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New Keynesian or RBC Transmission? The Effects of Fiscal Policy in Labor Markets

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New-Keynesian or RBC transmission?
The effects of fiscal shocks in labor markets.

Abstract

We study the mechanics of transmission of fiscal shocks to labor markets. We characterize a set of robust implications following government consumption, investment and employment shocks in a RBC and a New-Keynesian model and use part of them to identify shocks in the data. In line with the New-Keynesian story, shocks to government consumption and investment increase real wages and employment contemporaneously both in US aggregate and in US state data. The dynamics in response to employment shocks are mixed, but in many cases are inconsistent with the predictions of the RBC model.

JEL classification: C11, E12, E32, E62.

Key Words: sticky and flexible prices, labor markets, sign-restrictions, VARs.

1 Introduction

Our understanding of the sources of cyclical fluctuations has improved over the last 15 years thanks to the work of Shapiro and Watson (1988), Blanchard and Quah (1989), Gali (1999), Canova and DeNicolo (2002) among others. Still, the mechanics of transmission of structural disturbances are as elusive as ever. In particular, little is known about how the economy reacts to fiscal shocks. Two reasons can explain this state of affairs. First, the theoretical predictions emphasized in the literature are often fragile. Second, the empirical evidence is, at best, contradictory.

Theoretically, neoclassical Real Business Cycles (RBC) models predict that increases in government expenditure crowd out the private sector. The induced wealth effect makes labor supply and output increase and consumption fall, while the dynamics of investments are typically determined by the persistence of the shock. However, as it is clear from the work of Baxter and King (1993) and Ludvigson (1996) among others, even the qualitative features of the dynamics crucially depend on the way the increases are financed (bond or distorting taxes) and on the exact details of the model. Keynesian models of both traditional partial equilibrium and new general equilibrium types, on the other hand, typically predict that an increase in government expenditure will increase labor demand, consumption and output. However, also in this case, the qualitative features of the dynamics depend on the underlying details of the model. For example, Basu and Kimball (2003) show that, absent investment adjustment costs, an increase in government expenditure may reduce output. Gali et al. (2004), on the other hand, show that consumption may fall in response to an expenditure increase unless rule-of-thumb consumers are present.

Empirically, there exists little consensus on the size of the output multipliers, or on the magnitude of the crowding-out (crowding-in) of government expenditure shocks, and, in general, on the sign of private sector responses. In fact, fiscal shocks obtained with different identifying restrictions yield sharply different outcomes. For example, Rotemberg and Woodford (1992), Ramsey and Shapiro (1999), Edelberg et al. (1999) and Cavallo (2003) focusing on specific case studies involving increases in government spending for national defense found that they reduce private consumption and increase nonresidential investments. Blanchard and Perotti (2002), Perotti (2004) and others, on the other hand, identify fiscal shocks imposing the restriction that government spending does not contemporaneously affect output in a VAR and find that private consumption positively comoves with the spending shock, while investments usually fall with a lag after the shock. Finally, studies where shifts in fiscal variables are identified via the comovements of output and deficits, such as Mountford and Uhlig (2002), typically find negligible effects on consumption and measurable crowding out of investments.

Historical evidence does not help to sort out the various alternatives. The early 1960s seemed to provide support for Keynesian theories. In particular, Kennedy's 1964 income tax cuts did much to boost the economy by increasing investment, employment and consumption. However, Carter's job spending programs of the late 1970's, could not remedy the negative effects produced by oil shocks.

This paper sheds some light on the dynamic of transmission of government expenditure shocks by concentrating on the reaction of labor markets. This shift of focus allows us to derive a set of robust theoretical predictions in response to government consumption (unproductive) and government investment (productive) disturbances in both RBC and New-Keynesian models. We show that the latter paradigm predicts that a shock to government consumption and investment contemporaneously increases output, deficit, employment and real wages for a wide range of parameterizations. On the other hand, the RBC paradigm predicts a contemporaneous increase in output, deficit and employment following an expansionary government consumption and investment shocks but a reduction in real wages for a wide range of parameterizations. Given that the two theories imply qualitatively different conditional comovements of labor market variables, the qualitative features of the dynamic responses of real wages and employment to shocks can be used to evaluate which of the two transmission mechanisms explains the data better. Our analysis also considers the effects of a shock to government employment. However, since the predictions of the New-Keynesian theory for labor market variables are tenuous, we use the dynamics of the labor market in response to these shocks to only verify the mechanics of transmission implied by the RBC model.

Apart from Rotemberg and Woodford (1992) and Burnside et. el. (2003), we are not aware of any study directly or indirectly examining the dynamics of labor markets in response to government expenditure shocks. Our exercise differs from the one conducted in these two papers in several respects: first, they concentrate only on aggregate data while we study both aggregate and state data; second, they focus on the dynamics following military expenditure shocks, while we examine other types of expenditure disturbances; third, they do not use robust model restrictions for identification purposes; finally their estimation and evaluation techniques different from ours. Our analysis produces, as a by-product, information that we believe is useful to policymakers. In particular, it shows which component of government spending is more effective as a countercyclical policy tool and highlights the contribution of government expenditure disturbances to the dynamics of labor productivity.

To identify expenditure shocks in the data, we employ the common restrictions implied by the two models for the dynamics of output and deficit in response to disturbances. Once shocks are identified, we qualitatively compare the dynamics of labor markets in the theory and the data. We keep the comparison informal because the quantitative implications of the two models depend on the parametrization. However, formal measures of fit can be designed and easily implemented (see Canova (2002) or Dedola and Neri (2004)).

Our empirical analysis uses both US aggregate and state data. Besides having a larger set of experiments over which to generalize our conclusions, the use of US state data has two additional advantages. First, monetary policy can be taken as given in the analysis. This assumption is problematic when aggregate data is used. In fact, the interaction between monetary and fiscal policies constitutes one of the major stumbling blocks when identifying shocks to the two policy reaction functions. Second, since good and comparable international data on fiscal variables is difficult to find, our analysis can characterize cross-sectionally the dynamics of transmission of fiscal shocks and give some indications of what one should expect to find in other monetary unions.

Our data supports the transmission mechanism embedded in the Keynesian paradigm. In fact, increases in government consumption and/or investment contemporaneously increase real wages and employment, both in the aggregate and in a "typical" US state. Furthermore, in about 90 percent of the states, shocks of this type increase both real wages and employment and in two-thirds of the cases significantly so. The data is less clear regarding the dynamics following government employment shocks. In aggregate data the prediction of the RBC model are supported. However, in about half of the US states labor market responses have the wrong sign.

The rest of the paper is organized as follows. The next section presents a general model which embeds the New-Keynesian (sticky price) and the RBC (flexible price) paradigms as special cases and describes the testing methodology. Section 3 characterizes the dynamics following fiscal shocks in the two theories and highlights a set of robust predictions of the two models. Section 4 presents the econometric framework used to test the transmission mechanism of the two theories. Results appear in section 5 and section 6 concludes. The appendix contains a description of the data used.

2 The Model

This section presents a general equilibrium dynamic model that encompasses a flexible price RBC and a New-Keynesian sticky price setup as special cases. As in Finn (1998), and contrary e.g., to Baxter and King (1993), Ludvingson (1996), Burnside et al. (2003), we distinguish between government expenditure for consumption and investment, and also consider government employment. There are four agents in the economy: a representative household, a continuum of firms, a monetary and a fiscal authority.

2.1 Households

Households derive utility from private consumption, C_t^p, public consumption, C_t^g and leisure, $1-N_t$. At time 0 households choose sequences for private consumption, labor supply, capital to be used next period K_{t+1}^p, nominal state-contigent bonds, D_{t+1} and government bonds, B_{t+1} to maximize the expected discounted utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(C_t^p, C_t^g, N_t) = \beta^t \frac{\left[\left\{\omega C_t^{p\frac{\eta-1}{\eta}} + (1-\omega) C_t^{g\frac{\eta-1}{\eta}}\right\}^{\frac{\phi\eta}{\eta-1}} (1-N_t)^{1-\phi}\right]^{1-\sigma} - 1}{1-\sigma} \tag{1}$$

where $0 < \phi, \beta, \omega < 1$, and $\sigma > 0$. Here β is the subjective discount factor and σ a risk aversion parameter. Public consumption is exogenous from the point of view of households. The degree of substitutability between private and public consumption is regulated by η. The share parameter ω determines how much public consumption affects utility: when $\omega = 1$, public consumption is useless from the agents' point of view, whereas when $\omega = \frac{1}{2}$ agents consume public and private goods in the same proportion. Available time each period is normalized at unity. We assume that $C_t^p = \left[\int_0^1 C_{it}^p(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}$, and $C_t^g = \left[\int_0^1 C_{it}^g(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}$ and let ε be the elasticity of substitution between different varieties of goods. The household maximizes utility subject to the sequence of budget constraints:

$$\begin{aligned} P_t(C_t^p + I_t^p) + E_t\{Q_{t,t+1} D_{t+1}\} + R_t^{-1} B_{t+1} \quad &\leq \\ (1-\tau^l) P_t w_t N_t + [r_t - \tau^k (r_t - \delta^p)] P_t K_t^p + D_t + B_t - T_t P_t + \Xi_t & \end{aligned} \tag{2}$$

where $(1-\tau^l)P_t w_t N_t$, is the after tax nominal labor income, $[r_t - \tau^k(r_t - \delta^p)]P_t K_t^p$ is the after tax nominal capital income (allowing for depreciation), Ξ_t, are nominal profits from the firms (which are owned by consumers), and $T_t P_t$ are lump-sum taxes. We assume complete private financial markets: D_{t+1} is the holdings of the state-contingent nominal bond that pays one unit of currency in period $t+1$ if a specified state is realized and $Q_{t,t+1}$ is the period-t price of such bonds, and R_t the gross return of a government bond B_t. With the disposable income the household purchases consumption goods, $P_tC_t^p$, capital goods, $P_tI_t^p$, and assets. Private capital accumulates according to:

$$K_{t+1}^p = I_t^p + (1-\delta^p)K_t^p - \nu\left(\frac{K_{t+1}^p}{K_t^p}\right)K_t^p \tag{3}$$

where δ^p is a constant depreciation rate and the function $\nu(.)$ is parametrized as

$$\nu\left(\frac{K_{t+1}^p}{K_t^p}\right) = \frac{b}{2}\left[\frac{K_{t+1}^p - (1-\delta^p)K_t^p}{K_t^p} - \delta^p\right]^2 \tag{4}$$

where b determines the size of the adjustment costs. Since households own and supply capital to the firms, they bear the adjustment costs.

2.2 Firms

A firm j produces output according to:

$$Y_t(j) = (Z_tN_t^p(j))^{1-\alpha}K_t^p(j)^\alpha(K_t^g)^\mu(N_t^g)^\nu \tag{5}$$

where $K_t^p(j)$ and $N_t^p(j)$ are private capital and labor inputs hired by firm j, Z_t is an aggregate technology shock and K_t^g and N_t^g are the government's capital and labor inputs, respectively. The production function in (5) displays constant returns to scale with respect to private inputs. It differs from the standard production function for the inclusion of K^g and N^g. We assume that the government labor and capital inputs are taken as given by the firm. The parameters μ and ν regulate how public inputs affect private production: when $\mu(\nu)$ is zero, government capital (employment) is unproductive.

We assume that firms are perfectly competitive in the input markets [1]: they minimize costs by choosing private inputs, taking wages, the rental rate of capital, government employment and capital as given. Since firms are identical, they all choose the same amount of private inputs and cost minimization implies

$$\frac{K_t^p}{N_t^p} = \frac{\alpha}{(1-\alpha)}\frac{w_t}{r_t} \tag{6}$$

Equation (6) and the production function imply that the common (nominal) marginal costs is given by:

$$MC_t = \frac{1}{\Upsilon}Z_t^{\alpha-1}K_t^{g(-\theta)}N_t^{g(-\nu)}w_t^{1-\alpha}r_t^\alpha P_t \tag{7}$$

where $\Upsilon = \alpha^\alpha(1-\alpha)^{1-\alpha}$.

[1] The sign of the responses we present below are independent of the presence of sticky wages, or labor unions, and, hence, this assumption is not essential for our analysis.

In the goods market firms are monopolistic competitors. The strategy firms use to set prices depends on whether prices are sticky or flexible. In the latter case we use the standard Calvo (1983) setting. That is, at each point in time each domestic producer is allowed to reset her price with a constant probability, $(1-\gamma)$, independently of the time elapsed since the last adjustment. When a producer receives a signal to change her price, she chooses her new price, P_t^*, to maximize:

$$\max_{P_t^*(j)} E_t \sum_{k=0}^{\infty} \gamma^k Q_{t+k+1,t+k}(P_t^* - MC_{t+k})Y_{t+k}(j) \tag{8}$$

subject to the demand curve $Y_{t+k}(j) = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\varepsilon} Y_{t+k}$. Optimization implies

$$\sum_{k=0}^{\infty} \gamma^k E_t\{Q_{t+k+1,t+k}Y_{t+k}(j)(P_t^* - \frac{\varepsilon}{\varepsilon-1}\frac{1}{1-\tau^\varepsilon}MC_{t+k})\} = 0 \tag{9}$$

where $\tau^\varepsilon = -(\varepsilon-1)^{-1}$ is a subsidy that, in equilibrium, eliminates the monopolistic competitive distortion[2]. Given the Calvo pricing assumption, the evolution of the aggregate price index is:

$$P_t = [\gamma P_{t-1}^{1-\varepsilon} + (1-\gamma)P_t^{*1-\varepsilon}]^{\frac{1}{1-\varepsilon}} \tag{10}$$

For the flexible-RBC version of the model, the fraction of firms that can reset the price at each t is equal to one. Hence, prices are determined by:

$$P_t = \frac{\varepsilon}{\varepsilon-1}\frac{1}{1-\tau^\varepsilon}MC_t, \qquad \forall t \tag{11}$$

2.3 Fiscal and Monetary Policy

Government's income consists of tax revenues minus the subsidies to the firms and the proceeds from new debt issue; expenditures consist of consumption and investment purchases, salaries and wages, and repayment of debt. The government budget constraint is:

$$P_t(C_t^g + I_t^g + w_t N_t^g) - \tau^\varepsilon P_t Y_t - \tau^l w_t P_t N_t - \tau^k(r_t - \delta^p)P_t K_t^p - P_t T_t + B_t = R_t^{-1}B_{t+1} \tag{12}$$

where I_t^g is government's investments. The government capital stock evolves according to:

$$K_{t+1}^g = I_t^g + (1-\delta^g)K_t^g - \nu\left(\frac{K_{t+1}^g}{K_t^g}\right)K_t^g \tag{13}$$

where δ^g is a constant depreciation rate and $\nu(.)$ is specified as in (4) and controls adjustment costs to public capital. We treat tax rates on labor and capital income parametrically and

[2]This assumption is not necessary for comparing the two models. As shown by Hornstein (1993), the qualitative implications of a monopolistic competitive RBC model are identical to those of a competitive one.

abstract from distortionary taxation, since distortionary taxes are relatively flat both in US states and in the aggregate for the sample we consider. We also assume that the government takes market prices, private hours and private capital as given, and that B_t endogenously adjusts to ensure that the budget constraint is satisfied. In order to ensure determinacy of equilibria and a non-explosive solution for debt (see e.g., Leeper (1991)), we assume that a debt targeting rule of the form:

$$T_t = \overline{T} \exp(\zeta_b(b_t - \overline{b})) \tag{14}$$

where $b_t = \frac{B_t}{GDP_t}$.

Since our empirical analysis examines data, where implicitly or explicitly, fiscal rules require balance budgets period-by period a few words justifying our modelling choice are in order. First, balance budget rules apply only to the general budget and exclude a number of important items. Second, although some states are required to hold zero guaranteed debt (either in the short, or in the long run, or in both), the practice of issuing non-guaranteed debt is generalized. These two observations imply that creative budget accounting practices are widespread. Third, the debt rule in (14) implies that deficit in equilibrium is small in size and has low volatility for both models. Fourth, and perhaps more importantly, none of the robust predictions we derive below depends on the exact fiscal rule we assume [3].

Finally, there is an independent monetary authority which sets the nominal interest rate as a function of current inflation according to the rule:

$$R_t = \overline{R} \exp(\zeta_\pi \pi_t + \epsilon_t^R) \tag{15}$$

where ϵ_t^R is a monetary policy shock.

2.4 Closing the model

There are two types of aggregate constraints. First, labor supply must equate labor employed by the private firms, N_t^p, and in the public sector, N_t^g :

$$N_t = N_t^p + N_t^g \tag{16}$$

Second, aggregate production must equal the demand for goods from the private and public sector:

$$Y_t = C_t^p + I_t^p + C_t^g + I_t^g \tag{17}$$

[3] For example, following Schmitt-Grohe and Uribe (2003)) an earlier version of the paper had abstracted from debt. The sign restrictions we emphasize below are robust to this change.

The model features five exogenous processes $S_t = [Z_t, C_t^g, I_t^g, N_t^g, \epsilon_t^R]'$, which are parametrized as:

$$\log(S_t) = (I - \boldsymbol{\varrho}) \log(\overline{S}) + \boldsymbol{\varrho} \log(S_{t-1}) + V_t \tag{18}$$

where V is a (5x1) vector of innovations, I is a (5x5) identity matrix, $\boldsymbol{\varrho}$ is a (5x5) diagonal matrix and $\overline{S}$ is the mean of S. The innovation vector V is generated from a stationary, zero-mean, white noise process and all the roots of $\boldsymbol{\varrho}$ are assumed to be less than one in modulus.

While the focus of the paper is on the effects of the government shocks on labor market variables, we have also included technology and monetary shocks in the model to avoid confusions in the identification of fiscal shocks since, e.g., Z_t enters the production function in the same way as K_t^g and N_t^g. That is to say, we want to derive restrictions which are unique to fiscal shocks and allow us to pin down the dynamics following these shocks in the data.

We solve both models by approximating the equilibrium conditions around a non-stochastic steady state in which all prices are flexible[4].

2.5 The testing methodology

To test whether the flexible price RBC version, or the sticky price New-Keynesian version of the model produce dynamics in response to fiscal shocks which match those present in the data, we use the methodology of Canova (2002). The exercise consists of three steps:

1) We search for robust implications characterizing the dynamics following fiscal shocks in each of the two theoretical models.

2) We use a subset of the (common) restrictions found in 1) to empirically identify fiscal disturbances in the data.

3. We compare conditional labor market responses in the theory and in the data. Comparisons can be done both informally (checking the sign and/or the shape of the responses) and formally (setting up measures of distance between impulse responses in the model and in the data).

We call a dynamic implication robust if its sign does not depend on the parameter values employed. For example, if the dynamic response of, say, output to consumption expenditure shocks has the same sign for a wide range of parameterizations, we call this implication

[4] Details of the approximation are in a technical appendix available on request.

robust. Formally speaking, let $h(y(\theta|x)))$ be a $M \times 1$ vector of functions produced by the model when the $N \times 1$ vector of structural parameters θ is employed, conditional on shock x. Let $H(\theta) = \frac{\partial(h(y(\theta|x)))}{\partial\theta}$ where $\theta \in \Theta$ and Θ is a set of admissible parameter values. Then, an implication is robust if $sgnH(\theta)$ is unchanged for almost all $\theta \in \Theta$.

In practice, we check the sign restriction on $H(\theta)$ numerically. That is, we let $\Theta = \prod_i \Theta_i$ and let each Θ_i be an interval. Then, we draw $\theta_i^l, i = 1, \ldots, N$ from each Θ_i, construct $h(y(\theta^l|x))$ for each draw $l = 1, \ldots, L$ and order them increasingly. Then $h_j(y(\theta|x))$, $j = 1, \ldots M$ is robust if $sgn[(h_j^U(y(\theta|x))] = sgn[h_j^L(y(\theta|x))]$ and where h^U and h^L are the 97.5 and 2.5 percentiles of the simulated distribution of $h(y(\theta|x))$.

Note that this procedure has a simple Bayesian interpretation. In fact, if Θ_i is treated as a prior which reflects either subjective theoretical considerations, or objective measures of uncertainty, then our approach tries to map out the predictive density of the model and, conditional on the shock, to understand how flat this density is in the dimensions of interest. Clearly, one can make this prior more or less informative. Here we simply restrict the range of Θ_i on the basis of theoretical and practical considerations. Hence, our approach is intermediate between calibrating the parameters (to a point) and assuming informative subjective priors and formalizes, via Monte Carlo methods, standard sensitivity analysis conducted in many calibration exercises.

We decompose $\theta = (\theta_1, \theta_2)$ where θ_1 represents the parameters which are fixed to a particular value, either to avoid indeterminacies, or because they are restricted by steady state considerations, while θ_2 are the parameters which are allowed to vary. Table 1 gives the parameters in θ_1 and the ranges for the parameters in θ_2. In the first set of parameters we have the discount factor, which is set so that the annual real interest rate equals 4%, and the debt ratio, $\frac{B}{Y}$, which is selected to match the time averages in aggregate data.

The intervals for the other parameters are centered around calibrated values and include values that have been either estimated in the literature, or assumed in calibration exercises. For example, the range for the *risk aversion parameter* σ includes the values typically used in RBC (σ from 0.5 to 2), and those used in New-Keynesian models (σ from 1 to 6). Note that since σ controls how consumers dislike consumption fluctuations, the dynamic effects of fiscal shocks on consumption may directly or indirectly depend on this parameter.

The share of public goods in total consumption, $1-\omega$, is usually set to zero. Theoretical considerations suggest that ω has to be low since the size of the private wealth effect following fiscal shocks crucially depends on this parameter. Similarly, since dynamic responses may depend on the elasticity of substitution between private and public goods, η, we allow for both complementarities and substitutabilities between the two.

The parameter ϕ regulates the labor supply elasticity and is crucial in determining the labor market responses to fiscal shocks. We have chosen its range so that the labor supply elasticity varies in the interval [0.1,10], which covers well the range of existing estimates (See e.g., Gali et.al (2002)).

The *capital adjustment costs parameter* shapes investment responses to shocks and therefore indirectly affects the labor markets dynamics. Especially for the sticky price model the presence of capital adjustment costs seems crucial (see Basu and Kimball (2003)). The chosen range allows for small adjustment costs (b=1) up to very large ones (b=10). The range for *the depreciation of private capital* may also affect labor market responses, given the Cobb-Douglas production function we employ. The range varies from a low 0.05 (implying complete depreciation in 20 years) to a high 0.20 (implying complete depreciation in 5 years). Following Finn (1998), we assume that government capital uniformly depreciates at a slower rate.

	Table 1: Parameter values or ranges	
β	discount factor	0.96
B/Y	steady state debt to output ratio	0.3
σ	risk aversion coefficient	[0.5,6]
$1-\omega$	share of public goods in consumption	[0.0,0.15]
η	elasticity of substitution public/private goods	[-0.5,2.5]
ϕ	preference parameter	[0.1,0.9]
b	adjustment cost parameter	[1,10]
δ^p	private capital depreciation rate	[0.05,0.2]
δ^g	public capital depreciation rate	[0.02,0.1]
μ	productivity of public capital	[0,0.25]
ν	productivity of public employment	(0,0.25]
α	capital share	[0.2,0.4]
τ^l	average labor tax rate	[0,0.3]
τ^k	average capital tax rate	[0,0.2]
C^g/Y	steady state C^g/Y ratio	[0.07,0.12]
I^g/Y	steady state I^g/Y ratio	[0.02,0.04]
N^g/N^p	steady state N^g/N^p ratio	[0.05,0.2]
ζ_π	Taylor's coefficient	[0.5,3]
ζ_b	coefficient on debt rule	[0.25,1.5]
γ	degree of price stickiness	[0.25,0.85]
$\frac{\varepsilon}{\varepsilon-1}$	steady state markup	[7,8]
ρ_{C_g}	persistence of C^g shock	[0.6,0.9]
ρ_{I_g}	persistence of I^g shock	[0.6,0.9]
ρ_{N_g}	persistence of N^g shock	[0.6,0.9]

The parameter μ controls the interactions between public and private goods in production. Depending on its value, an increase in government capital has large, or small effects on private output. We choose the range [0, 0.25], which covers both the case of unproductive and very productive government capital.

The productivity of government employment, ν is also restricted in the interval (0,0.25]. We do not allow for unproductive government employment for two reasons. First, both state and aggregate data on government employment do not include employees in government defense, which in our framework is the closest empirical counterpart of unproductive government employment. Second, the induced dynamics when $\nu = 0$ are comparable with those obtained in the case of a natural disaster and our data is unlikely to contain information about such events[5].

The *capital share* in production α is allowed to vary in the interval [0.2,0.4] which covers reasonably well the range of values estimated for US data, while the *average tax on labor income* can vary from 0.0 to 0.3 which covers estimates of average income tax at state and federal level in the US in the period 1969-2001. The range on the tax on capital income parameter [0.0, 0.2] is somewhat lower to account for the cross state evidence in the US. Similarly, the ranges for the fiscal ratios, $\frac{C^g}{Y}$, $\frac{I^g}{Y}$, $\frac{N^p}{N^g}$ match the cross sectional range of values found in US states.

The *degree of price stickiness* and the *coefficient on inflation* in the policy rule determine both the shape and the size of output and inflation responses following a fiscal shock. We know that the higher (lower) is the degree of price stickiness (the inflation coefficient), the stronger is the impact of a fiscal expansion on the labor markets. The range of values used covers both aggressive and weak interest rate responses to inflation changes and both high and low degree of price stickiness. Given that the determinacy of equilibria depends nonlinearly on the values of γ, ζ_π and ζ_b, the ranges for these parameters are truncated so as to guarantee determinacy of equilibria.

The *persistence of the government spending shocks* determines the magnitude of the wealth effect produced by fiscal shocks and, thus, quantitatively affects the response of hours and real wages to such shocks. The range we have selected represents a reasonable compromise between theoretical desires and the cross state evidence we have available[6].

[5] See, also, Finn (1998) and Ardagna (2001) for the effects of unproductive shocks to government employment in RBC models.

[6] Since the form of the utility function is important for the transmission of fiscal shocks, we have also varied the functional form for the utility. For example, we have studied the case where preferences are separable in consumption and leisure and where public and private goods are only substitutes. None of the qualitative features of the dynamic responses we present below is altered by these changes.

3 Theoretical Predictions

3.1 A Government Consumption Disturbance

Figure 1 plots the 95% bands for the responses of output, consumption, private investments, private and total employment, the real wage, CPI inflation, the nominal interest rate, real debt and deficits to a standardized 1 percent increase in government consumption when parameters are randomized over the ranges reported in Table 1. The solid lines represent responses obtained in the RBC version of the model (the price stickiness parameter γ is set to zero); dotted lines represent the responses of the sticky price version of the model.

For the RBC model two features need to be stressed. First, while quantitatively, the response of the endogenous variables depends on the parameterization, the responses of labor market variables are qualitatively robust, both in terms of sign and shape. In particular, a positive government consumption shock, financed by a deficit increase, increases labor supply because of a standard negative wealth effect: households feel poorer because the fiscal expansion lowers their permanent income. Since leisure is a normal good, labor supply rises. In turn, given the unchanged labor demand by the private and public sector, this increase induces a decline in real wages (and labor productivity) and an expansion of output. The size of the wealth effect is quite modest: a one percent increase in government consumption produces a maximum contemporaneous effect on employment and output of 0.2 percent. The maximum negative response of real wages is also quite limited in size, despite the large range of values used for the labor supply elasticity. Note that inflation and interest rate responses are negligible.

Second, private consumption can move in any direction after an expansion of government expenditure, while private investment robustly falls. The sign of private consumption responses on impact depends on the size of the wealth effect and hence on ω and the degree of substitutability/ complementarity between private and public goods, η. While it is known that persistent government consumption shocks crowd-out private consumption (especially when $\omega = 1$), it is typical to find small or insignificant negative responses of private investments to such disturbances (see Baxter and King (1993), Ludvingson (1996)) unless the government shock is permanent. Here the persistence of government spending shocks is allowed to vary from 0.6 to 0.9. Since we do not allow for permanent shocks, positive investments response fail to appear in our simulations. In principle, the increase in employment increases the expected return of capital and therefore might stimulate investment, regardless of the persistence of the shock. However, the unitary elasticity of substitution between capital and labor in production implies that this effect, if it exists, is quite small.

Hence, investment falls after the shock due to the increased absorption of resources.

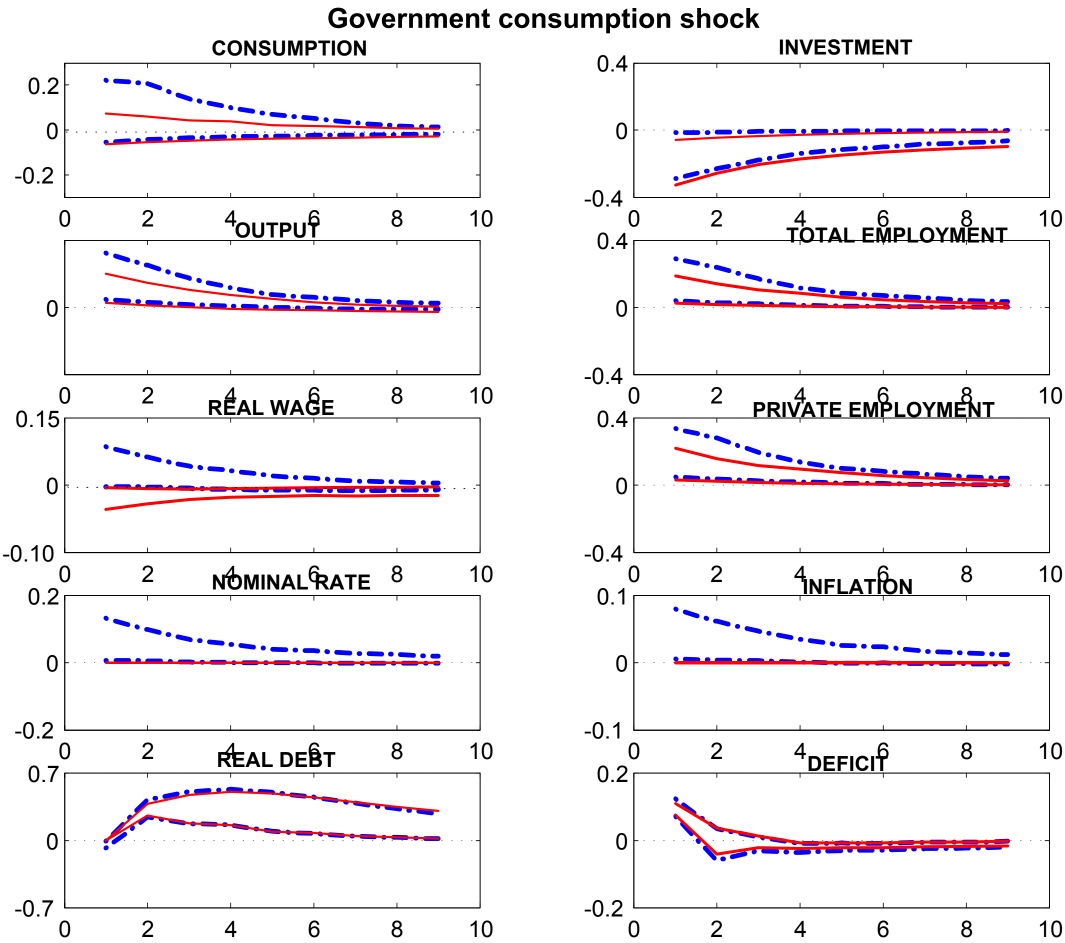


Figure 1: Responses to government consumption shocks, solid RBC, dotted New-Keynesian.

The qualitative predictions of the sticky price model are also quite robust: in fact, except for consumption, the response bands are all on one side of zero. Note also that the responses of seven of the ten variables are qualitatively similar to those of the RBC model.

To understand the dynamics induced by the government consumption shock in this version of the model notice that, since here output is mainly demand determined, an increase in government spending financed by a deficit increase, increases labor demand and output. Since private consumption declines for some parameterizations, a negative wealth effect that shifts the labor supply curve to the right must be present also in this case. However, the demand effect is in general much stronger and the increase in labor demand pushes real wages up. Note that, quantitatively, the increases in employment and output (and consumption) are larger than those obtained in the RBC model. Here the contemporaneous median response of output and employment is about twice as large as the contemporaneous maximum response of these variables in the RBC model. Given the expansion of demand, inflation increases and, given the monetary policy rule, the nominal interest rate increases as well. Note also that the upper range of the response band of private consumption is twice as large as the one obtained in the RBC model. This is because increases in government consumption may raise expectations of future inflation typically making agents consume more immediately.

Gali et al. (2004) have argued that the latter mechanism is not enough to generate positive responses in private consumption to a government consumption shock and suggest that a combination of price rigidities and "rule of thumbs consumers" can bring about such private consumption responses. Here it is the complementarity between public and private consumption that produce such a pattern of responses.

Our results seem to contradict those of Basu and Kimball (2003), who have shown that, even with adjustment costs in capital, output and real wages might decline after a government consumption increase on impact. There are two reasons for the difference between their results and ours: we use a more general specification for preferences and monetary policy in our specification is active, while they consider only a passive money rule. Note that the fact that output and wages do not fall in Figure 1 does not imply that they never decline: in fact, there is 1% of parameter combinations which makes both variables decline after a shock.

In sum, both models produce a number of robust implications in response to government consumption shocks. In the RBC model a surprise increase in government consumption financed with deficit expansion increases output and employment, while investment and real wages decline. In particular, the pattern of employment and real wage responses implies a movement of the labor supply curve along a given labor demand curve. In the sticky price model a surprise increase in government consumption financed by deficit creation makes output, employment and real wages increase, while investment falls. Hence government consumption shocks imply movements of the labor demand along an (almost) fixed labor supply curve.

3.2 A Government Investment Disturbance

The effects of shocks to government investment are depicted in Figure 2: solid lines represent the 95% bands obtained with the RBC model, dotted lines the 95% bands obtained with the sticky price model.

In the RBC model, the contemporaneous responses induced by these shocks are qualitatively similar to the ones produced by a government consumption shock, but the lagged effects are quite different. An increase in government investment has two contrasting effects on private wealth. The first, similar to the one produced by government consumption shocks, is contractionary, since government absorption increases. The second is expansionary, since a higher I_t^g increases public capital and, thus, enhances the productivity of private factors. Clearly if, $\mu = 0$ and $\omega = 0$, the latter effect disappears and the responses to the government consumption and investment shocks would be identical. On the other hand, when μ is very high, the positive effect dominates.

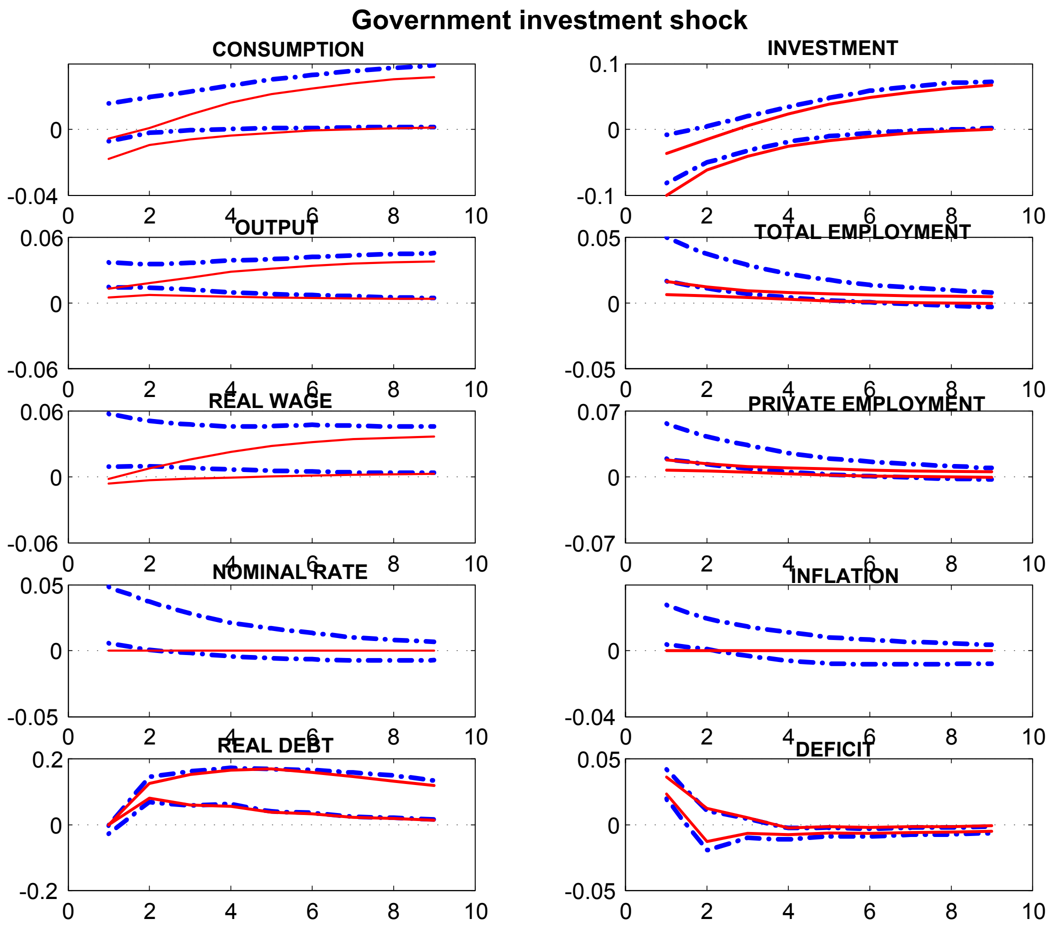


Figure 2: Responses to government investment shocks, solid RBC, dotted New-Keynesian.

Figure 2 shows that the contractionary effect dominates in the impact period but as time goes by the expansionary effect comes into play. In fact, after the impact period consumption and investment gradually and persistently increase, while employment falls. Note that the sign of the contemporaneous effects is robust and, apart from consumption, identical to the case of a government consumption shock. That is, deficit, output, and employment increase after the disturbance, while real wages and investment fall.

The contemporaneous responses to a government consumption and government investment shocks look very similar also in the sticky price model. The main difference again appears after the impact period. To understand the pattern of responses note that the two effects present in the RBC model here interact with the positive demand effect induced by price stickiness. In the impact period, the demand effect is stronger leading to an increase of output, consumption, real wages and employment, while in subsequent periods the positive effect induced by the larger stock of public capital leads to persistent increases in output, consumption and real wages and, eventually, investments.

To sum up, the predictions of the two theories regarding the effects of government investment increases are quite robust to parameter variations and differ again in the induced labor market dynamics. While in the RBC model employment increases and real wages fall contemporaneously, in the NK model both employment and real wages rise due to the predominant demand effect.

Notice that while we had some latitude in terms of timing of responses to distinguish the two theories in the case of unproductive government expenditure shocks, here it is only the contemporaneous predictions that differentiate them. When the positive effect produced by the increase in public capital kicks in, it dominates any other factor at play, making both real wages and employment increase.

3.3 A Government Employment Disturbance

Figure 3 illustrates the effects of a shock to government employment in the two models. As before, solid lines represent the 95% bands generated by the RBC model; dotted lines correspond to their sticky price counterparts.

As with any other type of expenditure, an increase in government employment has a negative effect on private wealth, since it expands the governments usage of private resources. This negative wealth effect tends to increase labor supply and reduce consumption in the RBC model. However, the increase in total employment occurs through increases in government employment, while private employment falls. In other words, there is a sectoral reallocation involving a shift of labor out of the private sector and into the government sector. In addition, real wages increase since for given capital stock, private employment falls.

Other things equal, the decrease in private employment should cause also output to contract. However, the productive nature of public employment deters this and output, consumption and investments, in most of the cases, increase after the shock. Note that, for $\nu = 0$, output, consumption and investments all fall after a shock to government employment.

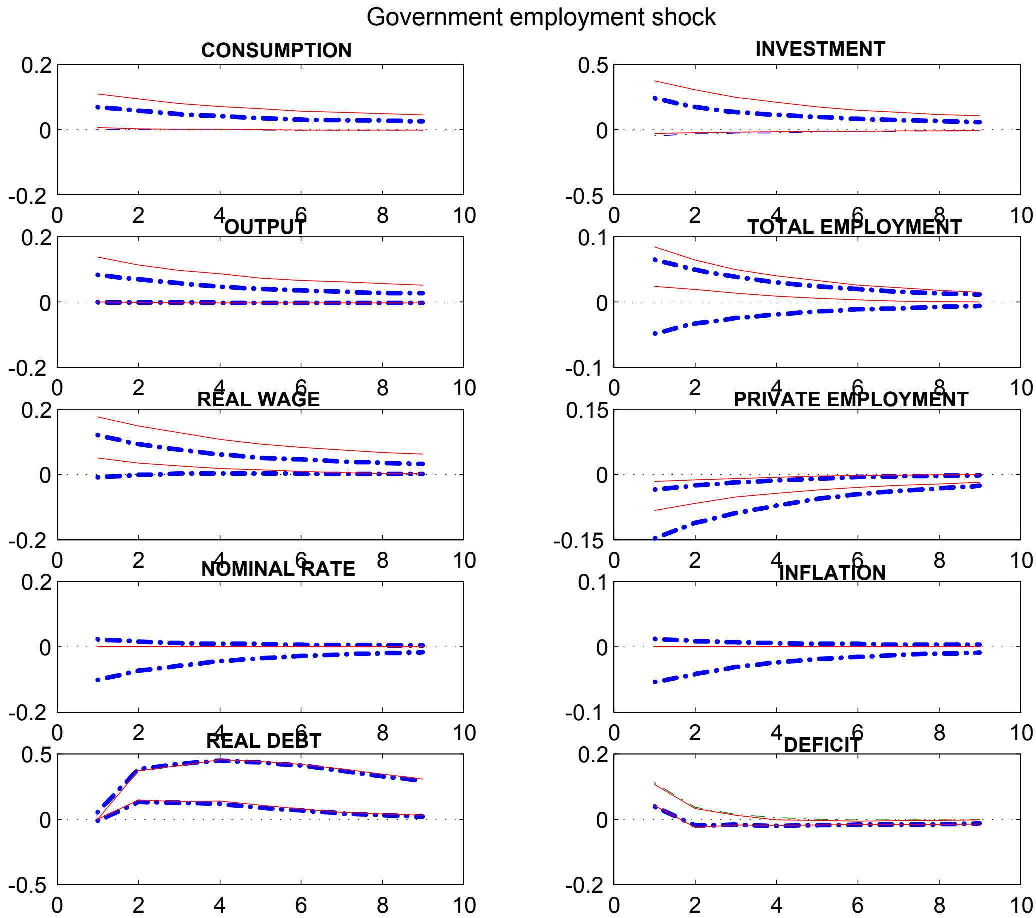


Figure 3:Responses to government employment shocks, solid RBC, dotted New-Keynesian.

The mechanics of transmission of shocks to government employment are similar in the sticky price model. Increases in government employment increase output, real wages, consumption and investments (most of the times) in this model too. Yet, the productive nature of government employment coupled with price stickiness narrows the range of responses of these variables relative to the RBC model. This is because the increase in productivity due to increases in the government employment increases output for constant private inputs. Although the increase in government absorption increases demand, firms do not need to augment their labor demand in response to the shock. Actually, for some parameterization they can even decrease it. As a result, real wages and output do not increase by as much as in the RBC model and total employment may even fall.

Hence, the predictions of the New-Keynesian model regarding labor markets responses are tenuous and depend both on the productivity of public employment, ν, and the degree of price stickiness, γ. The higher is ν and/or γ, the stronger the need to decrease private labor demand after a shock to public employment and, thus, the more likely is aggregate employment to fall.

To conclude, the responses to government employment shocks are qualitatively similar in the two models. Consumption, output, real wages and deficit increase, while private employment falls after the shock. The two models differ in the intensity with which private employment reacts to the fiscal expansion, and as a result, in the reaction of total employment. In the RBC model total employment increases for all possible parameterizations, while in the sticky price model the fall in private labor is severe enough to induce a decline in total employment in several cases. Hence, for this third type of shock, testing the two models against the other is not possible and we simply examine if the labor market data conforms to the predictions of the RBC model.

4 The Econometric framework

4.1 The Data

We use annual aggregate and state data for the US from 1969 to 2001. State data cover 48 states (Alaska and Hawaii are excluded). The majority of both the aggregate and state data comes from the regional government finance series of the Bureau of the CENSUS. State wages and employment come from the Bureau of the Labor Statistics. A complete description of the variables used is in the data appendix.

Together with aggregate data, we decided to use US state data for several reasons. First, US state data is homogeneous and of good quality; therefore, besides allowing us to check the robustness of the conclusions obtained with aggregate data, it permits us to highlight both average tendencies and individual idiosyncrasies. Such an exercise would not be possible, e.g., using OECD data, since data is hard to get for a large number of countries and often is of uneven quality. Second, since with state data we can take US monetary policy as given, we can verify if the interaction between fiscal and monetary policy is important to explain the pattern of results we obtain in aggregate data. Third, since aggregations typically induce higher persistence in the responses to shocks, the use of state data allows us to examine whether average (cross state) results differ from aggregate ones.

4.2 The reduced form model

For aggregate data our reduced form model includes five endogenous, five exogenous variables and a constant. The endogenous variables are log of real per capita GDP, log of real per capita government expenditure in either (a) goods purchases, (b) capital outlays, or government employment, log of real per-capita tax revenues, log of average real wage per job and log of total employment. The exogenous variables are the Federal Funds rate, oil prices, unemployment and the log of current and lagged US debt to GDP ratio. Similarly for state data we employ five endogenous variables: we use GSP series instead of GDP and state instead of aggregate government expenditure, revenues, real wages and employment series. As exogenous variables we use real lagged state debt to GDP ratios, the Federal Funds rate, per capita real US GDP, per capita real US deficit, and the level of oil prices. In both models oil prices and the nominal interest rate are used to capture aggregate supply and demand effects respectively. For state level models, the per capita US GDP and aggregate fiscal variables are included to control for aggregate demand driven effects which are common to all units.

We treat each state as a closed economy and, as a result, neglect possible neighborhood effects. Ideally, these effects should be taken into account. However, the short data set we have available does not allow many degrees of freedom. The use of aggregate (exogenous) variables strikes a compromise between having all the interdependencies across states spelled out and treating each state in isolation. For the same degrees of freedom problems we limit the lag length of the VAR to one for each unit. After a short specification search, we make all aggregate exogenous variables except oil prices enter only contemporaneously in the systems[7].

4.3 Identifying the shocks

In order to discriminate between the two theoretical paradigms, we employ identifying restrictions which are robust and common to both models. The robustness requirement

[7] We have examined several variants of the model (e.g. a VAR with revenues and expenditures in percentage of GDP, a model where the aggregate GDP level is substituted for the aggregate unemployment level, a model where the debt to GDP ratio is included as a sixth endogenous variable, a model where wages are deflated with regional instead of US prices and a model where variables are expressed in growth rates (but not per-capita terms)). The results are unaffected by all of these changes.

excludes, for example, the use of restrictions on consumption and investment to identify shocks. Moreover, since magnitude restrictions typically depend on the parametrization, we only employ sign restrictions. Since the dynamics of output and deficit in response to government consumption and investment shocks are similar in the two models and qualitatively robust, we will use them to identify these disturbances in the data. Once these shocks are obtained we examine which model better explains the dynamics of labor market variables. We also use the dynamics of output and deficit to identify government employment shocks. However, in this case, only the predictions of the RBC model for labor market dynamics will be examined.

Besides making the link between the model and the data tighter, the use of robust sign restriction 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, and the scarceness of reasonable zero-identifying restrictions emphasized, e.g. in Mountford and Uhlig (2002), Canova and Pappa (2003), and Perotti (2004), are to a large extent solved. In fact, all relevant variables are endogenous and since we control for both the state of the local and of the aggregate business cycle, there is no need to produce cyclically adjusted estimates of fiscal variables. Furthermore, since theory defines the features of the fiscal disturbances we are looking for and the timing of the responses of the endogenous variables is largely unrestricted, the other two problems are also considerably eased.

4.4 Combining cross sectional information

As mentioned, we use both US aggregate and state data to check the validity of the theories. With US state data we construct two measures of transmission of fiscal shocks to labor markets: one which captures the response in a "typical" US state, and one which represents individual state information. Typically these measures are obtained using OLS on pooled or individual state data. However, when dynamic heterogeneity is present and the data is short neither of the two choices is appealing. For this reason, the measures we present allow for partial pooling in a Bayesian fashion. That is, a hierarchical model where state impulse responses are assumed to be random variables with some mean and some variance (representing the dispersion of impulse responses across states) is postulated. Furthermore, the mean impulse response at each step is assumed to be a random variable with some distribution. Then, given some assumptions about this distribution (for example, mean zero and large variance), one can construct posterior estimators for both individual impulse responses and the "typical" mean response which combine a-priori and sample information.

These estimators have a particular form: the "typical" response is a weighted average of sample and prior information, while the individual response is a weighted average of unit specific and average information, with weights given by the precision of prior and sample information (see, e.g. Canova and Pappa (2003)). Since our prior information is relatively loose, sample information dominates.

What are the advantages of this approach over more standard ones? First, structural responses obtained with individual data are likely to be imprecisely estimated because of the short data set. If the cross section provides useful information, stronger statements about the validity of theories can be made. If the cross section is silent, our estimators collapse to standard OLS estimators, state by state. Second, although we have treated each state separately, information about the labor market responses of, say, Massachusetts can be useful to understand the labor market dynamics in, say, Maine. By modelling, the cross section of experiments as repeated observations of the same underlying unknown phenomena (the responses of the labor market to fiscal shocks), we make use of this information in constructing state impulse responses. Finally, pooled estimates are biased and inconsistent under dynamic heterogeneities (see e.g. Pesaran and Smith (1995)). Since our task is to trace out responses in units which potentially differ in their dynamic characteristics, it seems unwise to proceed in this fashion.

Are there disadvantages? Since our measures collapse to standard measures when the cross section does not carry information no counterindications exist, as long as prior information is loosely specified.

5 The Evidence

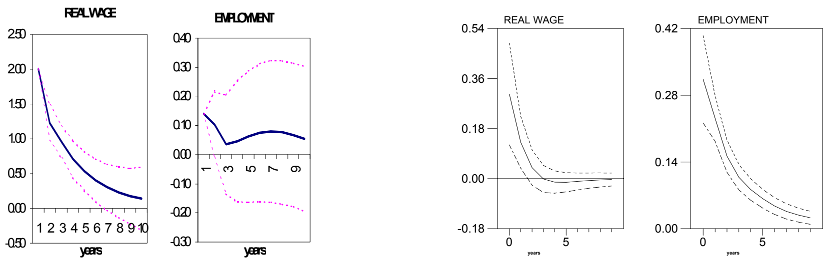
5.1 Aggregate and "Typical" Effects

We present aggregate and average estimates of the responses of real wages and employment to a 1% increase in government spending in figure 4. The first two panels refer to aggregate data and the last two to the "typical" state in the US. The first row reports the responses to government consumption, the second to government investment and the third to government employment shocks. Each box presents median estimates (solid line) and 95% confidence bands (dotted lines).

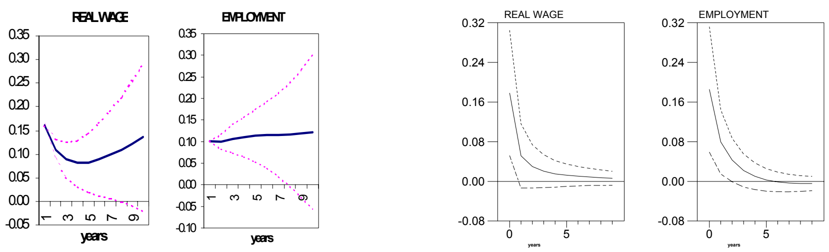
In aggregate US data increases in government consumption, investment and employment accompanied by increases in output and deficits, increase real wages and employment, at least contemporaneously. Therefore, there is evidence that movements in the aggregate demand curve are of larger magnitude than movements in the aggregate supply curve. The contemporaneous response of real wages to consumption shocks is stronger than the one produced by the other two shocks. In fact, a one percent increase in government consumption pushes real wages up by two percent instantaneously; an employment disturbance increases them by 0.6 percent, while an investment shock increases them by only 0.15 percent.

Aggregate OLS responses **Average posterior responses**

Government consumption shock



Government investment shock



Government employment shock

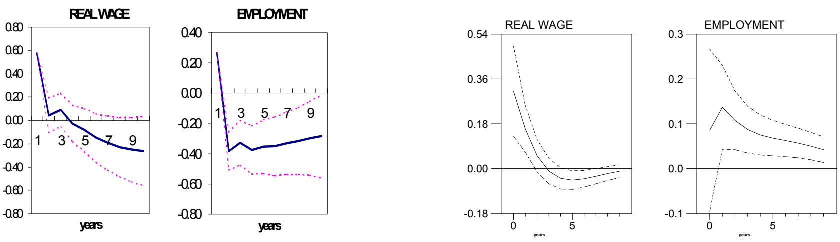


Figure 4: Labor market responses in the US

Roughly speaking, it appears that the initial jump in real wages takes longer to dissipate if government consumption shocks occur, while the real wage effect of a government employment shock lasts only one period. On the other hand, the contemporaneous responses of employment to the three shocks are similar: the instantaneous effect of a one percent increase is between 0.10 and 0.25. However, the response to employment and investment shocks is more persistent.

Since the data set is relatively short, one may wonder about the robustness of the dynamics we report. There are potentially three aspects worth investigating. First, short data sets typically imply imprecise estimates and insignificant responses. However, this does not seem to be the case here. Second, labor market responses to government investment and employment shocks appear to deviate from their theoretical characterization (shocks to the former appear to generate nearly non-stationary responses in aggregate data, while responses to employment shocks change sign after one period). A final source of concern is the fact that standard aggregation problems become more severe when the sample is short. To examine whether the conclusions are robust, we examine average estimates of labor market responses across US states.

Overall, the evidence is quite supportive of the conclusions obtained with aggregate data. In fact, the responses of real wages and employment to government consumption and investment shocks are both positive on impact. However, contrary to what had occurred in the aggregate data, responses tend to die out quickly. Also, the magnitude of the impact is slightly different. For example, a one percent increase in government consumption increases real wages in the median by only 0.30 percent. This pattern is consistent with output responses: in fact, while output responses are sizable on impact and very persistent in aggregate data, they are much smaller in size and die out much faster when averages are taken. Despite of these quantitative differences, it is still the case that government consumption and investment shocks produce labor market effects which are consistent with the dynamics of the New-Keynesian model.

The evidence for government employment shocks is mixed. In particular, while the response of real wages is positive and significant on impact, the one of employment is insignificantly different from zero on impact and turns positive after one year. As we will see later on, the large initial band for the response of employment is the result of a substantial heterogeneity in individual state (total) employment responses to increases in government employment. Consistent with the previous evidence, the responses to employment shocks in the average data are weaker than in the aggregate - the median impact response of real wages here is only 0.30 percent - and less persistent, suggesting that aggregation problems could be quantitatively important.

In sum, the evidence so far indicates that the labor market dynamics in response to government consumption and investment disturbances agree with those of the New-Keynesian version of the model, at least on impact. For government employment, the pattern is more mixed but seems to lean against a RBC interpretation of the dynamics induced by these shocks. To corroborate this evidence we now turn to examine the responses of real wages and employment to the three types of shocks in individual US states.

5.2 Individual unit responses

We summarize information concerning the impact effect of government expenditure shocks in state labor markets in table 2, where we report the median impact response for each state and each shock (responses statistically different from zero are in bold)[8].

Overall, state data confirm the conclusions we have obtained with aggregate data and on average. Take for example, government consumption shocks. Over the cross section impact responses vary on the range [-0.21, 2.15] for real wages and on the range [0.01, 2.27] for employment.

However, the majority of the responses are relatively small (the median cross sectional response of real wages is 0.16 and the median cross sectional responses of employment is 0.13) and excluding some outliers, heterogeneity in the responses is rather minor. The instantaneous responses of employment and real wages are positive in 39 of the 43 states where it is possible to identify such a shock and in 26 of these states both responses are significantly different from zero. For the four states where real wages fall (California, Florida, Kansas and Minnesota), the impact output effect of government consumption shocks is among the smallest. In other words, while the labor supply effect tends to dominate, the output multiplier effect induced by the increase in labor supply is relatively small, as our simulation performed in section 3 had suggested.

The message is similar when we consider the responses to a government investment shock. Here instantaneous real wage responses vary in the range [-0.10, 2.56] (cross sectional median 0.03) and those of employment in the range [0.00, 3.01] (cross sectional median 0.05) and excluding a few outliers, responses are very homogeneous. In 36 of the 40 states where such shocks are identifiable we find that real wages and employment both increase and in 24 of them both responses are significantly positive. Illinois, Minnesota, and Vermont are the states where real wage responses are significantly negative. Also, confirming the results obtained for government consumption shocks, instantaneous output responses for these three states are among the smallest of all.

Consistent with the predictions of our model, employment multipliers produced by government investment shocks are larger on average than those obtained with government consumption shocks. These larger multipliers are due to the smaller share of capital outlays spending in state output. Note also that, consistent with the predictions of the model, employment multipliers in states where the Keynesian transmission mechanism prevails are larger than those where the RBC mechanism dominates.

[8] Plots of the responses of real wages and employment for each US state for each of the three shocks are in a technical appendix available on request.

Table 2: Instantaneous Multipliers

	C^g Shocks		I^g shocks		N^g shocks	
	Wage	Empl.	Wage	Empl.	Wage	Empl.
AL	**0.06**	**0.12**	0.001	0.01	**0.16**	**0.13**
AR	**0.21**	**0.24**			**0.21**	0.08
AZ	**1.25**	**2.00**	**0.17**	**0.10**	**0.38**	**0.62**
CA	**-0.14**	**0.15**	**0.09**	**0.06**		
CO	0.03	**0.12**	**0.03**	**0.07**	**0.25**	**0.75**
CT	**0.41**	0.07			**1.06**	**1.27**
DE	**0.24**	**0.44**	**0.03**	**0.03**	**0.41**	**-0.87**
FL	**-0.05**	**0.13**	0.00	**0.06**	**0.93**	**-3.33**
GA	**0.67**	**0.54**	**0.28**	**0.14**	**0.38**	**-0.61**
ID			**0.06**	**0.07**	**0.04**	**0.16**
IL	**0.27**	0.03	**-0.10**	**0.04**	**0.07**	**0.07**
IN	**0.22**	0.03	**0.04**	**0.05**	**0.26**	**-0.19**
IA			**0.06**	**0.12**	**0.06**	**0.09**
KS	**-0.21**	**0.14**	0.001	0.001	**0.59**	-0.06
KY	**1.11**	**0.81**	**0.07**	0.00	**0.14**	-0.04
LA	**0.08**	**0.08**	**0.07**	0.01	**0.61**	**0.25**
ME	**0.26**	**0.18**	**0.35**	**0.44**	**0.09**	**0.15**
MD	**0.07**	**0.04**	**0.02**	0.00	**0.39**	**-0.33**
MA	**2.15**	**2.27**				
MI	**0.59**	**0.87**	**0.07**	**0.13**	**0.06**	0.02
MN	**-0.05**	**0.04**	**-0.01**	**0.08**	**0.30**	**0.13**
MS	**0.51**	0.06	0.00	**0.02**	**0.21**	**0.23**
MO	**0.05**	**0.04**	**0.44**	**0.26**	**0.17**	**0.27**
MT	**0.17**	**0.17**	**0.55**	**0.77**	0.06	**0.16**
NB	0.05	0.05			0.01	-0.001
NV	0.0004	0.01	**0.03**	**0.02**	**0.08**	**0.33**
NH	**0.38**	**0.44**	**0.03**	**0.05**	**0.99**	**1.06**
NJ	0.03	0.02			**0.76**	**0.28**
NM	**0.43**	**0.25**	**0.02**	**0.03**	**1.51**	**0.56**
NY	**0.16**	**0.05**	**0.77**	**0.19**	**0.18**	**0.13**
NC			**0.07**	**0.02**	**0.33**	**-0.33**
ND			-0.01	0.00	**0.16**	**0.47**
OH	**0.17**	**0.40**			**0.16**	**0.37**
OK	**0.16**	**0.25**	0.02	0.00	**0.06**	**0.15**
OR	**0.08**	**0.12**	**0.08**	**0.05**	**0.40**	**-0.22**
PA	**0.07**	0.01	**0.02**	**0.01**	0.01	**0.09**
RI	**0.24**	**0.70**	0.01	**0.03**	**0.44**	**0.76**
SC	0.09	**0.41**			**0.13**	**-0.24**
SD	**0.15**	**0.32**			**0.10**	**0.43**
TN	**0.18**	0.03	**0.77**	**1.07**	**0.24**	**0.38**
TX	0.04	**0.11**	0.00	0.01	**0.24**	0.08
UT	**0.42**	**0.51**	**0.03**	**0.21**		
VT			**-0.03**	**0.09**	**0.09**	**0.19**
VA	**0.76**	**0.22**	**0.40**	**0.10**	**0.29**	**0.14**
WA	**0.06**	0.001	0.01	**0.02**	**0.46**	**-0.32**
WV	**0.12**	**0.11**	0.02	0.01		
WI	**0.06**	**0.03**	**2.56**	**3.01**	**0.10**	**0.18**
WY	**1.55**	**0.96**	**0.09**	**0.05**	**0.12**	**0.35**
average	**0.30**	**0.31**	**0.18**	**0.19**	**0.31**	0.09

Finally, the evidence concerning government employment shocks is mixed. Recall that in this case the predictions of the New-Keynesian model are tenuous and that the RBC model predicts that in response to these shocks both real wages and total employment contemporaneously increase. Table 2 indicates that such a pattern occurs in 32 states (with significant responses in 29 states), while in the remaining 12 states for which shocks were identified total employment falls after the disturbance (and in 9 of them significantly so).

Instantaneous real wage responses vary in the range [0.01, 1.51] with a cross sectional median of 0.21 and are almost always significant. However, employment responses are very heterogeneous and vary from -3.33 in Florida to 1.27 in Connecticut. In 40 percent of the cases the sign of the responses predicted by the RBC model fails to materialize. Moreover, in line with the theoretical predictions of the New-Keynesian model, employment and output multipliers for the states in which total employment falls after a shock to public services are much lower than on average. In general, it appears that the RBC model does not seem to represent the data dynamics very well.

5.3 Discussion

We next examine the magnitude of employment multipliers for the three different components of spending. This exercise is useful since it indicates whether fiscal policy is an effective countercyclical policy tool and, which component of government spending, among the three studied here, is the most powerful one.

Using conditional employment (and output) multipliers one can see that investment shocks are the most effective countercyclical policy tools[9]. In fact, while in aggregate data employment and output multipliers are large for both government investment and employment shocks, on average employment and output multipliers are modest for government employment shocks. This is due to the heterogeneity in individual unit responses following the latter type of shocks. Overall, the employment effects of expenditure shocks appear to be considerable. In aggregate data the employment multiplier is 0.35 for government employment shock, 0.36 for government investment shocks and a mere 0.15 for government consumption shocks. In the cross-section of US states, however, employment multipliers are larger than one for both consumption and investment shocks in several of the units. This difference is important and may provide a rationale for distinguishing between budget rules at state and at federal level.

In an influential work Gali (1999) has emphasized that a standard RBC model can-

[9] Multipliers are computed multiplying employment (output) responses to the shock by the average government spending to employment (output) ratio.

not account for the effects of technology shocks on labor productivity. His findings have prompted a growing literature aimed at providing evidence on the role of technology as a source of economic fluctuations[10]. The bulk of this evidence suggests a limited role for technology disturbances, while it points to demand factors, such as government spending, as main driving forces behind the positive comovements between output and labor input measures. It is therefore interesting to examine what our analysis for fiscal shocks has to say about the behavior of labor productivity in the models and in the data. In general, the dynamics of labor productivity in both models fail to qualitatively replicate those present in the data. In the RBC model labor productivity equals the real wage and, hence, it contemporaneously falls after a shock to government consumption and investment and increases after a shock to government employment. In the sticky price model labor productivity falls slightly after a shock to government consumption and investment, while the sign of its response to a government employment shock depends on the parameterization. Both on average and in the aggregate, output and total employment responses in US data imply an increase in labor productivity for all the types of disturbances considered. The rise in labor productivity is typically larger for government consumption and employment shocks than for investment shocks in both types of data. Hence, while the direction of the changes is consistent with the New-Kenesian story, the magnitude of output and employment responses is inconsistent with the data. We conjecture that some mild frictions in the labor market may improve the match between the theory and the data.

6 Conclusions

This paper explored the effects of three types of fiscal shocks in labor markets. We characterized a set of robust theoretical restrictions produced by a standard RBC and a New-Keynesian model for shocks to three different types of government spending: (a) goods purchases, (b) investment purchases and (c) government employment. We used the robust sign restrictions induced by these shocks on the dynamics of output and deficit to identify them in US aggregate and state data and examine the dynamics they induce in real wages and employment to select between the two transmission mechanisms.

We show that in a flexible price-RBC model government consumption and investment shocks induce instantaneous movements in the labor supply that lead to increases in total employment and declines in real wages contemporaneously. On the other hand, government employment shocks imply positive effects on real wages and total employment.

[10]For a recent review of this literature see e.g., Gali and Rabanal (2004).

The New-Keynesian (sticky price) model, produces dynamics which are largely demand driven. Therefore, government expenditure and government investment shocks produce instantaneous increases in both real wages and total employment. Government employment shocks have similar effects in both models. Their only difference concerns the responses of total employment, which are tenuous and depend on the parametrization used in the New-Keynesian model, while they are positive in the RBC model.

All the data we have analyzed favor the New-Keynesian transmission mechanism for the first two types of shocks: both real wages and labor contemporaneously increase and significantly so. The magnitude of the effect differs across average and aggregate US data because the responses of output differ in size but the qualitative conclusions appear to be statistically robust and economically meaningful. Individual state data also confirm these conclusions. In fact, government consumption and investment shocks increase real wages and employment in about 90% of units where the shock is identified. Finally, the magnitude of the employment multipliers and their relative ordering squares well with the predictions of the versions of the two models we have examined.

The data is not very informative about the dynamics following a government employment shock. In fact, while in aggregate data the predictions of the RBC model are satisfied, the typical instantaneous effect of total employment in average data is insignificant and in 40 percent of the states the predictions of the model are disproved.

The generally weak theoretical implications and the mixed empirical evidence we have obtained in response to government employment shocks could be explained in several ways. First, theoretically, we have assumed perfect labor mobility between private and public sectors and that the government acts competitively in labor markets. Clearly, modifications of these assumptions may alter not only the dynamics following employment shocks but also the relative predictions for labor market variables in the two models. Second, the fall in total employment after a shock to government employment we empirically observe is consistent with certain parameterizations of the New-Keynesian model. However, our inability to pin down with precision the productivity of government employment does not allow us stronger statements on this issue.

Our results provide a few general policy conclusions which are worth stressing. First, the analysis has indicated that public investment shocks appear to produce the largest employment (and output) multipliers. Therefore, public investments could help to push economies out of recessions more than government consumption or employment shocks. Conversely, if expenditure cuts need to be implemented (because of balance budget restrictions or Maastricth-style rules are in place) these should probably leave public investment out. In other words, the results of this paper support the choice of Golden rule-type of budget requirements. Second, the employment effects of government expenditure appear to be considerable. Therefore, and contrary to the common wisdom, expenditure programs maybe as effective as tax incentives (not considered in this paper) as countercyclical tools. Finally, the data suggests that expenditures at federal level tend to be less expansionary than the expenditures of the same combined magnitude at state level. While other considerations may be important on this issue, the results provide a rationale for clearly distinguishing between budgets deficits at state levels and those at federal level.

Appendix: Data Sources and Definitions

The study's data are annual, real, seasonally adjusted, and per capita for the US states from 1969 -2000. U.S. Census Bureau, Bureau of Labor Statistics and Bureau of Economic Analysis are the main sources. A description of the data follows.

Population: CENSUS, total state population in thousands

Aggregate price deflator: FRED, US gross domestic product price deflator, base 1982.

Gross state product (in constant 1982 prices): BEA, total gross state product.

Total state revenue: *CENSUS,* Total revenue from own sources

Capital outlays: CENSUS, direct state expenditure for purchase or construction, by contract or force buildings and other improvements: for purchase of land, equipment structures; and for payments of capital leases. These series have been used as a proxy for the variable government investment.

Current expenditure: *CENSUS,* direct expenditure - capital outlays - subsidies. Direct expenditure compromises all expenditure other than intergovernmental expenditure.

Expenditures in salaries and wages: CENSUS, Total state expenditure during fiscal year for salaries and wages for all further activities, including the general government, liquor stores utility expenditure. Salaries and wages consists of gross amounts paid for compensation of government officers and employees.

Government employment: CENSUS, Public Employment and Payroll data - historical series on total state and local government employment.

Government consumption: CENSUS, We constructed these series by subtracting payments in salaries and wages from current expenditure.

State debt: *CENSUS,* Total debt outstanding at the beginning of the fiscal year. It includes both guaranteed and non-guaranteed debt, to capture possible substitution effects induced by debt limits.

State employment: We have used two alternative series for this variable, (a) BLS, total full and part time state employment, and (b) BLS, state wage and salary employment and (c) CENSUS, total employment series from statistics of U.S. Businesses (1988-2001). In the estimations presented we use series (a).

Average wage per job (in constant 1982 prices): BLS, These series include state level series on average wage per job. We have used this variable as a proxy for the real wage per state in our estimations. To calculate state real wages we have used the aggregate US price deflator. However, in a separate exercise we have used state prices data from Del Negro (1998), that run from 1969 to 1995 to deflate wages. Our results concerning the superiority of the NK transmission are independent of the way we deflate state wages.

The data for the US aggregates for interest rates and prices come from Federal Reserve Bank of St. Louis, while the rest of the data on expenditures, deficits and debt come from the CENSUS.

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