeta^p \bar{v}^p + \zeta^g \bar{v}^g}{\sum \bar{w}^i \bar{l}^i}$	0.025	$\frac{\bar{c}^g}{\bar{y}}$	0.07
$\bar{l}^p$	0.80	$\bar{q}^p$	4.7	$\bar{f}^p$	0.77	$\bar{p}^p$	0.80	$\frac{\nu_l}{u_c \bar{w}^g}$	0.63	$\frac{\bar{w}^g \bar{l}^g}{\bar{y}}$	0.14	$\frac{\bar{i}^g}{\bar{y}}$	0.04

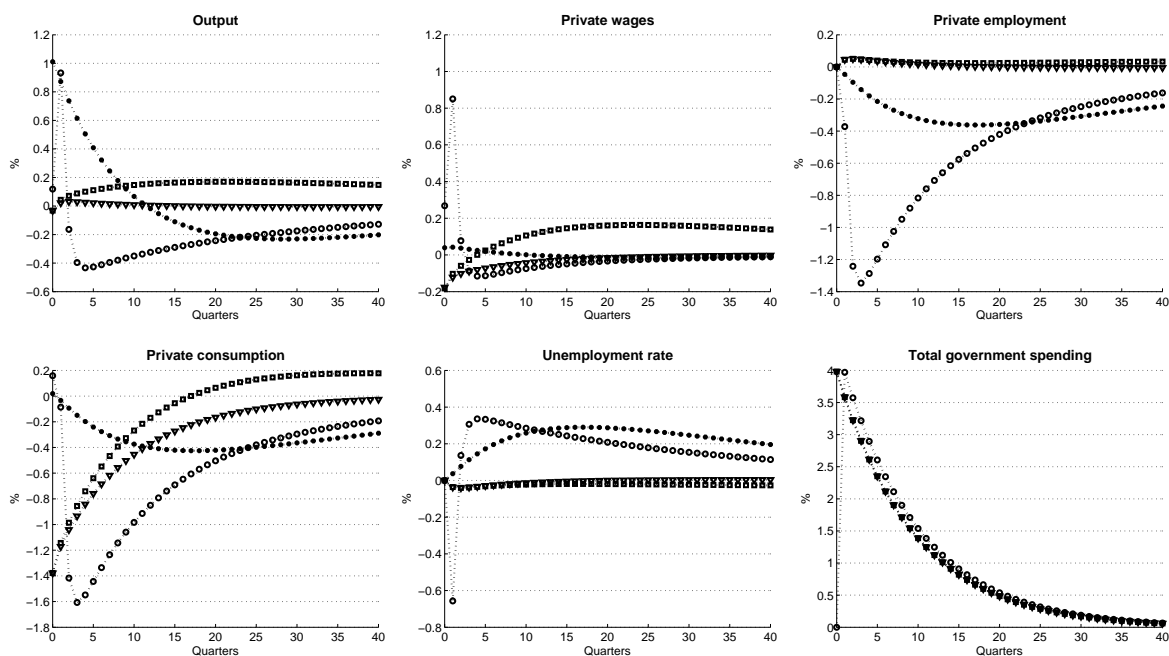
## 4 Simulations

### 4.1 Response to government spending shocks

Figure 2 shows the impulse responses to a shock to each of the components of spending. Each shock is normalized such that the increase in total spending is equivalent to 1 percent of GDP and that the autocorrelation coefficient is 0.9.

The effect on output are very different across shocks. Employment has a very high impact multiplier, because it has a very strong effect in reducing unemployment, at the time of the hiring. After the initial period of hiring, than unemployment increases and the effect on output is negative.

Figure 2: Effect of fiscal shocks in key variables



Notes: Response to a 1 percent of GDP fiscal shocks: wages (solid line), employment (dash line), consumption (dotted line) and investment(dash-dotted line).

We can summarise the results as follows:

- Employment and wages have much stronger effect on output than consumption or investment.
- Wage is a fundamentally different component, because it does not drain resources from the private sector directly. It is also peculiar because output includes the government



wage bill, so by increasing the wages, the government is increasing output, without any change in the production of both private and public goods.

- Employment and wages affect the market of inputs, putting an upward pressure on private wage and crowding out private employment. On the other hand, the effects of consumption and investment work through the wealth effect.
- Although investment builds up public capital which affects the private sector productivity, it has only a minor added effect than consumption.

## 4.2 VAR Estimation

The second objective of the model is to show the potential problems with using aggregate spending data on a VAR. For that, we simulate data from the model. We include a technology shock and the four government spending shocks: wage, employment, consumption and investment. We calibrate the shocks so they match roughly the properties shown in Table 1.

Table 4: Calibration of shock processes

	<b>Wage</b>	<b>Employment</b>	<b>Investment</b>	<b>Consumption</b>	<b>Technology</b>
Autocorrelation	0.9	0.9	0.7	0.6	0.9
Unconditional variance	$0.01^2$	$0.01^2$	$0.04^2$	$0.04^2$	$0.016^2$

We then simulate the model for 1 million periods and estimate a two variable VAR with total government spending and output.<sup>8</sup> To get the impulse responses of other variables, we run alternative VAR substituting output for the variable of interest. The results are shown in Figure 3. The estimated effect on output, private wages and private consumption is close to the response to a consumption and investment shock. However, the substantial crowding out of private employment is only consistent with the wage and employment shock. Furthermore, the model estimates an increase of the unemployment rate, much stronger than the theoretical response to any of the spending shocks.

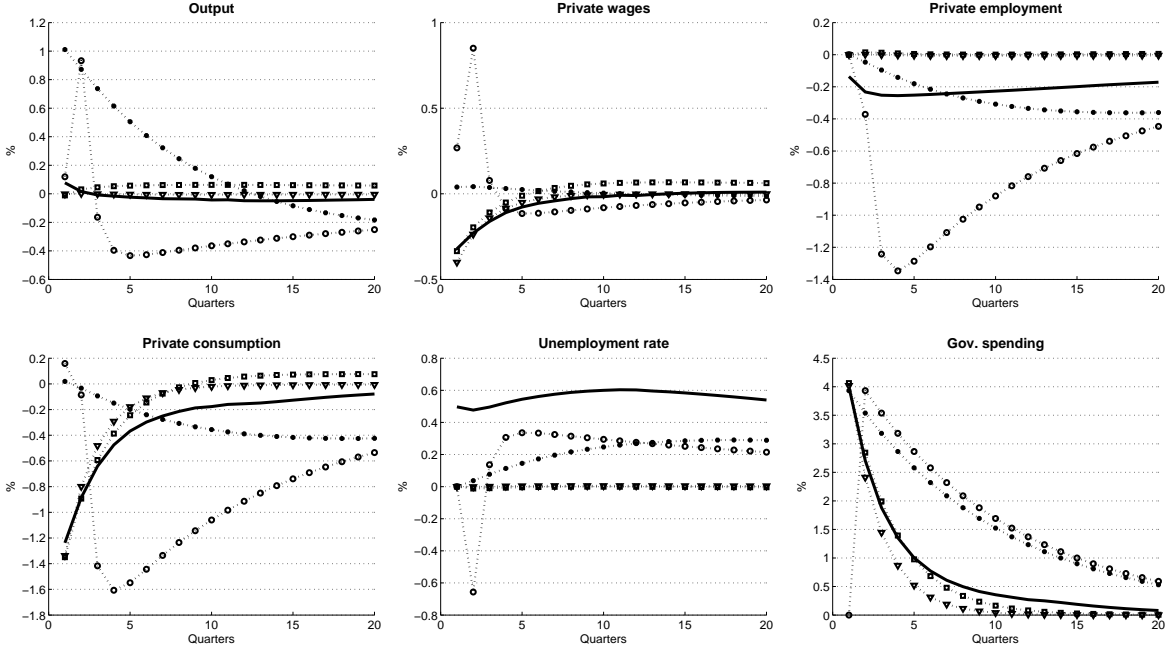
## 5 Disaggregation in existing identification settings

### 5.1 Blanchard and Perotti identifications

We start our VAR analysis based on the identification strategy proposed by Blanchard and Perotti (2002). We estimate a VAR with government spending, taxes and output. Taxes are

<sup>8</sup>We also estimate a 5 variable VAR with all the different components to show that the VAR would do a good job in matching the theoretical impulse responses of each component. The graphs are in Appendix.

Figure 3: Estimated impulse responses to a total government spending shock



Notes: Response to a 1 percent of GDP government spending shock: VAR response (solid line), VAR error bands (dash line).

defined as total government revenue net of transfers. From the estimated residuals ( $\mu$ ), we retrieve the structural shocks ( $\epsilon$ ) using:

$$\begin{bmatrix} 1 & 0 & -b_1 \\ 0 & 1 & -a_1 \\ -c_2 & -c_1 & 1 \end{bmatrix} \times \begin{bmatrix} \mu_t^g \\ \mu_t^t \\ \mu_t^x \end{bmatrix} = \begin{bmatrix} 1 & b_2 & 0 \\ a_2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} \epsilon_t^g \\ \epsilon_t^t \\ \epsilon_t^x \end{bmatrix}$$

As there are 6 parameters and only 3 can be identified we have to make three additional assumptions. Blanchard and Perotti use as a measure of government spending “Purchases of goods and services”, abstracting from transfers or interest rates. They argue that at quarterly frequency governments cannot react with consumption or investment to innovations in output so  $b_1 = 0$ , which is their main identifying assumption.

Their definition of taxes, is total revenue of several taxes (indirect taxes, personal taxes, corporate income taxes, social security contributions), net of transfers and interest payments. The response of taxes to output,  $a_1$ , is calculated using institutional information regarding the elasticity to output of the different tax receipts and transfers. They set  $a_1 = 2.08$ . We use the same value.<sup>9</sup>

<sup>9</sup>Notice, that this is the crucial parameter to identify tax shocks, but not to identify spending shocks, which is our main objective.

Finally, we can make two different assumptions for the timing of taxes and expenditures. Either  $b_2 = 0$  and tax decisions come after the spending decisions or  $a_2 = 0$  and taxes decisions are not affected by the spending decisions. In general, the correlation between the two residuals is sufficiently small so the ordering does not matter. We assume that spending decisions come first ( $b_2 = 0$ ).

The VAR is estimated with 4 lags, linear and quadratic time trend, seasonal dummies and a dummy that takes the value 1 for the 1975:2 temporary tax cut. For robustness, we also estimate the VAR in first differences (stochastic detrending). We use data from 1960:1 until 1997:4. We are going to estimate the same model, using different government spending variables: real average per employee wage, employment per capita, real consumption per capita and real investment per capita and the aggregate spending per capita (wage bill plus consumption plus investment).<sup>10</sup> We then shock each variable such that the increase in government spending is equal to 1 percent of GDP. For instance, government investment corresponds to 4 percent of GDP on average, so a shock of 25 percent to investment is equivalent to 1 per cent of GDP. For the wage bill, it corresponds to 12 percent of GDP on average, so a shock of the size of 1 per cent of GDP is equivalent to a shock of 8.4 percent to either the average wage or employment.

The results are shown in Table 5. The impact multiplier of a total spending shock is around 1 for both detrending methods, which is in line with the values found in Blanchard and Perotti. The response of output peaks after 3 quarters and is significant after 2 years.

When we substitute total spending by its components, we find that the effects are very heterogeneous. Government consumption has a very small effect on output. The impact multiplier is between 0.27 and 0.37 depending on the detrending and the effect is not significant after 4 quarters. Public investment has, in general, very high impact multipliers (1.62 to 1.83), but the effect also dies out quickly.

On the other hand, both components of the wage bill seem to have a stronger and more lasting effect. For the deterministic detrending, the impact multiplier of wage is 1.44 and the one of employment is 1.69. The effect of wages on GDP peaks after 14 quarters at 3.22 and the effect of employment peaks after 6 quarters at 12.15. For the stochastic detrending the numbers are slightly different. For the wage, the effect tends to grow over time, peaking after 20 quarters at 10.12, while the employment peaks after 1 year at 4.65. The difference between the two methods originates from the fact that they have different implications for the

---

<sup>10</sup>We abstract from interest payments, which is not chosen by the government.

Table 5: Effects of 1% of GDP fiscal shocks on GDP (Blanchard and Perotti)

Type	1 qrt	4 qrt	8 qrt	12 qrt	20 qrt	Peak	P.V. Multiplier (20qts)	
<b>Deterministic Detrending</b>								
Spending	1.00	[0.94,1.07]	0.94*	0.61*	0.58	0.54	1.25 (3)	0.80
Wage	1.44	[1.36,1.51]	2.31*	2.46	3.08*	2.93*	3.23 (14)	2.08
Employment	1.69	[1.62,1.75]	10.45*	10.31*	4.72*	-1.04	12.15 (6)	3.52
Consumption	0.37	[0.30,0.44]	-0.19	0.36	0.95	0.81	0.96 (14)	0.89
Investment	1.62	[1.56,1.69]	0.39	0.08	0.19	0.24	1.62 (1)	0.75
Transfers	0.20	[0.14,0.27]	0.28*	0.30*	0.26*	0.14	0.30 (8)	0.50
Taxes	-0.20	[-0.27,-0.14]	-0.28*	-0.30*	-0.26*	-0.14	-0.30 (8)	-0.50
<b>Stochastic Detrending</b>								
Spending	1.05	[0.98,1.12]	1.08*	0.92*	0.82	0.78	1.34 (3)	0.56
Wage	1.48	[1.41,1.55]	3.37*	6.76*	8.79*	10.12*	10.12 (20)	3.07
Employment	0.55	[0.48,0.63]	4.65*	3.86	2.83	2.31	4.65 (4)	1.25
Consumption	0.27	[0.20,0.35]	-0.37	-0.46	-0.52	-0.53	0.27 (1)	-0.35
Investment	1.83	[1.77,1.90]	0.78*	-0.20	-0.25	-0.16	1.62 (1)	0.22
Transfers	0.17	[0.10,0.23]	0.27*	0.43*	0.42*	0.41*	0.43 (8)	0.52
Taxes	-0.17	[-0.23,-0.10]	-0.27*	-0.43*	-0.42*	-0.41*	-0.43 (8)	-0.52

Notes: The VAR is estimated with 4 lags, linear and quadratic time trend, seasonal dummies and a 4-lag dummy for 1975:2. The sample starts in 1960:1 and runs until 1997:4. Error bands are at 10% and 90%. Under the stochastic detrending, we exclude the quadratic time trend. Spending incorporates the wage bill, consumption and investment. The line transfers are just the opposite sign as Taxes, given that the variable included on the VAR is taxes net of transfers, and was estimated using the VAR with total spending.

amplification and persistence of the shocks. For instance, under the stochastic detrending, wages keep increasing after the original shock (8%) up to 25%, while in the deterministic detrending, they go back to zero.

To account for this issue, we show in the last column the present value cumulative multiplier at a 5 year horizon, as calculated in Mountford and Uhlig (2009). We find that the multipliers for both wages and employment are between 1.25 and 3.52, much higher than consumption (-0.35 to 0.89) or investment (0.22 to 0.75).

As we include in the VAR taxes net of transfers we are implicitly assuming that they have the exact opposite effects. The impact multiplier of a tax cut is around 0.2 and the present value cumulative multipliers is estimated around 0.5.

## 5.2 Specification with sign restrictions

Mountford and Uhlig (2009) have a different approach to estimate the effects of government spending. They first estimate a VAR with GDP, private consumption, government expenditure, taxes net of transfers, real wages, private non-residential investment, interest rate, adjusted reserves, the producer price index for crude materials and the GDP deflator.

Their sample runs from 1955 to 2000. They then propose an agnostic identification strategy, imposing sign restrictions on impulse response functions to non-fiscal shocks (business cycle and monetary policy shocks) and to fiscal shocks.

We use their specification and the identical sample and variables. As in the previous section we estimate several versions with the different types of spending. The results are shown in Table 6. As expected, the size of multipliers are different from the previous section, but a number of facts regarding the different effects of the components of spending are consistent across identification strategies.

Table 6: Effects of 1% of GDP fiscal shocks on GDP (Mountford and Uhlig)

Type	1 qrt	4 qrt	8 qrt	12 qrt	20 qrt	Peak	P.V. Multiplier	
		<b>Output</b>						(20qts)
Spending	0.50 [0.23,0.82]	-0.07	-0.35	-0.50	-1.18	0.53 (3)	-0.47	
Wage	0.81 [-0.18,2.31]	1.94	2.23	5.29*	4.75	5.83 (14)	2.27	
Employment	-2.16 [-4.29,-0.36]	7.07*	0.44	-8.80	-16.16	7.43 (3)	-2.97	
Consumption	0.67 [0.39,1.07]	-0.40	-0.55	-0.68	-0.96	0.67 (1)	-1.13	
Investment	0.49 [0.03,1.13]	-0.15	-0.81	-1.22	-0.91	0.85(3)	-1.16	

*Notes: The VAR is estimated with 6 lags, no constant or time trend. The sample starts in 1955:1 and runs until 2000:4. Confidence intervals are at 16% and 84%. Spending incorporates the wage bill, consumption and investment.*

When we include all components together, a spending shock has a significant positive effect on output but only for 1 quarter. A consumption shock has very similar qualitative and quantitative features as the total spending shocks, but the response to the other components is very different. As in the previous section, we see that the only two components that have a lasting positive effect on output are the wage and employment. Albeit a negative impact multiplier, employment is able to stimulate output for two years, with a peak effect after 3 quarters at 7.43. Wages have a positive effect on output, which is significant between 2 to 4 years. The cumulative multiplier after 5 years is around 2.27.

An advantage of using Mountford and Uhlig's approach on top of Blanchard and Perotti's, is that we can also examine what are the effects on other variables besides GDP. We can see that both employment and wage have a positive effect on private consumption. The response of private consumption to an employment shock is significant until the 6th quarter, while the response to a wage shock is significant between 2 and 4 years after the shock. As for private wages, there is a negative response to a government consumption shock, while the response is positive for a wage and employment shock. For private non-residential investment, it seems to be crowded out by all types of shocks.

Table 7: Effects of 1% of GDP fiscal shocks on other variables (Mountford and Uhlig)

Type	1 qrt		4 qrt	8 qrt	12 qrt	20 qrt	Peak
<b>Private Consumption</b>							
Spending	-0.05	[-0.24,0.15]	-0.17	-0.44	-0.36	-0.88	-0.05 (1)
Wage	-0.43	[-1.46,0.52]	1.08	2.73	5.70*	4.53	5.97(13)
Employment	-3.58	[-4.74,-2.24]	3.72*	-1.07	-7.44	-13.22	4.31(6)
Consumption	-0.03	[-0.31,0.20]	-0.32	-0.53	-0.41	-0.72	-0.03(1)
Investment	0.29	[-0.12,0.64]	-0.34	-1.04	-1.03	-0.54	0.69(2)
<b>Non-residential investment</b>							
Spending	-0.20	[-1.92,1.97]	-4.13	-7.06*	-8.38*	-8.91*	-9.54 (18)
Wage	0.59	[-8.51,10.11]	-0.79	-13.25	1.44	0.07	4.79(14)
Employment	-19.29	[-33.39,-7.49]	-14.17	-20.15	-59.71*	-87.87*	7.37(3)
Consumption	-0.23	[-2.06,2.73]	-7.12	-7.94*	-8.06*	-8.15*	-8.15(20)
Investment	-4.49	[-7.49,0.42]	-5.39	-9.52*	-14.03*	-11.40*	-15.53 (15)
<b>Private wages</b>							
Spending	-0.56	[-0.82,-0.32]	0.07	0.28	0.30	-0.61	0.38(11)
Wage	0.35	[-1.12,1.64]	1.80	4.06*	4.99*	5.49*	5.49(20)
Employment	-0.31	[-2.15,1.26]	2.02*	0.85	-4.56	-16.58	2.59(5)
Consumption	-0.59	[-0.26,-0.92]	-0.13	-0.03	-0.25	-0.90	-0.90(20)
Investment	-1.19	[-1.63,-0.75]	-0.26	0.20	0.91	0.11	-1.19(1)

Notes: The VAR is estimated with 6 lags, no constant or time trend. The sample starts in 1955:1 and runs until 2000:4. Confidence intervals are at 16% and 84%. Spending incorporates the wage bill, consumption and investment.

## 6 Interaction between components

Our analysis so far is limited, in the sense that it does not allow for interactions between the different types of spending. The components might have different patterns of substitutability or complementarities that we have not captured so far. A shock to one particular type of spending, might be done at the expenses of other types of spending. To address this issue, we generalize the Blanchard and Perotti approach to include the five main types of expenditures. Our modeling of the error terms is:

$$\begin{bmatrix} 1 & -a_1 & 0 & 0 & 0 & 0 & -b_1 \\ 0 & 1 & 0 & 0 & 0 & 0 & -b_2 \\ 0 & 0 & 1 & 0 & 0 & 0 & -b_3 \\ 0 & 0 & 0 & 1 & 0 & 0 & -b_4 \\ 0 & 0 & 0 & 0 & 1 & 0 & -b_5 \\ 0 & 0 & 0 & 0 & 0 & 1 & -b_6 \\ -c_1 & -c_2 & -c_3 & -c_4 & -c_5 & -c_6 & 1 \end{bmatrix} \begin{bmatrix} \mu_t^w \\ \mu_t^l \\ \mu_t^c \\ \mu_t^i \\ \mu_t^{tr} \\ \mu_t^t \\ \mu_t^x \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & d_1 & 0 \\ 0 & 1 & 0 & 0 & 0 & d_2 & 0 \\ 0 & 0 & 1 & 0 & 0 & d_3 & 0 \\ 0 & 0 & 0 & 1 & 0 & d_4 & 0 \\ 0 & 0 & 0 & 0 & 1 & d_5 & 0 \\ \gamma_1 & \gamma_2 & \gamma_3 & \gamma_4 & \gamma_5 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \epsilon_t^w \\ \epsilon_t^l \\ \epsilon_t^c \\ \epsilon_t^i \\ \epsilon_t^{tr} \\ \epsilon_t^t \\ \epsilon_t^x \end{bmatrix}$$

We maintain the identification assumptions of Section 5.1. We assume that the innovations in output do not affect general government expenditure contemporaneously at a quarterly frequency. The only exception is transfers and taxes so  $b_1 = b_2 = b_3 = b_4 = 0$ . With respect to the effect of output on transfers, B&P estimate it to be  $b_5 = -0.2$ . We then

back out the effect of output on total taxes which is around  $b_6 = 1.8$ . Finally, we again assume spending decisions come first ( $d_1 = d_2 = d_3 = d_4 = d_5 = 0$ )<sup>11</sup>.

To generalize the method to include all the components, we have to make some further assumptions on the covariance structure of the residuals of the 5 types of expenditures. We first compute the correlation between the estimated structural innovations of the models in section 5.1. We find that the correlations are between -0.10 and 0.12. The only exception is the correlation between employment and the average wage which is -0.36.

Given these low values, we assume that the different shocks are uncorrelated, so that the all the off-diagonal elements of A and B matrix corresponding to spending are 0. The only exception is that the average wage can respond contemporaneous to the employment residuals. The rationale for this is that, in general, the wages of the new hires are different from the average wage so there is a mechanical effect on the average wage of any shock to employment.

Because we are assuming that the residuals of the several expenditures are uncorrelated, we have too many restrictions, meaning that the model is overidentified. We test the validity of the identification strategy, with an overidentifying restriction test, which in both cases validates our supplementary restrictions.

Table 8: Effects of 1% of GDP fiscal shocks on GDP

Type	1 qrt	4 qrt	8 qrt	12 qrt	20 qrt	Peak	P.V. Multiplier	
<b>Deterministic Detrending</b>								
							(20qts)	
Wage	2.06	[2.00-2.12]	3.52*	2.44	1.47	1.69	3.53 (5)	1.08
Employment	1.94	[1.88-2.01]	11.51*	7.35*	1.18	-1.86	11.51 (4)	3.01
Consumption	0.05	[-0.01-0.11]	-0.38	0.62	0.70	0.96*	0.96 (20)	1.23
Investment	1.25	[1.18-1.31]	-1.33*	-1.78*	-1.61*	-0.35	1.25 (1)	-2.93
Transfers	0.05	[-0.01-0.11]	-0.14	-0.68	-0.87*	-0.31	0.14 (2)	-6.24
Taxes	-0.52	[-0.58;-0.46]	-0.17	-0.25*	-0.36*	-0.18	-0.55 (1)	-0.64
<b>Stochastic Detrending</b>								
Wage	2.27	[2.21-2.34]	5.40*	9.40*	12.45*	14.77*	14.78 (20)	2.55
Employment	0.53	[0.46-0.59]	4.94*	3.21	2.15	2.78	4.95 (4)	0.65
Consumption	0.12	[0.06-0.19]	-0.18	-0.03	0.17	0.72	0.72 (20)	0.14
Investment	1.91	[1.85-1.98]	0.61	-0.59	-0.77	-0.43	1.91 (1)	-0.09
Transfers	-0.03	[-0.09-0.03]	-0.02	-0.03	0.40	0.52	0.52 (20)	0.42
Taxes	-0.60	[-0.67;-0.54]	-0.76*	-0.77*	-0.64*	-0.51	-0.85 (7)	-0.80

*Notes: The VAR is estimated with 4 lags, linear and quadratic time trend, seasonal dummies and a 4-lag dummy for 1975:2. The sample starts in 1960:1 and runs until 2006:4. Error bands are at 10% and 90%. Under the stochastic detrending, we exclude the quadratic time trend. The overidentifying restriction test has a p-value of 0.168 for the DD and 0.068 for the SD, validating our identification strategy.*

<sup>11</sup>For a more detailed description of the identification strategy, see appendix D

When we have all the components of spending in the VAR, we cannot talk of an investment shock or a consumption shock. Any shock will imply an adjustment of the other components. Some of them can also increase, but others might be crowded out. So we can only talk of spending shocks, driven by investment or consumption.

The results, shown in Table 8, are very similar to the ones of Section 5.1. Wage and employment components have higher impact and cumulative multiplier. Employment has a stronger impact under the deterministic detrending, while the wage has higher multipliers when we estimate the VAR in differences. Consumption has a very small impact multiplier and, if any, its positive effect on output only seems to occur after 5 years. Investment has a very high impact multiplier on output, but after 1 year the effect is significantly negative. This happens, because an investment shock seems to crowd out other components, particularly government employment which starts falling immediately after the shock.

One should be careful when interpreting the effects of transfers and taxes as they rely strongly on the elasticity with respect to output that we assumed to be -0.2 and 1.8 respectively. Under this assumption, the impact multiplier of a tax cut is estimated between 0.5 and 0.6 and the cumulative multiplier between 0.6 and 0.8. On the other hand, the impact multiplier of transfers is roughly 0 and its dynamic effects are zero at best, negative at worst.

## 6.1 Event-study approach

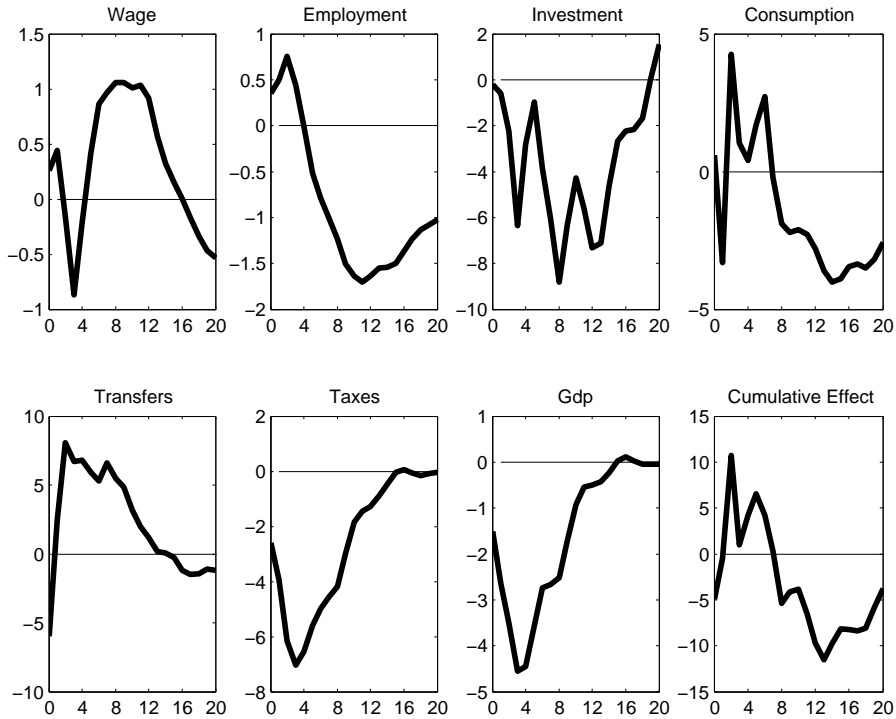
The third identification strategy found in the literature is the event-study approach introduced by Ramey and Shapiro (1998). They isolate three historical events that led to three large military buildups: Korean War (1955:3), the Vietnam war (1965:1) and the Carter-Reagan buildup (1980:1). More recently, Eichenbaum and Fisher (2005) argued that the expansion of defense spending in the aftermath of 9/11 should be added to these exogenous events (2001:3).

In our seven-variables VAR, we include a dummy variable at the onset of each of the episodes with the exception of the Korean war. The dummy is included contemporaneously and with 4 lags. Our objective is to analyse how these build-ups were done. We show the response to each of the episodes in separate in Figures 4-6.

We can see from the three figures that the responses to the three events are very distinct, both in terms of the composition of spending and in the response of GDP. For the Vietnam War, most of the increase in spending is driven by the 10 percent increase in government



Figure 4: Response to the Vietnam buildup



consumption that lasted for 4 years. Employment and investment increase slightly in the first year, but then they fall sharply thereafter. On the other hand, the average wage started increasing after 1 year. We find the cumulative multiplier to be negative (-1.68).

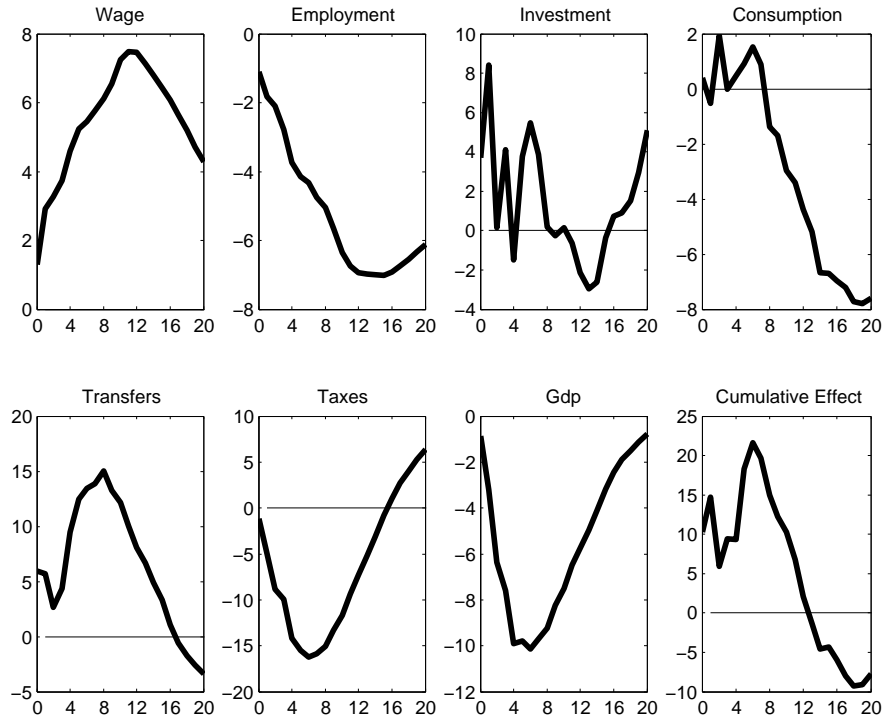
For the Reagan buildup, we see that, despite generating an increase in military spending, it did not increase total spending. In the first year there was a slight increase of government consumption, all the other types of spending decreased. The most striking aspect is the reduction of government employment, which peaked at -4 percent after 3 years. Also, the response of GDP was negative, so the cumulative multiplier is around 2.42.

The buildup to the war on terror also seemed very particular. It consisted of a long lasting increase of government consumption of around 4 percent and an increase in the wage, particularly in the first year. The cumulative multiplier was around 5.67.

## 7 Conclusion

The objective of this paper is to highlight a dimension that has been overlooked in this vast literature of the effects of government spending. We disaggregate government spending into

Figure 5: Response to the Carter-Reagan buildup

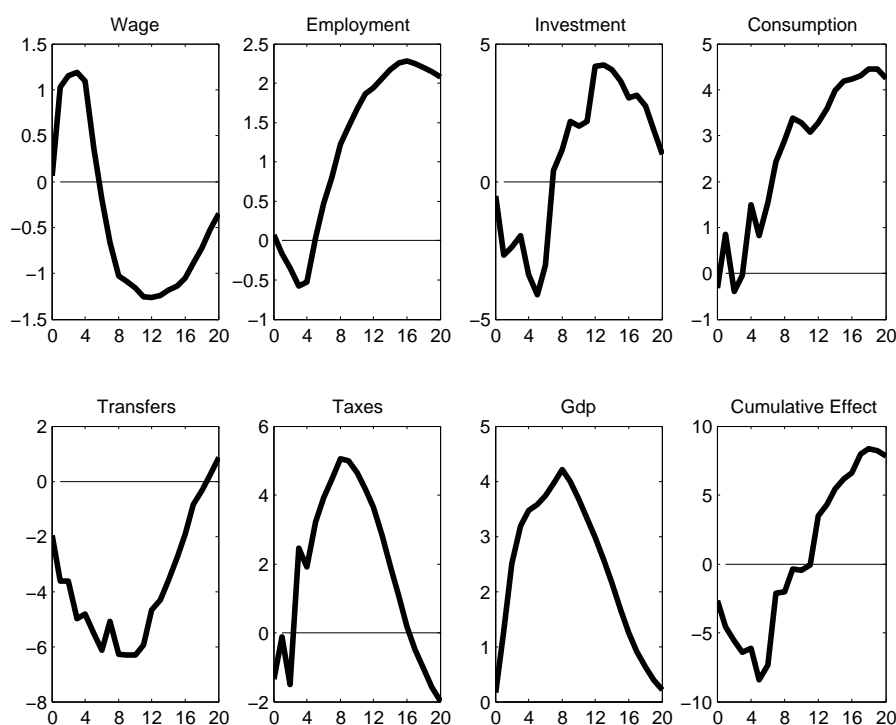


five macroeconomic relevant components: average wage, employment, purchases, investment and transfers. Each of these components has very different properties in terms of volatility, comovement with total spending and with output.

We then show, using both Blanchard and Perotti (2002) and Mountford and Uhlig (2009) frameworks, that the fiscal multipliers are very different across types of spending. We find that both the average wage and employment have bigger multipliers than purchases of intermediate goods, investment and transfers. We then use the event-study approach and show that each of the events consisted of changes in particular types of spending.

Our paper has implications for both policy and macroeconomic theory. For policy makers, given the need to start reducing deficits soon, these results suggests that they can reduce government spending and still have a stimulating effect in the economy if, for instance, they reduce government purchases or transfers and then partially offset with increasing hiring. For macroeconomic theory, we should look more attentively at the effects of different components of spending, namely of government employment and wages.

Figure 6: Response to the September 11 buildup



## References

- ALESINA, A., S. ARDAGNA, R. PEROTTI, AND F. SCHIANTARELLI (2002): “Fiscal Policy, Profits, and Investment,” *American Economic Review*, 92(3), 571–589.
- ALESINA, A., AND R. PEROTTI (1995): “Fiscal Expansions and Fiscal Adjustments in OECD Countries,” NBER Working Papers 5214, National Bureau of Economic Research, Inc.
- BAXTER, M., AND R. G. KING (1993): “Fiscal Policy in General Equilibrium,” *American Economic Review*, 83(3), 315–34.
- BLANCHARD, O., AND R. PEROTTI (2002): “An Empirical Characterization Of The Dynamic Effects Of Changes In Government Spending And Taxes On Output,” *The Quarterly Journal of Economics*, 117(4), 1329–1368.
- EDELBERG, W., M. EICHENBAUM, AND J. D. FISHER (1999): “Understanding the Effects of a Shock to Government Purchases,” *Review of Economic Dynamics*, 2(1), 166–206.

- FATÁS, A., AND I. MIHOV (2001): “The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence,” CEPR Discussion Papers 2760.
- FINN, M. G. (1998): “Cyclical Effects of Government’s Employment and Goods Purchases,” *International Economic Review*, 39(3), 635–57.
- GOMES, P. (2010): “Fiscal Policy and the Labour Market: The Effects of Public Sector Employment and Wages,” IZA Discussion Papers 5321, Institute for the Study of Labor (IZA).
- LANE, P. R. (2003): “The cyclical behaviour of fiscal policy: evidence from the OECD,” *Journal of Public Economics*, 87(12), 2661–2675.
- LANE, P. R., AND R. PEROTTI (1998): “The trade balance and fiscal policy in the OECD,” *European Economic Review*, 42(3-5), 887–895.
- LUETKEPOHL, H. (2005): *New Introduction to Multiple Time Series Analysis*. Berlin: Springer.
- MERZ, M. (1995): “Search in the labor market and the real business cycle,” *Journal of Monetary Economics*, 36(2), 269–300.
- MOUNTFORD, A., AND H. UHLIG (2009): “What are the effects of fiscal policy shocks?,” *Journal of Applied Econometrics*, 24(6), 960–992.
- PAPPA, E. (2009): “The Effects Of Fiscal Shocks On Employment And The Real Wage,” *International Economic Review*, 50(1), 217–244.
- PEROTTI, R. (1996): “Fiscal Consolidation in Europe: Composition Matters,” *American Economic Review*, 86(2), 105–10.
- (2008): “In Search of the Transmission Mechanism of Fiscal Policy,” in *NBER Macroeconomics Annual 2007, Volume 22*, NBER Chapters, pp. 169–226. National Bureau of Economic Research, Inc.
- RAMEY, V. A. (2009): “Identifying Government Spending Shocks: It’s All in the Timing,” (15464).
- RAMEY, V. A., AND M. D. SHAPIRO (1998): “Costly capital reallocation and the effects of government spending,” *Carnegie-Rochester Conference Series on Public Policy*, 48(1), 145–194.

ROTEMBERG, J. J., AND M. WOODFORD (1992): “Oligopolistic Pricing and the Effects of Aggregate Demand on Economic Activity,” *Journal of Political Economy*, 100(6), 1153–1207.

TENHOFEN, J., AND G. B. WOLFF (2007): “Does anticipation of government spending matter? Evidence from an expectation augmented VAR,” Discussion Paper Series 1: Economic Studies 2007,14, Deutsche Bundesbank, Research Centre.

# Appendix

## A Data - Definition and Description

The data on government expenditures comes from the National Income and Product Account tables of the Bureau of Economic Analysis, while the data on government employment comes from the Bureau of Labor Statistics.

1- **Compensation of General Government Employees** is a sub-element of Government Consumption expenditures (Table 3.10.5. Government Consumption Expenditures and General Government Gross Output, Quarterly, Billions of dollars, Seasonally adjusted at annual rates, Line 4).

2- **All Employees: Government** (USGOVT, U.S. Department of Labor: Bureau of Labor Statistics, Monthly (3 Month average for quarter), Seasonally Adjusted, Millions).

3- **Government Per Employee Wage** (Own calculation: Total Compensation to Employees (billions of dollars) divided by number of Employees (Millions)).

4- **Government purchases of intermediate goods and services** is a sub-element of Government Consumption expenditures (Table 3.10.5. Government Consumption Expenditures and General Government Gross Output, Quarterly, Billions of dollars, Seasonally adjusted at annual rates, Line 6).

5- **Gross Government Investment** (Table 3.1, Gross government investment, line 35, Billions of dollars, Seasonally adjusted at annual rates)

6- **Government transfers** (Table 3.1, Current transfer payments, line 17, Billions of dollars, Seasonally adjusted at annual rates)

7- **Government Interest payments** (Table 3.1, Interest payments, line 22, Billions of dollars, Seasonally adjusted at annual rates)

8- **Total Government Expenditure (Our)** The measure of government spending used throughout the paper is the sum of the expenditures (1, 5, 6 and 7).

9- **Total Government Expenditure (BEA)** (Table 3.1, Total expenditures, line 33, Billions of dollars, Seasonally adjusted at annual rates). It is composed by: Current expenditures, Gross government investment, Capital transfer payments, Net purchases of nonproduced assets minus Consumption of fixed capital. For the years before 1960, there is no data on Net purchases of non produced assets (corresponds to less than 0.2% of total government expenditures). It does not add to the sum of government consumption, gross investment, transfers and interest payments because they deduce the consumption of fixed capital.

10- **Government Consumption Expenditures** (Table 3.10.5. Government Consumption Expenditures and General Government Gross Output, Quarterly, Billions of dollars, Seasonally adjusted at annual rates, Line 1). Definition: Government consumption expenditures are services (such as education and national defense) produced by government that are valued at their cost of production. It includes *Compensation of General Government Employees*, *Consumption of General Government Fixed Capital* (or depreciation, is included in government gross output as a partial measure of the services of general government fixed assets), *Intermediate Goods and Services Purchased* minus *Own-account investment* and *Sales to other sectors*.

11- **Total Government Receipts** (Table 3.1, Total Receipts, line 30, Billions of dollars, Seasonally adjusted at annual rates).

12- **Government Net Savings**(Table 3.1, Net lending or net borrowing (-), line 39, Billions of dollars, Seasonally adjusted at annual rates).

13:21- **National Accounts** (Table 1.1.5., Billions of dollars, Seasonally adjusted at annual rates)

22:29- **National Accounts Price Deflators** (Table 1.1.9., Index numbers, 2005=100, Seasonally adjusted)

30- **Labour Force** (CLF16OV, Civilian Labor Force, Bureau of Labor Statistics, Seasonally Adjusted, Monthly (3 month average for quarter), Millions, Persons 16 years of age and older.)

31- **CPI** (CPIAUCSL, Consumer Price Index For All Urban Consumers: All Items, Bureau of Labor Statistics, Seasonally Adjusted Monthly (3 month average for quarter), Index 1982-84=100)

32- **FED** (FEDFUNDS, Effective Federal Funds Rate, Board of Governors of the Federal Reserve System, Monthly(3 month average for quarter), Percent)

33- **Nominal Private Wage** (HCOMPBS, Business Sector: Compensation Per Hour, Bureau of Labor Statistics, Seasonally Adjusted, Quarterly, Index 1992=100)

34- **Private total hours** (HOABS, Business Sector: Hours of All Persons, Bureau of Labor Statistics, Seasonally Adjusted, Quarterly, Index 1992=100)

35- **Real private wage** (RCPHBS, Business Sector: Real Compensation Per Hour, Bureau of Labor Statistics, Seasonally Adjusted, Quarterly, Index 1992=100)

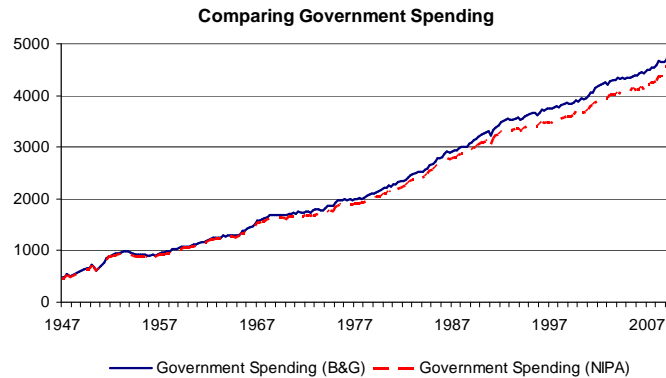
36- **Private productivity** (OPHPBS, Business Sector: Output Per Hour of All Persons, Bureau of Labor Statistics, Seasonally Adjusted, Quarterly, Index 1992=100)

37- **Unemployed** (UNEMPLOY, Unemployed, Bureau of Labor Statistics, Seasonally Adjusted, Monthly (3 month average for the quarter), Millions)

38- **Private sector employment** (USPRIV, All Employees: Total Private Industries, Bureau of Labor Statistics, Seasonally Adjusted, Monthly (3 month average for the quarter), Millions)

## B Looking at the data

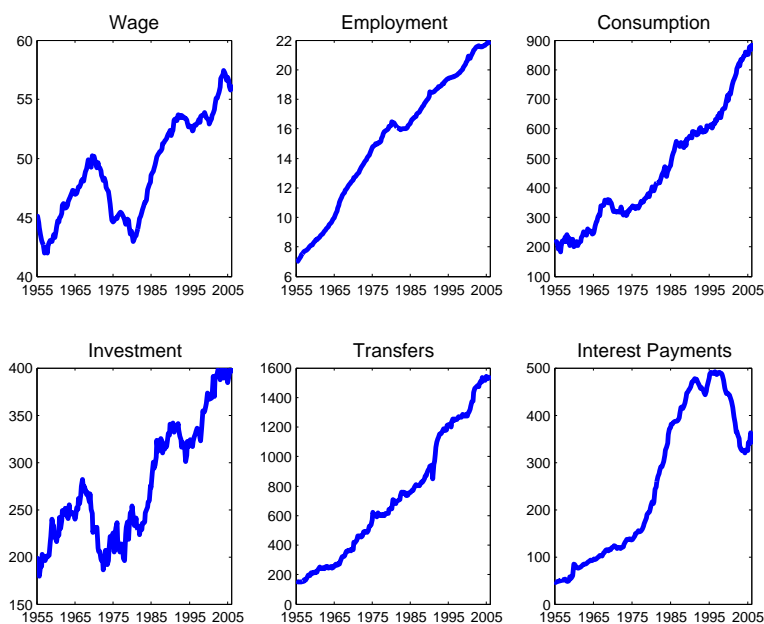
Figure 7: Evolution of different measures of government expenditure



*Note: The value in real 2005 dollar. Deflated using Implicit Price Deflator: Government consumption expenditures and gross investment*



Figure 8: Components of government expenditure



*Note: Government consumption, investment, transfers and interest payments are in billion dollars. Government employment is in million and the wage is in thousand dollars. All variables except employment are deflated using Implicit Price Deflator: Government consumption expenditures and gross investment.*

Figure 9: Deviations from an HP-filtered trend of components of government expenditure

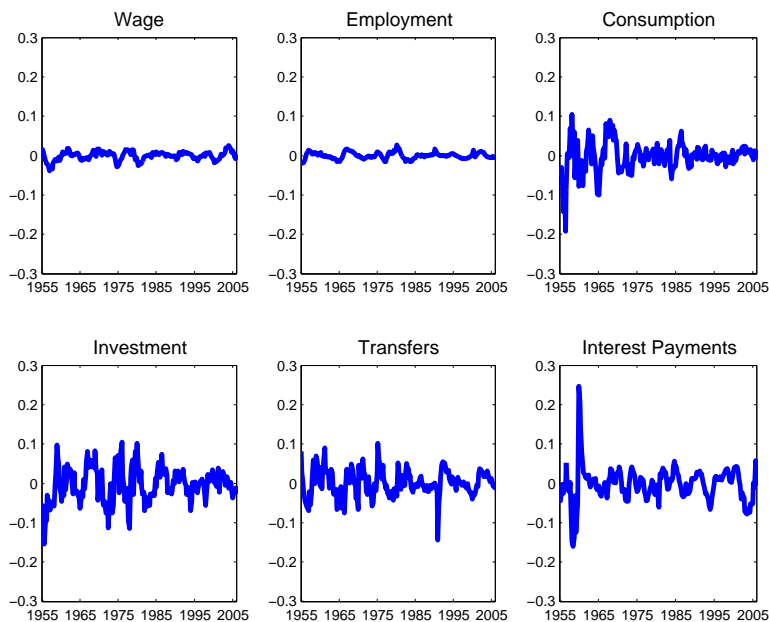


Figure 10: Standard deviations of components of government expenditure on a rolling window of 10 years

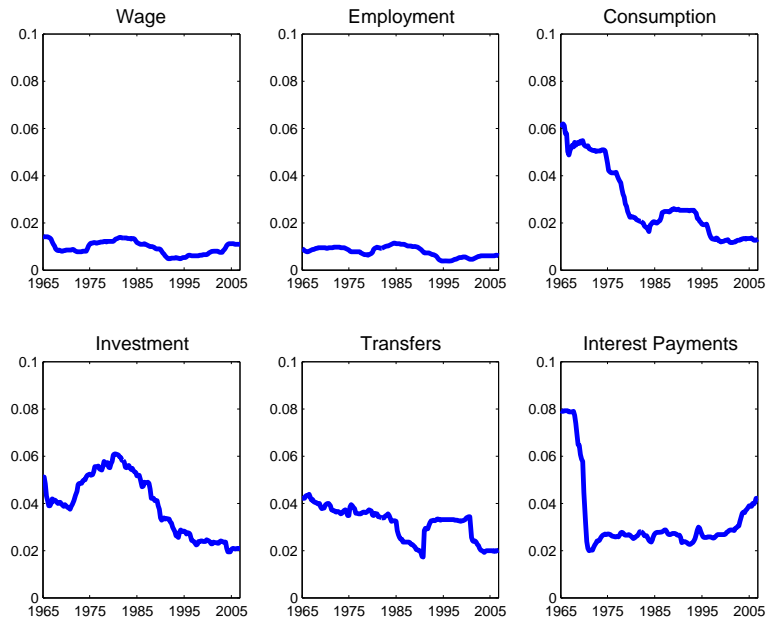


Figure 11: Correlation of Government spending with ... (rolling window of 10 years)

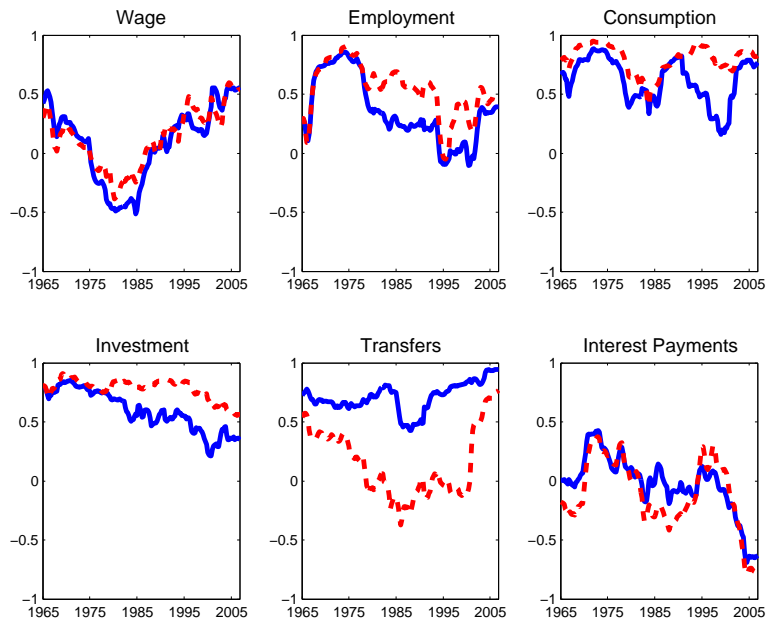


Figure 12: Correlation of Real GDP with ... (rolling window of 10 years)

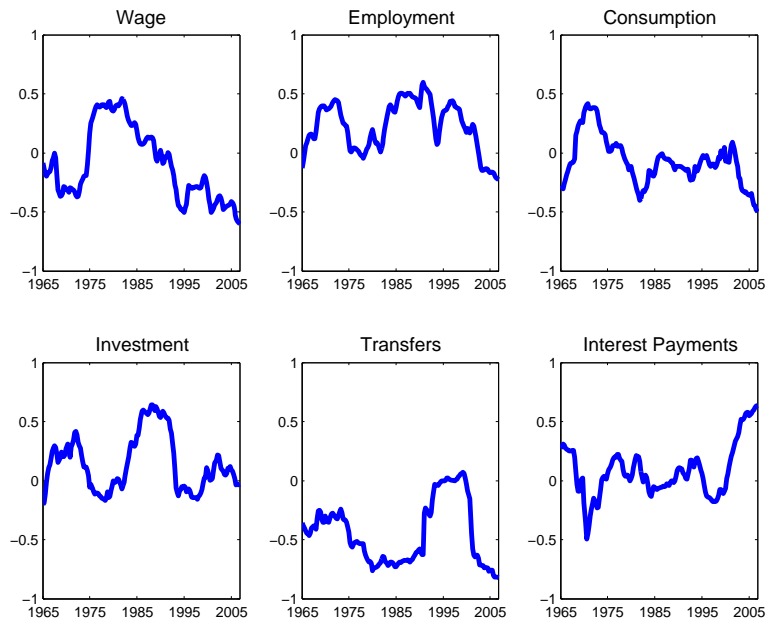


Table 9: Large changes in government spending components in the 1955:2006 sample

<b>Wage</b>				<b>Employment</b>				<b>Consumption</b>						
sd=0.006				sd=0.005				sd=0.034						
2 <	$\frac{\Delta g}{sd}$	< 3	$\frac{\Delta g}{sd}$	$\geq 3$	2 <	$\frac{\Delta g}{sd}$	< 3	$\frac{\Delta g}{sd}$	$\geq 3$	2 <	$\frac{\Delta g}{sd}$	< 3	$\frac{\Delta g}{sd}$	$\geq 3$
56q1	-0.014	69q3	0.020	56q2	0.013	66q2	0.017	55q3	-0.073	71q1	-0.102			
57q1	-0.016	74q3	-0.021	56q3	0.010			59q1	0.076	78q2	0.132			
58q1	0.015			64q4	0.011			61q1	0.078					
61q4	0.015			65q3	0.014			69q4	-0.087					
74q2	-0.016			65q4	0.013			75q2	-0.095					
79q3	-0.015			66q1	0.014			75q3	0.075					
80q2	-0.015			66q3	0.014			76q2	-0.083					
84q1	0.019			66q4	0.013			79q1	-0.085					
91q1	0.017			67q1	0.012									
				74q4	0.010									
				75q1	0.010									
				77q3	0.011									
				80q2	0.013									
				81q2	-0.010									
				90q2	0.013									
				00q2	0.012									
<b>Investment</b>				<b>Transfers</b>				<b>Gov. Spen. (2)</b>						
sd=0.033				sd=0.028				sd=0.011						
2 <	$\frac{\Delta g}{sd}$	< 3	$\frac{\Delta g}{sd}$	$\geq 3$	2 <	$\frac{\Delta g}{sd}$	< 3	$\frac{\Delta g}{sd}$	$\geq 3$	2 <	$\frac{\Delta g}{sd}$	< 3	$\frac{\Delta g}{sd}$	$\geq 3$
56q1	-0.070	56q3	-0.145	57q2	0.064	59q1	0.087	55q4	-0.027	58q2	0.039			
56q2	0.079	56q4	0.100	58q2	0.067	70q2	0.129	60q1	-0.032	65q3	0.034			
57q1	0.083	58q3	-0.109	66q4	0.083	80q3	0.091	63q3	0.023	67q1	0.046			
57q4	0.069	59q1	-0.122	67q1	0.061	91q1	-0.109	66q4	0.027					
58q1	-0.075	60q1	-0.123	71q2	0.066	91q2	0.106	75q1	0.028					
58q2	0.098	67q1	0.102	72q4	0.060			91q1	-0.034					
63q3	0.082			74q2	0.064			91q2	0.034					
65q3	0.072			75q1	0.060			01q4	0.025					
				75q2	0.081									

Notes:  $\Delta g$  are quarter-on-quarter changes of the log of real variables (employment not in real terms) normalized by the size of the population. "+" or "-" corresponds to the kind of the change in the corresponding component. Gov. Spen. (2) corresponds to equation (2).

## C Detailed Discussion of Baseline Identification Strategy

To transform the reduced-form model into a structural model, we employ the so called AB model, which is described in detail for example in Luetkepohl (2005), p. 364. The subsequent paragraphs shall give a thorough explanation for the reasoning the restrictions in the baseline identification are based upon.

The functional relationship between the reduced-form and the structural disturbances is expressed by  $A\boldsymbol{\mu}_t = B\boldsymbol{\epsilon}_t$ , where  $\boldsymbol{\mu}_t$  is the vector of reduced-form disturbances associated with the five main types expenditures, taxes and output.  $\boldsymbol{\epsilon}_t$  is the corresponding vector of structural disturbances. This can be expressed in matrix form

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} & a_{17} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} & a_{27} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} & a_{37} \\ a_{41} & a_{42} & a_{43} & a_{44} & a_{45} & a_{46} & a_{47} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} & a_{57} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & a_{67} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} \end{bmatrix} \begin{bmatrix} \mu_t^w \\ \mu_t^l \\ \mu_t^c \\ \mu_t^i \\ \mu_t^{tr} \\ \mu_t^t \\ \mu_t^x \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} & b_{17} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} & b_{27} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} & b_{36} & b_{37} \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} & b_{46} & b_{47} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & b_{56} & b_{57} \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} & b_{67} \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & b_{77} \end{bmatrix} \begin{bmatrix} \epsilon_t^w \\ \epsilon_t^l \\ \epsilon_t^c \\ \epsilon_t^i \\ \epsilon_t^{tr} \\ \epsilon_t^t \\ \epsilon_t^x \end{bmatrix}$$

### Restrictions

- $\underline{a_{11} = a_{22} = \dots = a_{77} = b_{11} = b_{22} = \dots = b_{77} = 1}$ : Normalization.
- $\underline{a_{17} = a_{27} = a_{37} = a_{47} = 0}$ : Blanchard and Perotti (2002) refer to the distinction between the discretionary and the automatic effect of economic activity on fiscal variables. They argue that the former effect can be ruled out due to the institutional delays in the decision process. The total effect can therefore be attributed to an automatic effect of economic activity on the fiscal variable. B&P do not find any automatic feedback from economic activity to government purchases of goods and services. We extend this finding to wages, employment and investment and assume the feedback of economic activity to these variables to be zero.
- $\underline{a_{57} = 0.2}$ : B&P quantify the elasticity of transfers with respect to GDP as -0.2 (see B&P, appendix A.2)

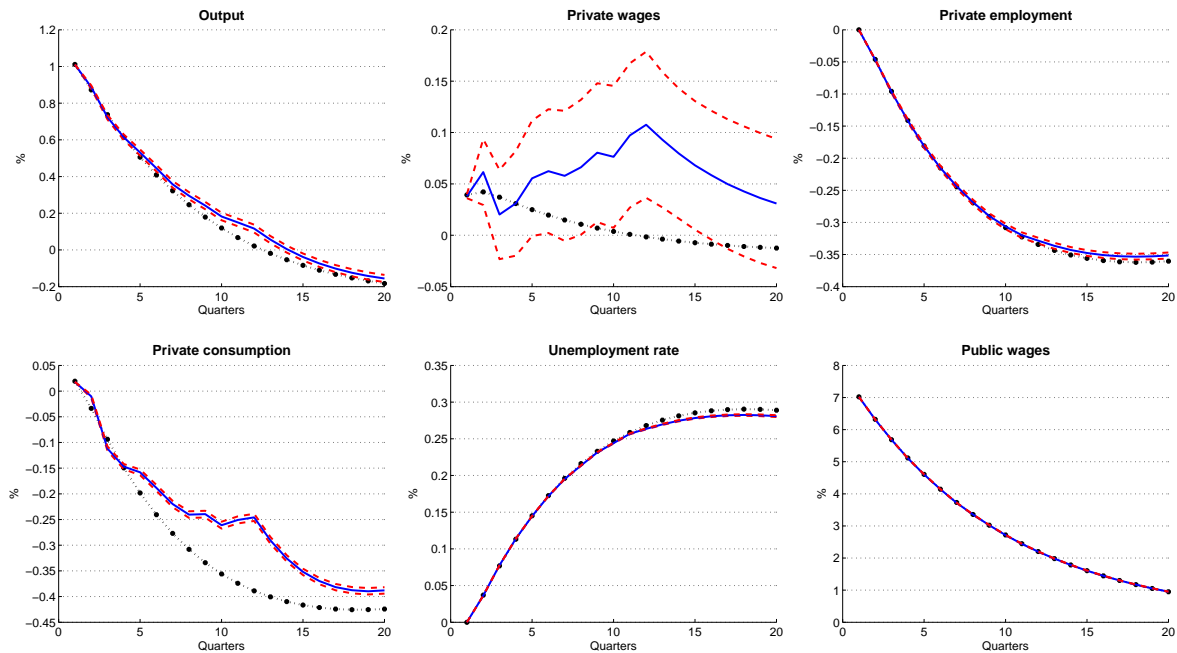
- $a_{67} = -1.8$ : B&P estimate the feedback of economic activity on net taxes (taxes net of transfers) over the 1947:1 to 1997:4 period to be 2.08. However, our measure of taxes does not net out transfers. Knowing the transfer elasticity of output and the shares of taxes and transfers in net taxes, we can solve the following equation:

$$2.08 = \underbrace{\omega^{\text{Tax}}}_{=\frac{\text{Tax}}{\text{Tax}-\text{Transfers}}} \underbrace{X}_{=-a_{67}} - \omega^{\text{Transfers}}(-0.2)$$

- $a_{16} = a_{26} = a_{36} = a_{46} = a_{56} = a_{61} = a_{62} = a_{63} = a_{64} = a_{65} = 0$ : All cross correlation between spending and taxes occurs at the innovations levels.
- $b_{16} = b_{26} = b_{36} = b_{46} = b_{56} = 0$ : Spending decisions are taken first so taxes can respond to innovations in spending.
- $a_{13} = a_{14} = a_{15} = a_{23} = a_{24} = a_{25} = a_{34} = a_{35} = a_{45} = a_{21}$   
 $= a_{31} = a_{32} = a_{41} = a_{42} = a_{43} = a_{51} = a_{52} = a_{53} = a_{54}$   
 $= b_{12} = b_{13} = a_{14} = b_{15} = b_{23} = b_{24} = b_{25} = b_{34} = b_{35} = b_{45} = b_{21}$   
 $= b_{31} = b_{32} = b_{41} = b_{42} = b_{43} = b_{51} = b_{52} = b_{53} = b_{54} = 0$ : All contemporaneous cross-correlations between the several types of spending are zero (with the exception of wages and employment), which imply several overidentifying restrictions.

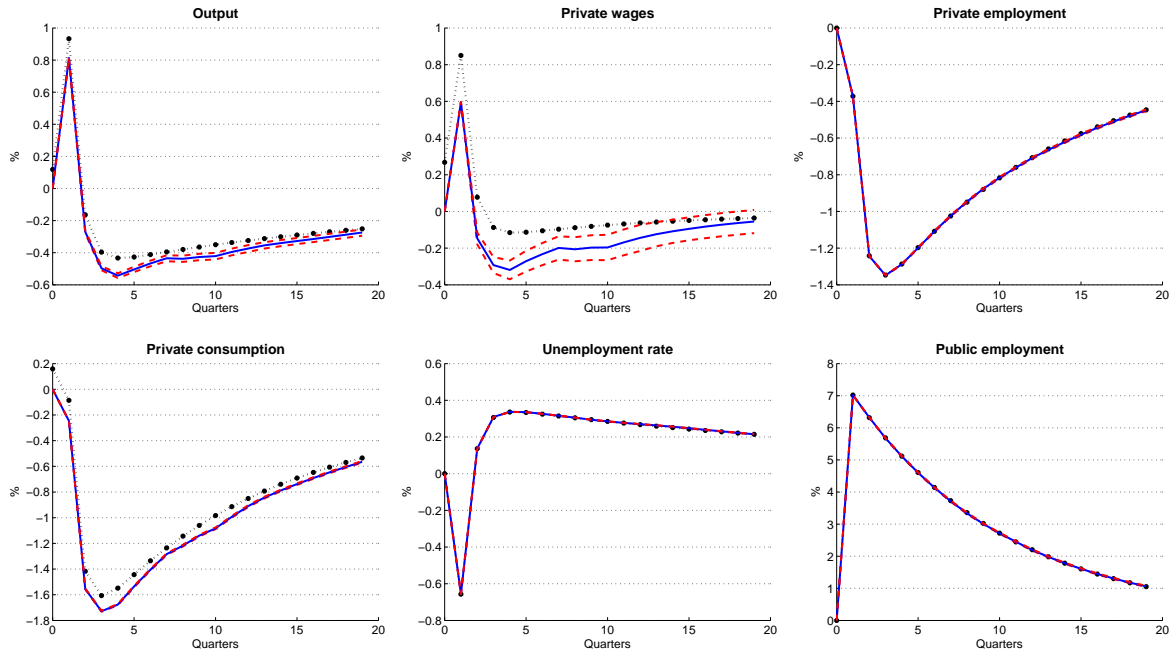
## D Estimation of government components shocks with simulated data

Figure 13: Theoretical and estimated impulse responses to a government wage shock



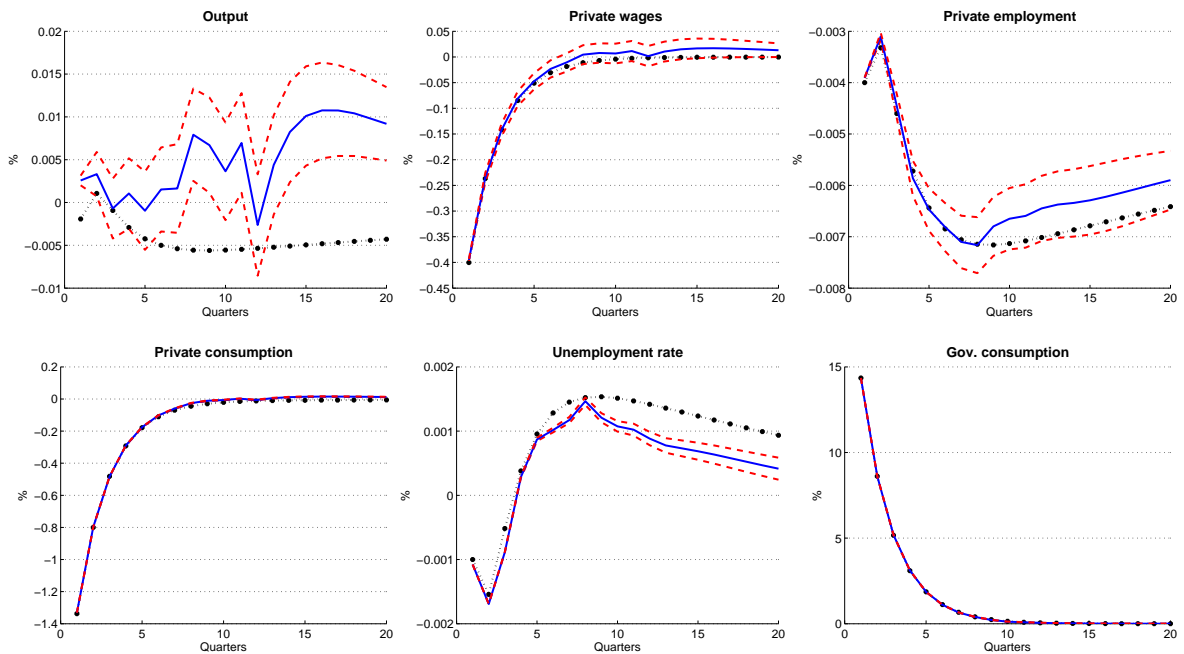
Notes: Response to a 1 percent of GDP wage shock: VAR response (solid line), VAR error bands (dash line) and theoretical impulse response (dotted line).

Figure 14: Theoretical and estimated impulse responses to a government employment shock



Notes: Response to a 1 percent of GDP employment shock: VAR response (solid line), VAR error bands (dash line) and theoretical impulse response (dotted line).

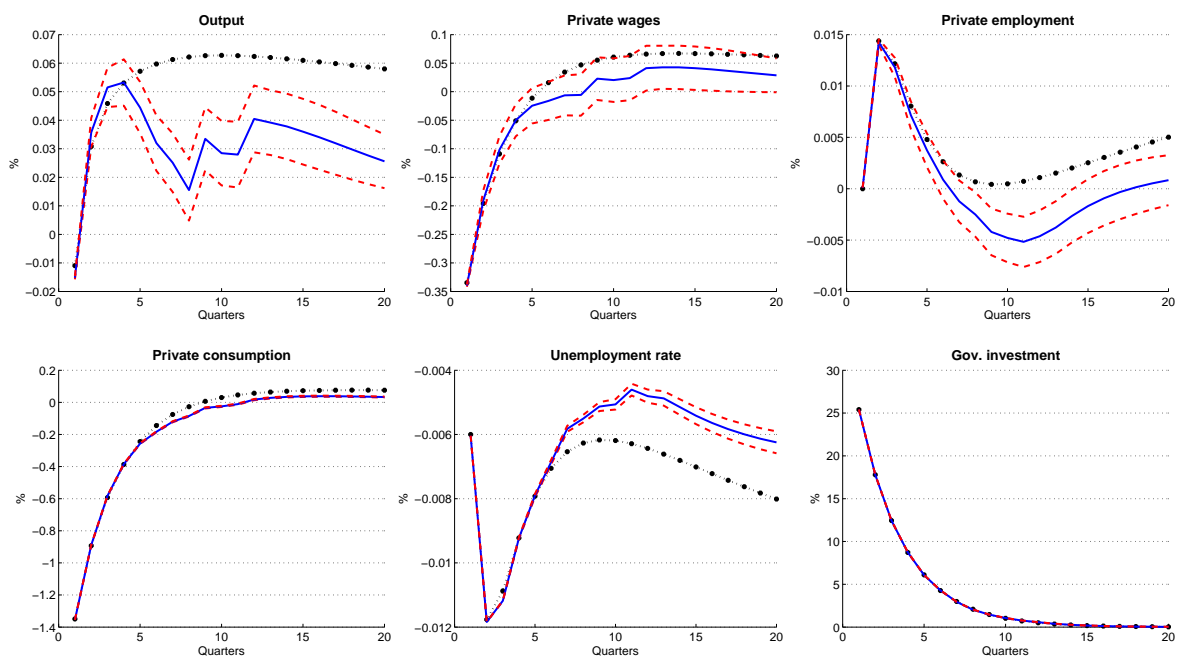
Figure 15: Theoretical and estimated impulse responses to a government consumption shock



Notes: Response to a 1 percent of GDP consumption shock: VAR response (solid line), VAR error bands (dash line) and theoretical impulse response (dotted line).



Figure 16: Theoretical and estimated impulse responses to a government investment shock



Notes: Response to a 1 percent of GDP investment shock: VAR response (solid line), VAR error bands (dash line) and theoretical impulse response (dotted line).