

THE EFFECTS OF FISCAL SHOCKS ON EMPLOYMENT AND THE REAL WAGE*

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We study the transmission of fiscal shocks in the labor market. We employ a structural VAR and base identification on the restrictions that shocks to government consumption, investment, and employment must raise output and deficits. These restrictions hold in both prototype Real Business Cycle (RBC) and New Keynesian models. Shocks to government consumption and investment increase real wages and employment contemporaneously, both at state level and in the aggregate. The dynamics in response to employment shocks are mixed: Increases in government employment raise the real wage and total employment in the aggregate. However, in one third of the states they reduce total employment.

1. INTRODUCTION

Economists have accumulated considerable knowledge on the sources of cyclical fluctuations. Yet, 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 Cycle (RBC) models predict that increases in government consumption crowd out the private sector and reduce the real wage. The induced wealth effect makes labor supply and output increase and consumption and the real wage fall. However, as 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 (bonds 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

* Manuscript received December 2005; revised October 2006.

¹ I would like to thank two anonymous referees, Frank Schorfeide (the editor), Arpad Abraham, Roel Beetsma, Fabio Canova, Juan Carlos Conesa, Stephanie Schmitt-Grohe, Martin Uribe, and participants of the Macroeconomic Seminar at the University of Amsterdam, Duke University, and the Bank of England for useful comments and suggestions. I would also like to thank the Spanish Ministry of Education and Science and FEDER through grant SEC2003-306 from the Generalitat de Catalunya through the Barcelona Economics program (CREA) and grant SGR2005-00447 for financial support. Please address correspondence to: Evi Pappa, UAB and CEPR - Universitat Autònoma de Barcelona, Departament d' Economia y d'Historia Econòmica, Edifici B - Campus de UAB, 08193, Bellaterra, Barcelona, Spain. E-mail: evi.pappa@uab.es.

hand, typically predict that an increase in government expenditure will increase labor demand, generating an increase in the real wage and output.²

Empirically, there exists little consensus on the size of the output multipliers, on the magnitude of the crowding-out (or crowding-in) of government expenditure shocks, and, in general, on the sign of private sector responses to these shocks. In fact, fiscal shocks obtained with different identifying restrictions yield sharply different outcomes. Perotti (2007) critically reviews this literature. The “Dummy Variable” approach, which considers fiscal shocks as episodes of significant exogenous and unforeseen increases in government spending, delivers results that are generally consistent with the RBC model. For example, Rotemberg and Woodford (1992), Ramey and Shapiro (1998), Edelberg et al. (1999), Burnside et al. (2004), and Cavallo (2005) found that increases in government spending for national defense reduce private consumption and the real wage and increase employment and nonresidential investments. Blanchard and Perotti (2002) and Perotti (2004), on the other hand, using quarterly data, identify fiscal shocks by imposing the restriction that government spending does not contemporaneously affect output in a structural VAR and find that private consumption, output, and the real wage positively comove with the spending shock, giving evidence in favor of the Keynesian paradigm.

Historical evidence does not help to sort out the various alternatives. The early 1960s seemed to provide support for Keynesian-style 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 1970s could not remedy the negative effects produced by oil shocks.

This article sheds some light on the dynamics of transmission of government expenditure shocks by concentrating on the reaction of labor markets. We use a structural VAR and identify fiscal shocks via sign restrictions. Sign restrictions have been recently used to identify fiscal shocks by Mountford and Uhlig (2002) and Canova and Pappa (2007). The methodology has a number of advantages over the existing approaches: It is theory based, it can be applied to data with any frequency, and it circumvents the problem of endogeneity and predictability of fiscal variables.

Our identification scheme is based on the idea that fiscal shocks raise output and the deficit. To formalize this idea we examine the responses of macrovariables to government consumption, government investment, and government employment disturbances in a prototypical RBC and a New Keynesian model and show that both models predict that a shock to the various components of government spending indeed increases output and the deficit on impact. To identify fiscal shocks in the data, we restrict the contemporaneous response of output and the deficit to positively comove with the fiscal disturbance. Once shocks are identified, we examine the dynamics of labor market variables.

² The response of private consumption is mainly determined by the negative wealth effect induced by increases in government spending (see, e.g., Linnemann and Schaubert, 2003); to generate an increase in private consumption one of two features need to be present: “rule-of-thumb” consumers, as in Gali et al. (2007) or complementarities between private and government consumption, as in Bouakez and Rebei (2007).

We use both U.S. aggregate and U.S. state data. Besides having a larger set of experiments over which to generalize our conclusions, the use of U.S. state data has two additional advantages. First, monetary policy can be taken as given in the analysis. This assumption is problematic when aggregate data are 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 are 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 monetary unions.

Increases in government consumption and/or investment contemporaneously increase real wages and employment, both in the aggregate and in a “typical” U.S. state. Furthermore, in about 90% of the states, shocks of this type increase both real wages and employment and in two-thirds of the cases significantly so. The data are less clear regarding the dynamics following government employment shocks. An increase in government employment increases the real wage and total employment contemporaneously. However, in about one third of the U.S. states, total employment responses are negative contemporaneously.

The rest of the article is organized as follows. The next section describes the methodology for extracting fiscal shocks. Section 3 presents the econometric framework. Results appear in Section 4, and Section 5 concludes. The Appendix contains a description of the data.

2. IDENTIFYING FISCAL SHOCKS: THE METHODOLOGY

In order to extract fiscal shocks from the data we use the methodology suggested by Canova (2002) and used in Dedola and Neri (2007). The exercise consists of five steps:

1. We study the effects of fiscal shocks in a model that encompasses a flexible price RBC and a New Keynesian sticky price setup (henceforth NK) as special cases.
2. We search for robust implications characterizing the dynamics induced by fiscal shocks in both models. In particular, we focus on the sign of the responses of the macrovariables after a fiscal disturbance in the impact period, as these are independent of parameterization and common to both models.
3. We use a subset of the restrictions common to the two models to disentangle fiscal disturbances in the data.
4. We establish that the restrictions used to identify fiscal shocks cannot be produced by other shocks.
5. We study the empirical effects of fiscal shocks on employment and the real wage.

2.1. *The Model.* Following Finn (1998), we distinguish between government expenditure for consumption and investment and also consider government

employment. There are five agents in the economy: a representative household, a final good firm, a continuum of monopolistically competitive intermediate good firms, and a monetary and a fiscal authority.

2.1.1. Households. Households derive utility from private consumption, C_t^p , public consumption, C_t^g , and leisure, $1 - N_t$. Their preferences are defined by

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

where $0 < \phi, \omega < 1$, and $\sigma > 0$ are preference parameters, $0 < \beta < 1$ is the subjective discount factor, and λ_{nt} is a labor supply shock.

Public consumption is regarded as exogenous. 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. Available time is normalized to unity each period. Households have access to a complete set of nominal state-contingent claims and maximize their objective function subject to an intertemporal budget constraint that is given by

$$(2) \quad P_t((1 + \tau^c)C_t^p + I_t^p) + B_{t+1}R_t^{-1} \leq (1 - \tau^l)P_t w_t N_t + [r_t - \tau^k(r_t - \delta^p)]P_t K_t^p \\ + D_t + B_t - T_t P_t + \Xi_t.$$

Current income consists of after tax nominal labor income, $(1 - \tau^l)P_t w_t N_t$; after tax nominal capital income (allowing for depreciation), $[r_t - \tau^k(r_t - \delta^p)]P_t K_t^p$; the net cash inflow from participating in state contingent securities at time t , denoted by D_t ; the dividends derived from the imperfect competitive intermediate good firms Ξ_t , minus nominal lump-sum taxes, $T_t P_t$. Households hold their financial wealth in terms of government bonds, B_t . Total income can be used for private consumption C_t^p , which is subject to a tax τ^c and investment I_t^p . Private capital accumulates according to

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

where δ^p is a constant depreciation rate and $\xi \left(\frac{K_{t+1}^p}{K_t^p} \right) = \frac{b}{2} \left[\frac{K_{t+1}^p - (1 - \delta^p)K_t^p}{K_t^p} - \delta^p \right]^2$, where b determines the size of the adjustment costs. Since households own and supply capital to the firms, they bear the adjustment costs.

2.1.2. Production

2.1.2.1. *Final good firm.* In the production sector, a competitive firm aggregates intermediate goods into a final good using the following constant-returns-to-scale technology:

$$(4) \quad Y_t = \left[\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where $\varepsilon > 1$ is the constant elasticity of demand for intermediate goods. The final good can be used for private and government consumption and investment.

2.1.2.2. *Intermediate firms.* There is a continuum of intermediate good firms in the (0,1) interval. Each intermediate firm j produces output according to

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

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 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.³ 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 $\frac{K_t^p}{N_t^p} = \frac{\alpha}{(1-\alpha)} \frac{w_t}{r_t}$. The common (nominal) marginal costs are $MC_t = \frac{1}{\Upsilon} Z_t^{\alpha-1} K_t^{g(-\mu)} N_t^{g(-\nu)} w_t^{1-\alpha} r_t^\alpha P_t$, where $\Upsilon = \alpha^\alpha (1-\alpha)^{1-\alpha}$.

In the intermediate goods market firms are monopolistic competitors. The strategy firms use to set prices depends on whether prices are flexible or sticky. In the latter case we use the standard Calvo (1983) setting and denote by $(1-\gamma)$ the probability for an intermediate good producer to reset her price. When a producer receives a signal to change her price, she chooses her new price, P_t^* , to maximize

$$(6) \quad \max_{P_t^*} E_t \sum_{k=0}^{\infty} (\beta\gamma)^k q_{t+k} (P_t^* - MC_{t+k}) Y_{t+k}(j)$$

subject to the demand curve for type j good $Y_{t+k}(j) = (\frac{P_t^*}{P_{t+k}})^{-\varepsilon} Y_{t+k}$, where q_t is the marginal value of a currency unit to the household, which is treated as exogenous by the firm.

³ 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.

The solution to the profit-maximizing problem gives the optimal pricing rule:

$$(7) \quad P_t^* = \frac{\varepsilon}{\varepsilon - 1} \frac{E_t \sum_{k=0}^{\infty} (\beta\gamma)^k q_{t+k} MC_{t+k} Y_{t+k}^d(j)}{E_t \sum_{k=0}^{\infty} (\beta\gamma)^k q_{t+k} Y_{t+k}^d(j)}$$

and the aggregate price index evolves according to $P_t = [\gamma P_{t-1}^{1-\varepsilon} + (1 - \gamma) P_t^{*1-\varepsilon}]^{\frac{1}{1-\varepsilon}}$.

For the flexible-RBC version of the model, the fraction of firms that can reset their price at each t is equal to one and prices are set as a constant markup over marginal costs.⁴

2.1.3. Fiscal policy. Government's income consists of tax revenues 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

$$(8) \quad P_t(C_t^g + I_t^g + w_t N_t^g) - \tau^c P_t C_t^p - \tau^l w_t P_t N_t - \tau^k(r_t - \delta^p) P_t K_t^p - P_t T_t + B_t = R_t^{-1} B_{t+1},$$

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

$$(9) \quad K_{t+1}^g = I_t^g + (1 - \delta^g) K_t^g - \xi \left(\frac{K_{t+1}^g}{K_t^g} \right) K_t^g,$$

where δ^g is a constant depreciation rate and $\xi(\cdot)$, which controls adjustment costs to public capital, is the same as in the private sector.

We treat the tax rates on labor and capital income and on consumption parametrically. Although at the federal level distortionary tax rates are time varying, at the state level they are relatively flat for the sample we consider.⁵ 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.

The government can use each of the expenditure components to react to changes in output growth. In particular, if $\Psi^g = C^g, I^g, N^g$ denotes the different expenditure components, we assume fiscal rules of the form

$$(10) \quad \Psi_t^g = \bar{\Psi}^g \Psi_{t-1}^{g\varrho_g^\psi} \exp(\varrho_g^y \Delta y_t + u_t^{\psi^g}) \quad \text{where } \Psi^g = C^g, I^g, N^g,$$

where Δy_t is output growth and $u_t^{\psi^g}$ is a zero-mean, white noise disturbance.

⁴ Usually a subsidy $\tau^e = -(\varepsilon - 1)^{-1}$ that neutralizes the monopolistic competitive distortion is assumed. We do not use this assumption for two reasons. First, it 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. Second, such a subsidy would predict strong procyclicality in deficits, which is inconsistent with the empirical evidence.

⁵ We calculate average labor and capital tax rates at state level following McGattan (1994) and Jones (2002). Details of the calculation are included in the Data Appendix.

In order to ensure determinacy of equilibrium and a nonexplosive solution for debt (see, e.g., Leeper, 1991), we assume a debt targeting rule of the form

$$(11) \quad T_t = \bar{T} \exp(\zeta_b(b_t - \bar{b})),$$

where $\bar{b}$ is the steady state level of $b_t = \frac{B_t}{Y_t}$.

Since our empirical analysis examines data where, implicitly, or explicitly, fiscal rules require balanced budgets, a few words justifying our modeling choice are in order. First, Equation (11) is consistent with the evidence that the United States debt to GDP ratio is mean reverting and that U.S. fiscal policy satisfies an intertemporal budget constraint (see, e.g., Bohn, 1998). Second, balanced budget rules apply only to the general budget and exclude a number of important items. Third, although some states are required to hold zero guaranteed debt (either in the short run, or in the long run, or in both), the practice of issuing nonguaranteed debt is generalized. These last two observations imply that creative budget accounting practices are widespread (see, e.g., Canova and Pappa, 2006). Fourth, the rule in (11) implies that deficit in equilibrium is small in size and has low volatility. Finally, and perhaps more importantly, the predictions we derive do not depend on the exact fiscal rule we assume.⁶

2.1.4. Monetary policy. There is an independent monetary authority that sets the nominal interest rate as a function of current inflation, according to the rule

$$(12) \quad R_t = \bar{R} \exp(\zeta_\pi \pi_t + \epsilon_t^R),$$

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

2.1.5. Closing the model. There are two types of aggregate constraints: Labor supply must equate labor employed by the private and the public sectors:

$$(13) \quad N_t = N_t^p + N_t^g.$$

Aggregate production must equal private and public demand:

$$(14) \quad Y_t = C_t^p + I_t^p + C_t^g + I_t^g.$$

The model features six exogenous disturbances. The shocks to the fiscal rules for each government component described in (10), a productivity, a labor supply, and a monetary policy shock. The vector of the nonfiscal shocks, $S_t = [Z_t, \lambda_{nt}, \epsilon_t^R]'$, is parameterized as

$$(15) \quad \log(S_t) = (I - \varrho) \log(\bar{S}) + \varrho \log(S_{t-1}) + V_t,$$

⁶ For example, following Schmitt-Grohe and Uribe (2007) an earlier version of the article had abstracted from debt. The sign restrictions we emphasize below are robust to this change.

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

We solve both models by approximating the equilibrium conditions around a nonstochastic steady state in which all prices are flexible and inflation is zero.

2.1.6. An alternative setup: a two-sector model. The model we have described features a single final good and productive government inputs. Since this specification may seem restrictive, in this subsection we show that it provides a good approximation of a more general two-sector setup, in which one sector produces private goods and the other produces public goods.

The household's optimization problem is unchanged, except that, now, households derive also utility from a public good, Y_t^g . The functional form of the household's utility is

$$(16) \quad u(C_t^p, Y_t^g, C_t^g, N_t) = \frac{\left[\left\{ \omega(C_t^p + \chi Y_t^g)^{\frac{\eta-1}{\eta}} + (1-\omega)C_t^g{}^{\frac{\eta-1}{\eta}} \right\}^{\frac{\phi\eta}{\eta-1}} (1-N_t)^{1-\phi} \right]^{1-\sigma}}{1-\sigma}.$$

The public good, Y_t^g , is produced with government employment and capital:

$$(17) \quad Y_t^g = (Z_t N_t^g)^{1-\zeta} K_t^{g\zeta}, \quad 0 < \zeta < 1.$$

The law of motion for the public capital stock is given by (9) and the price of the public good is flexible and determined by its demand.

The pricing problem of monopolistic competitive firms is unchanged, but their production function differs. Each firm, j , produces private output, $Y_t^p(j)$ according to

$$(18) \quad Y_t^p(j) = (Z_t N_t^p(j))^{1-\alpha} K_t^p(j)^\alpha, \quad 0 < \alpha < 1.$$

The final good firm aggregates intermediate goods and sells the final product to the households and the government: $Y_t^p = C_t^p + I_t^p + G_t$. Government purchases, G_t , are used for government consumption, C_t^g , and for government investment, I_t^g . That is, $G_t = I_t^g + C_t^g$. The government budget constraint is identical to (8), except that now the government generates also revenues from the sale of the public good $P_t^g Y_t^g$.

Total output, Y_t , is given by $Y_t = Y_t^p + q_t^g Y_t^g$, where $q_t^g = \frac{P_t^g}{P_t}$, is the relative price of the public good.

Notice that the two-sector model differs from its one-sector counterpart in the production structure and in the utility specification for the public good. To show that the two setups deliver similar results, we show, first, that the determination

of total output is similar in the two models. In particular, log-linearizing (5) yields

$$(19) \quad y_t = (1 - \alpha)z_t + (1 - \alpha)n_t^p + \alpha k_t^p + \mu k_t^g + v n_t^g,$$

whereas, log-linearizing the equation for total output in the two-sector model and combining it with (18) and (17) produces

$$(20) \quad y_t = [s_{y_p}(1 - \alpha) + s_{y_g}(1 - \zeta)]z_t + s_{y_p}(1 - \alpha)n_t^p + s_{y_p}\alpha k_t^p + s_{y_g}\zeta k_t^g + s_{y_g}(1 - \zeta)n_t^g,$$

where $s_{y_g} = (1 + \tau_c)\chi \frac{Y^g}{Y}$ and $s_{y_p} = \frac{Y^p}{Y}$.⁷ Thus, as long as s_{y_g} is small and ζ and α are not too different, the two specifications will be observationally equivalent. The average share of government to total output between 1969 and 2001 is 0.185,⁸ whereas estimates for the average consumption tax rate in the United States vary between 5% and 10% (see, e.g., Mendoza et al., 1994; Carey and Rabesona, 2002). Thus, for low values of χ , s_{y_g} will be small. On the other hand, the share of government employment compensation to government output, $1 - \zeta$, is difficult to calibrate since in the *NIPA* tables government output is computed as compensation of employees plus depreciation and ignores any contribution of government capital. To select a value I use the steady state of the model. If the returns of private and public inputs are equal, then $\frac{\zeta}{1 - \zeta} = \frac{\alpha}{1 - \alpha} \frac{K^g}{K^p} \frac{N^p}{N^g}$. We set $\frac{K^g}{K^p} = 0.31$ using the table “Net Stock of Fixed Reproducible Tangible Wealth: 1925–2004,” in the *Survey of Current Business*, April 2006 and obtain $\frac{N^p}{N^g} = 4.78$ using Census data. Hence for values of α , in the range [0.2, 0.4], the range of values for ζ is [0.2, 0.5], which is indeed close to that of α . Thus, for plausible values of the parameters, (19) and (20) will be similar.

The utility specification we use in the two-sector economy can generate similar wealth effects on impact in response to government investment and employment shocks as in the one-sector model as long as $\chi > 0$. This is necessary to match the dynamics of the one-sector set-up in response to these shocks, since output in the two-sector economy is independent of the level of government capital and labor.

Given the similarities in the production and preference structures, Table 2 below shows that for a variety of choices of χ , ζ , and s_{y_g} the restrictions on output, the deficit and the spending component we emphasize hold in both versions of the model.

2.2. Robust Restrictions. This step of our procedure is designed to tackle the intrinsic uncertainty implicit in calibration procedures. An implication is called robust if it holds independently of parameterization and of the functional forms for

⁷ The FOC for private consumption and for the public good imply that the relative price of the latter is constant and equal to $q_t^g = \chi (1 + \tau_c)$. Hence, q_t^g does not show up in (20).

⁸ This ratio is calculated using *NIPA* tables 3.1 and 3.10.5, as the value added of government consumption goods over total output, where total output is defined as GDP plus production subsidies and minus taxes on production and imports.

the primitives used. Robustness is not generic since many dynamic properties are sensitive to the exact parameterization employed and to specific features added, or subtracted to the model. What we are looking for here is to establish that the restrictions on output, deficit, and the spending component are representative for both RBC and NK models and, thus, can be used for the identification of fiscal shocks.

Formally speaking, let $h(y_t(\theta \mid x_t))$ be a $J \times 1$ vector of functions of the data y_t produced by the model, when the $N \times 1$ vector of structural parameters θ is employed, conditional on the shock x_t . We let θ be uniformly distributed over Θ , where $\Theta = \prod_i \Theta_i$ is the set of admissible parameter values and Θ_i is an interval for each parameter i . We draw $\theta_i^l, i = 1, \dots, N$ from each Θ_i , construct $h(y_t(\theta^l \mid x_t))$ for each draw $l = 1, \dots, 10,000$ and order them increasingly. Then $h_j(y_t(\theta \mid x_t)), j = 1, \dots, J$ is robust if $\text{sgn}[(h_j^U(y_t(\theta \mid x_t)))] = \text{sgn}[h_j^L(y_t(\theta \mid x_t))]$, where h^U and h^L are the 84 and 16 percentiles of the simulated distribution of $h(y_t(\theta \mid x_t))$.

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

2.2.1. Parameter ranges. The model period is one year. We let $\theta = (\theta_1, \theta_2)$, where θ_1 represents the parameters that are fixed to a particular value, either to avoid indeterminacies or because of steady state considerations, whereas θ_2 are the parameters that are allowed to vary. In the first set of parameters we have the discount factor, which is set so that the annual real interest rate equals 4%, and the debt to output ratio, $\bar{b} = 0.3$, which is selected to match the time average in aggregate data. Table 1 gives the ranges for the parameters in θ_2 .

The intervals for most parameters are centered around calibrated values and include values that have been either estimated in the literature or assumed in calibration exercises. Although the intervals for the majority of parameters should be uncontroversial, the selection of some ranges needs to be discussed. The share of public goods in total consumption, $1 - \omega$, 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. For that reason we limit ω to the $[0.9, 1]$ interval.

The parameter μ controls the interactions between public and private goods in production. Aschauer (1989) estimates the elasticity of output with respect to public capital to be in a range from 0.39 to 0.56. More recent studies, however, suggest lower values for μ (see, e.g., Garcia-Mila and McGuire, 1992). The range we choose includes both the case of unproductive government capital and most of the estimates for the elasticity of output to changes in public capital in the literature. Also, the productivity of government employment, ν is restricted to the interval $[0, 0.25]$. We allow for productive government employment for two reasons. First, at the state and local level more than half of the compensation of government employees is on education and the rest is mostly associated with general public service, public order and safety, and transportation. Second, setting $\nu = 0$ implies that the dynamic responses to a government employment shock are

TABLE 1
PARAMETER RANGES

σ	Risk aversion coefficient	[0.5,6]
$1 - \omega$	Share of public goods in consumption	[0.0,0.1]
η	Elasticity of substitution public/private goods	[-0.5,2.5]
ϕ	Preference parameter	[0.1,0.9]
b	Adjustment cost parameter	[1,15]
δ^P	Private capital depreciation rate	[0.05,0.1]
δ^g	Public capital depreciation rate	[0.02,0.1]
μ	Productivity of public capital	[0.0,40]
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	[0,0.3]
τ^c	Average consumption tax	[0.05,0.1]
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	[0.05,0.25]
ζ_π	Taylor's coefficient	[0.2,5]
ζ_b	Coefficient on debt rule	[0.1,5]
γ	Degree of price stickiness	[0.25,0.75]
$\frac{\varepsilon}{\varepsilon-1}$	Steady state markup	[1.09, 1.16]
$\varrho_g^{\psi y}, \psi = c, i, n$	Output growth coefficient of fiscal rule	[-0.1,0.1]
$\varrho_g^{\psi}, \psi = c, i, n$	Persistence of fiscal shock	[0.0,0.95]
ϱ	Persistence of nonfiscal shocks	[0.0,0.95]
<i>two-sector model (additional parameters)</i>		
χ	Utility of public good	[0.2,0.8]
Y^g/Y	Government to private output ratio	[0.17,0.22]
ζ	Government capital share	[0.1,0.5]

comparable to those obtained in the case of a natural disaster and our data are unlikely to contain information about such events. Finally, the parameter ranges for the steady state values of the fiscal variables are chosen to match the average values of their data counterparts in the cross-section of U.S. states. In the two-sector setup we set the parameter ranges for χ in the [0.2,0.8] interval, which includes estimates of this parameter for the United States (see, e.g., Aschauer, 1985). The range of values for Y^g/Y is centered around the mean of this variable in the data, and the range of values for ζ reflects previous calculations.

2.2.2. Dynamics. Figure 1 plots pointwise 68% probability bands for the responses of output, the deficit, total employment, and the real wage to a 1% increase in government consumption (first column), government investment (second column), and government employment (last column) when parameters are allowed to vary over the ranges reported in Table 1. The solid lines represent response bands obtained in the RBC version of the model; dotted lines represent response bands of the sticky price version of the model.⁹

⁹ The responses bands obtained in the two-sector model are similar (except those of total employment to a government employment shock) and are available on request.

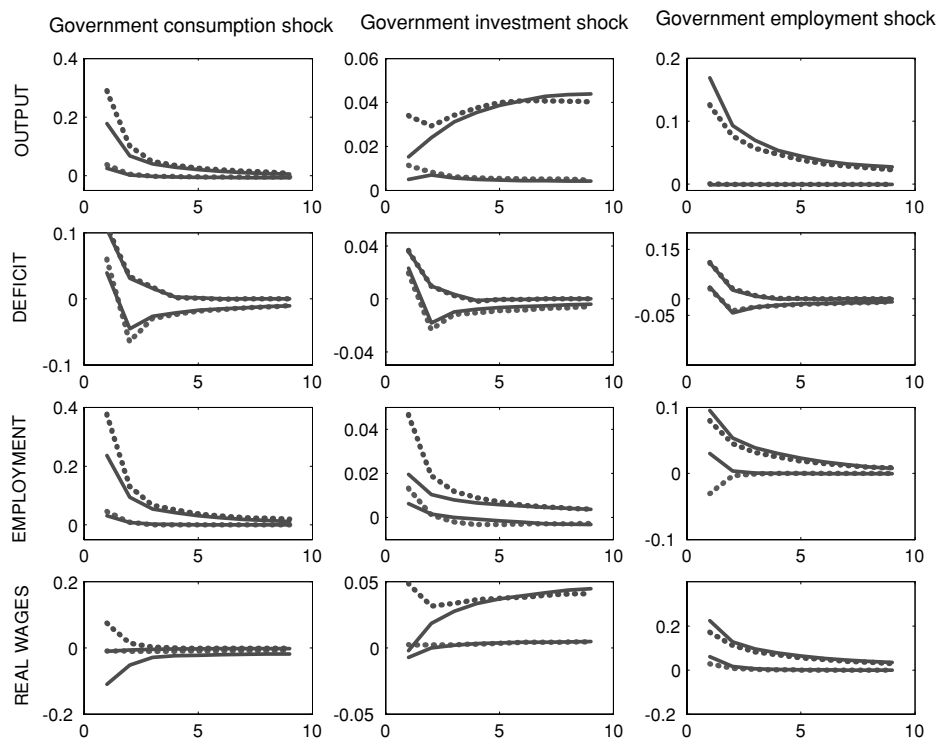


FIGURE 1

RESPONSES TO FISCAL SHOCKS, SOLID RBC, DOTTED NK

All the fiscal shocks we consider increase output and deficits contemporaneously in both models, whereas the responses of real wages and employment differ depending on whether prices are flexible or not.

In particular, a positive government consumption shock, financed by a deficit increase, increases labor supply contemporaneously due to a negative wealth effect: Households feel poorer because the fiscal expansion lowers their income. Since leisure is a normal good, labor supply rises. In turn, given the unchanged labor demand, this increase induces a decline in real wages and an expansion of output in the flexible price model. This pattern of employment and real wage responses implies a movement of the labor supply curve along a given labor demand curve. On the other hand, in the sticky price model output is mainly demand determined and the increase in government spending increases labor demand and output. A negative wealth effect that shifts the labor supply curve to the right is present also in this case. However, the demand effect is, in general, stronger and the increase in labor demand pushes real wages up.¹⁰ Hence government consumption shocks

¹⁰ 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

in the NK model imply movements of the labor demand along an (almost) fixed labor supply curve.

The contemporaneous responses induced by government investment shocks are qualitatively similar to the ones produced by a government consumption shock for both models, 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. When μ is very high, the positive effect dominates. The second column of Figure 1 shows that the contractionary effect dominates in the impact period in the RBC model but as time goes by the expansionary effect comes into play. In the NK model, the two wealth effects present in the RBC model 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, real wages, and employment, whereas in subsequent periods the positive effect induced by the larger stock of public capital leads to persistent increases in output and real wages.

Notice that here it is only the contemporaneous response of the real wage that differentiates the two theories, since 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 in consecutive periods also in the RBC model.

Finally, an increase in government employment also has a negative effect on private wealth, since it expands the government's usage of private resources. This negative wealth effect tends to increase labor supply. However, whereas total employment increases, there is a sectoral reallocation involving a shift of labor out of the private sector and into the government sector. Also, 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 generally increases in the impact period of the shock when prices are flexible.

The mechanics of transmission of shocks to government employment are similar in the NK model. Increases in government employment increase output and real wages, 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 input 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.

increase on impact. There are two reasons for the difference between their results and ours: we use a more general specification for preferences and an interest rate instead of a passive money rule.

TABLE 2
IDENTIFYING RESTRICTIONS

Shock/Variables	Y_t	DF_t	C_t^g	N_t^g	I_t^g	Probability of False Restriction (%)			
						RBC-1s	NK-1s	RBC-2s	NK-2s
$u_t^{C^g}$	>0	>0	>0	–	–	9.8	10.2	0.0	0.7
$u_t^{I^g}$	>0	>0	–	–	>0	2.3	2.8	0.0	0.6
$u_t^{N^g}$	>0	>0	–	>0	–	16.4	15.2	35.3	26.4

The higher is the productivity of public employment, ν , and/or the degree of price stickiness, 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. Hence, the predictions of the NK model for the labor market are tenuous and depend both on the specific assumptions for the structure of the economy and for price stickiness.

In Table 2 we report the probability that at least one of the two sign restrictions we will use to identify shocks is violated. Apart from the government employment shock in the two-sector specifications, the probabilities we report in Table 2 are low.

The reason for why the restrictions implied by government employment shock in the two-sector models are not very robust is simple. Since increases in government employment decrease private output and increase the production of public goods, if the relative price of public goods (or the share of public to private goods) is low increases in government employment might reduce total output. Alternatively, if the relative price of public goods (or the share of public goods to private output) is high, increases in government employment might increase total output, but they may increase government revenues inducing a fall in the deficit. The values of χ that determine the demand for public goods and, hence, their relative price and the share of public to private output, Y^g/Y , are crucial for determining which effect dominates.

To conclude, the responses of output and the deficit to fiscal shocks are qualitatively similar in the RBC and the NK versions of the one- and two-sector models. Hence, we will use sign restrictions on the contemporaneous effect of government spending shocks on output and deficits to identify the fiscal disturbances and then trace out their effects on labor market variables.

2.3. Other Disturbances. To make sure that the identifying restrictions used to extract fiscal shocks cannot be obtained for other shocks that might produce employment fluctuations, we present the dynamics induced by technology, labor supply, and monetary shocks on output, deficits, and the components of government expenditure. Figure 2 plots pointwise 68% probability bands obtained in the RBC (solid line) and the NK (dotted line) versions of the one-sector model; the responses for the two-sector model are similar.

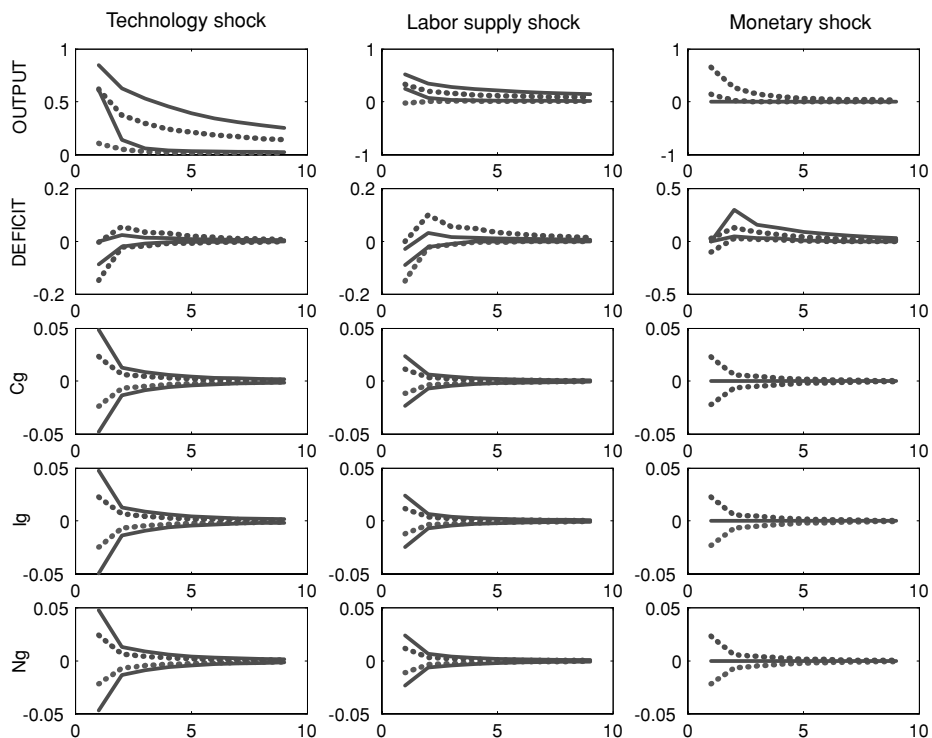


FIGURE 2

RESPONSES TO TECHNOLOGY, LABOR SUPPLY, AND MONETARY SHOCKS, SOLID RBC, DOTTED NK

The effects of technology shocks are in the first column, of labor supply shocks in the second column, and of monetary shocks in the last column of the figure. For all shocks and in both versions of the model the responses of the deficit are key for distinguishing fiscal disturbances from other shocks: Fiscal shocks increase deficits; the other shocks typically decrease them at least on impact.¹¹ This implication is in line with the evidence of Sorensen et al. (2001) on the procyclicality of surpluses in U.S. states.

3. THE ECONOMETRIC FRAMEWORK

3.1. The Data. We use annual aggregate and state data for the United States 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

¹¹ An important assumption to obtain the countercyclicality of deficits in response to technology shocks in the NK model is the tax on consumption. Without this tax and given the sluggishness in the movements of capital, increases in technology might contemporaneously decrease hours in the NK model for some parameterizations and, hence, income tax revenues, increasing deficits after a technological improvement.

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 use U.S. state data for several reasons. First, U.S. 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 are hard to get for a large number of countries and often are of uneven quality. Second, since with state data we can take 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.

3.2. The Reduced Form Model. For aggregate data our reduced form model includes eight variables and a constant: The log of real per capita GDP, the log of real per capita government expenditure in either (a) goods purchases, (b) capital outlays, or (c) government employment, the log of real per-capita tax revenues, the log of average real wage per job, the log of total employment, the Federal Funds rate, the log of U.S. debt to GDP ratio and oil prices. For state data we employ five endogenous variables: GSP, state government expenditure, revenues, real wages and employment series, whereas we treat the Federal Funds rate, per capita real U.S. GDP, per capita real U.S. deficit, and the level of oil prices as exogenous. In both models oil prices and the nominal interest rate are used to capture aggregate supply and demand effects, respectively. For state level models, per capita U.S. GDP and aggregate fiscal variables are included to control for aggregate demand driven effects that are common to all units.

We treat each unit 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 state systems.¹²

3.3. Identifying the Shocks. To identify the shocks in the data, we employ the sign restrictions reported in Table 2. As shown in Figures 1 and 2 the short run

¹² 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 an endogenous variable, a model where wages are deflated with regional instead of U.S. 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.

dynamics of output and the deficit are typically sensitive to parameter choices. For that reason, we present results obtained restricting only the impact period of the shock.

Let Σ be the covariance matrix of the VAR shocks and let $PP' = \Sigma$ be an orthogonal decomposition of Σ , where, for example, $P = Q\Lambda^{1/2}$, Q is the matrix of eigenvectors and Λ is the matrix of eigenvalues. Then structural shocks ε_t are constructed as $\varepsilon_t = P^{-1}u_t$, where u_t are reduced form shocks and for each element of ε_t , we check if the required restrictions are satisfied. If no structural shock that produces the required comovements in the variables is found, the eigenvalue-eigenvector decomposition is rotated by an orthonormal matrix $H(\lambda)$, with $H(\lambda)H(\lambda)' = I$, where λ measures the angle of rotation, and the comovements in response to the new set of shocks is examined. This search process continues, randomly varying λ in the range $(0, \pi)$ and randomly rotating the columns of $H(\lambda)$. Since many $H(\lambda)$'s can in principle produce the required pattern, the error bands we report reflect not only the uncertainty in Σ and the reduced form parameter estimates but also how responses vary with different λ s and H s.

Besides making the link between the model and the data tighter, the use of robust sign restrictions avoids, in principle, typical problems associated with the identification of economically meaningful fiscal shocks. In particular, problems concerning the endogeneity of fiscal variables, the delays between planning, approval, and implementation of fiscal policies, and the scarceness of reasonable zero-identifying restrictions emphasized, e.g., in Mountford and Uhlig (2002), Canova and Pappa (2007), 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. Moreover, sign restrictions resolve the problem of predictability of fiscal shocks since identification does not rely on delay restrictions.

3.4. Combining Cross-sectional Information. With U.S. state data we construct two measures of transmission of fiscal shocks to labor markets: one that captures the response in a “typical” U.S. state, and one that captures responses in individual states. In general, these measures are obtained using OLS on pooled or individual state data. However, when dynamic heterogeneity is present and the data are short, neither of the two choices is appealing. For this reason, the measures we present allow for stochastic pooling. That is, we specify a hierarchical model where state impulse responses are assumed to be random variables with some mean and some variance, the latter representing the a priori dispersion of impulse responses across states. Furthermore, the mean impulse response at each step is assumed to be a random variable with some distribution.

Let $VAR(p)$ for each unit $i = 1, \dots, N$ be written in a companion form $Z_{it} = A_i Z_{it-1} + B_i W_t + U_{it}$, where W_t includes all exogenous variables, Z_t is a $mp \times 1$ vector containing, stacked, the p lags of each of the variables of the model, A_i

is $mp \times mp$ and $U_{it} \sim (0, \Sigma_i)$, and m is the number of variables held. Let the structural moving average (MA) representation for the system be

$$(21) \quad X_{it} \equiv Z_{it} - A_i' Z_{i0} - B_i \sum_{j=0}^{t-1} A_i^j W_{t-j} = \sum_{j=0}^{t-1} C_i^j E_{it-j},$$

where $C_i^j = A_i^j H_i(\lambda)$, $E_{it} = H_i(\lambda)' P_i U_{it}$, for some $H_i(\lambda)$ with $H_i(\lambda) H_i(\lambda)' = I$ and $P_i' P_i = \Sigma_i^{-1}$. Let α_i be a $m^2 p^2 (J+1) \times 1$ vector, each i containing, stacked, the coefficients C_i^j for horizons ranging from 0 to $J \leq t-1$. We assume that α_i are related across the i units according to the following unit invariant specification:

$$(22) \quad \alpha_i = \psi + v_i \quad v_i \sim N(0, \varpi),$$

where ψ represents the vector of (cross-sectional) average MA coefficients and ϖ its dispersion. Our interest is in producing estimators for a subset of the ψ , the average real wage and employment responses to the three types of fiscal shocks, and of a subset of the α_i , the unit specific labor market responses to the three fiscal shocks.

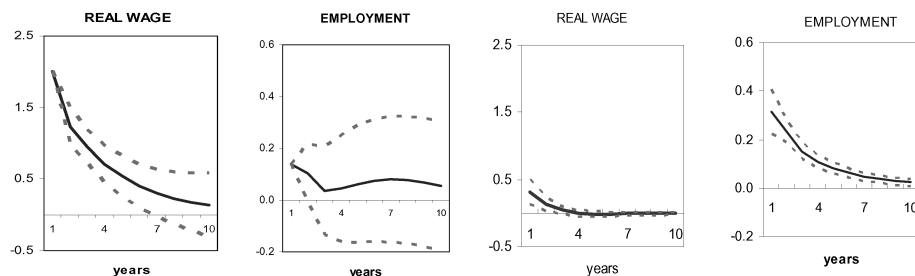
We assume that U_{it} are normally distributed and that Σ_{u_i} has an inverted Wishart distribution with scale S and ν degrees of freedom. Further, we let the prior mean of ψ and its standard deviation to be equal to the OLS estimates obtained for aggregate U.S. data and set $\varpi_j = \frac{0.2}{j}$, $j = 0, 1, \dots, J$.

With these assumptions, estimators of ψ and α_i have a particular form: The “typical” (mean) response is a weighted average of sample and prior information, whereas the individual response is a weighted average of unit specific and average information, with weights given by the precision of prior and sample information. Finally, since we use a relatively loose prior, sample information dominates.

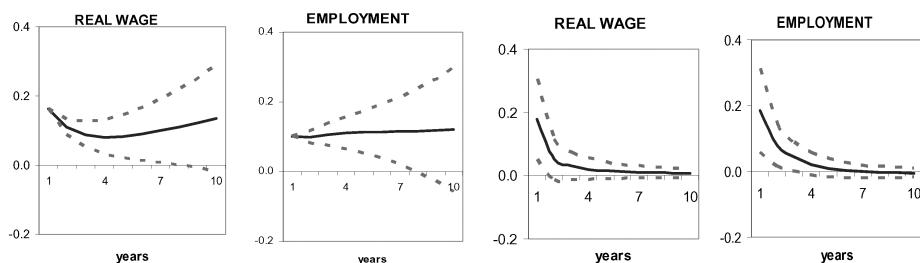
What are the advantages of this approach over more standard ones? First, structural responses obtained with individual data are likely to be imprecisely estimated because of the short sample. If the cross section provides useful information, stronger statements about the labor market effects of fiscal shocks 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, New Hampshire. By modeling, the cross section of experiments as repeated observations of the same underlying unknown phenomena (the responses of labor market variables 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 that potentially differ in their dynamic characteristics, it seems unwise to proceed in this fashion. Are there disadvantages? Since our responses collapse to standard ones when the cross section does not carry information, no disadvantages are present, as long as prior information is loosely specified.

Aggregate responses**Typical responses**

Government consumption shock



Government investment shock



Government employment shock

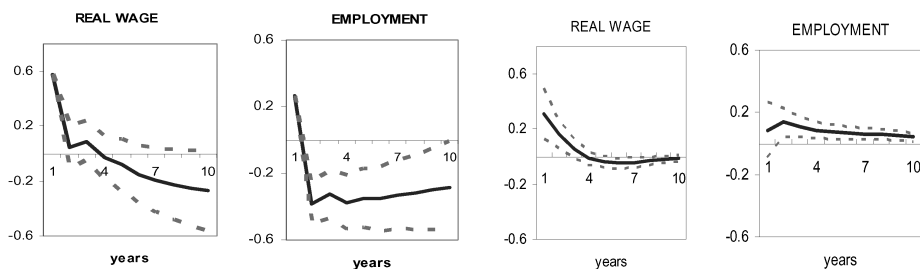


FIGURE 3

LABOR MARKET RESPONSES

4. THE EVIDENCE

4.1. 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 3. The first two panels refer to aggregate data and the last two to the “typical” U.S. state. 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 pointwise 68% probability bands (dotted lines).

With aggregate data, increases in government consumption, investment, and employment which increase output and deficits, increase real wages and

employment, at least contemporaneously. The contemporaneous response of real wages to consumption shocks is stronger than the one produced by the other two shocks. A 1% increase in government consumption pushes real wages up by 2% instantaneously; an employment disturbance increases them by 0.6%, whereas an investment shock increases them by only 0.15%. Furthermore, the initial jump in real wages takes longer to dissipate if government consumption shocks occur. The contemporaneous responses of employment to the three shocks are similar: The instantaneous effect of a 1% 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, whereas responses to employment shocks change sign after one period). Finally, standard aggregation problems become severe when the sample is short. To check the robustness of the results, we examine typical estimates of labor market responses obtained with U.S. state data.

Overall, the typical responses obtained with state data agree with those obtained with aggregate data. That is, the responses of real wages and employment to government consumption and investment shocks are both positive on impact. However, responses are less persistent than in the aggregate data. Also, the magnitude of the impact is slightly different. For example, a 1% increase in government consumption increases real wages in the median by only 0.30%. This pattern is consistent with output responses: In fact, although output responses are sizable on impact and very persistent in aggregate data, they are much smaller in size and die out much faster when typical state responses are considered.

The evidence for government employment shocks is mixed. Although the response of real wages is positive and significant on impact, the one of employment is insignificantly different from zero on impact and becomes significant 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 employment responses. 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%—and less persistent, suggesting that aggregation problems are quantitatively important.

In sum, movements in the aggregate demand curve appear to be of a larger magnitude than movements in the aggregate supply curve in response to government consumption and investment shocks. For government employment, the pattern is mixed. To corroborate this evidence we turn to examine responses of real wages and employment in individual U.S. states.

4.2. Individual Unit Responses. We summarize information concerning the impact effect of government expenditure shocks in state labor markets in the

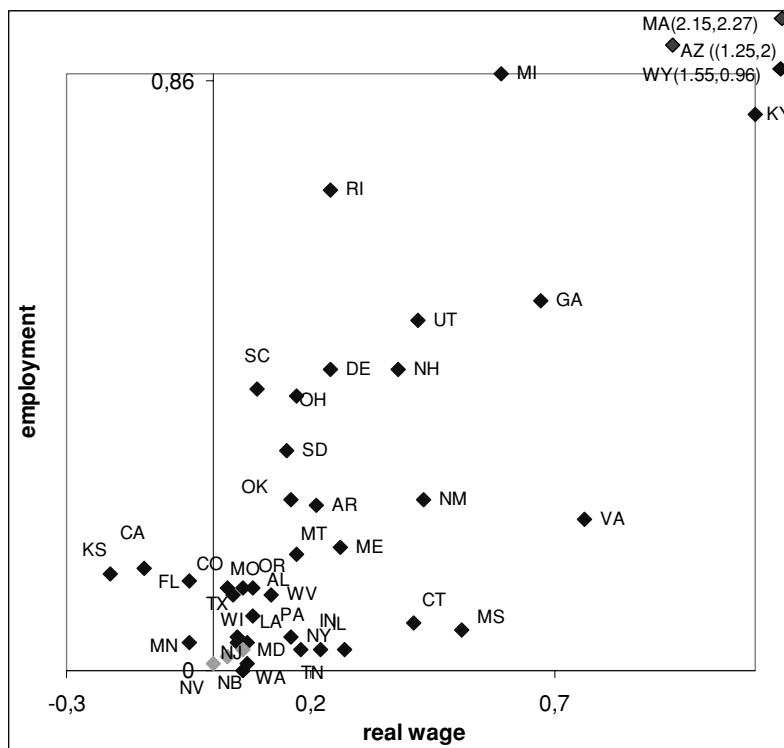


FIGURE 4

INSTANTANEOUS MULTIPLIERS TO GOVERNMENT CONSUMPTION SHOCKS, STATE DATA

following series of scatter plots, where we plot the median impact response of the real wage and employment for each state and each shock.

The identification of government expenditure shocks was quite successful, implying that the identification restrictions we used are quite meaningful. In fact, we were able to obtain C^g shocks in 43 states, I^g shocks in 40 states, and N^g shocks in 44 states. Moreover, at least one type of government expenditure shock was recovered for each state, whereas in 32 states we were able to obtain all types of shocks.

Overall, state data confirm previous results. Take for example, the responses to government consumption shocks, in Figure 4. 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. 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 small. 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 states both responses are significant. For the four states where real wages fall (California, Florida, Kansas, and Minnesota), the impact effect of government

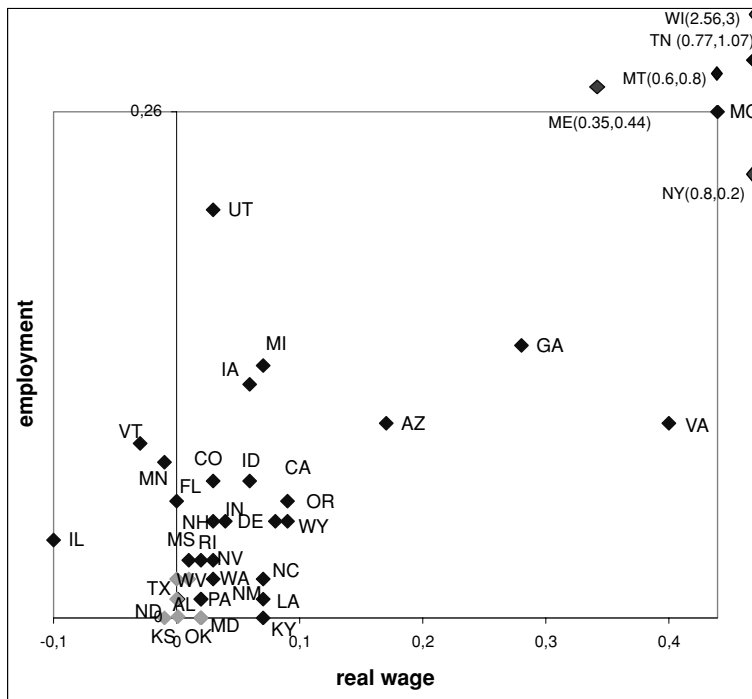


FIGURE 5

INSTANTANEOUS MULTIPLIERS TO GOVERNMENT INVESTMENT SHOCKS, STATE DATA

consumption shocks on output is among the smallest. In other words, whereas the labor supply effect tends to dominate, the output multiplier effect induced by the increase in labor supply is relatively small.

Christiano and Eichenbaum (1992) used the countercyclicality of real wages in response to government consumption shocks as a way to reduce the unconditional correlation between employment and real wages and bring the RBC model closer to the data. Our evidence suggests that real wages and employment both increase after a shock to government consumption and, thus, one has to find other mechanisms or shocks in order to explain the dynamics present in the data.

The message is similar when we consider the responses to a government investment shock in Figure 5. 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 responses are very homogeneous. In 36 of the 40 states where such shocks are identifiable, 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. Confirming results obtained for government consumption shocks, instantaneous output responses for these states are among the smallest.

The evidence for government employment shocks is mixed. Recall that the predictions of the NK model are tenuous and that the RBC model predicts that in

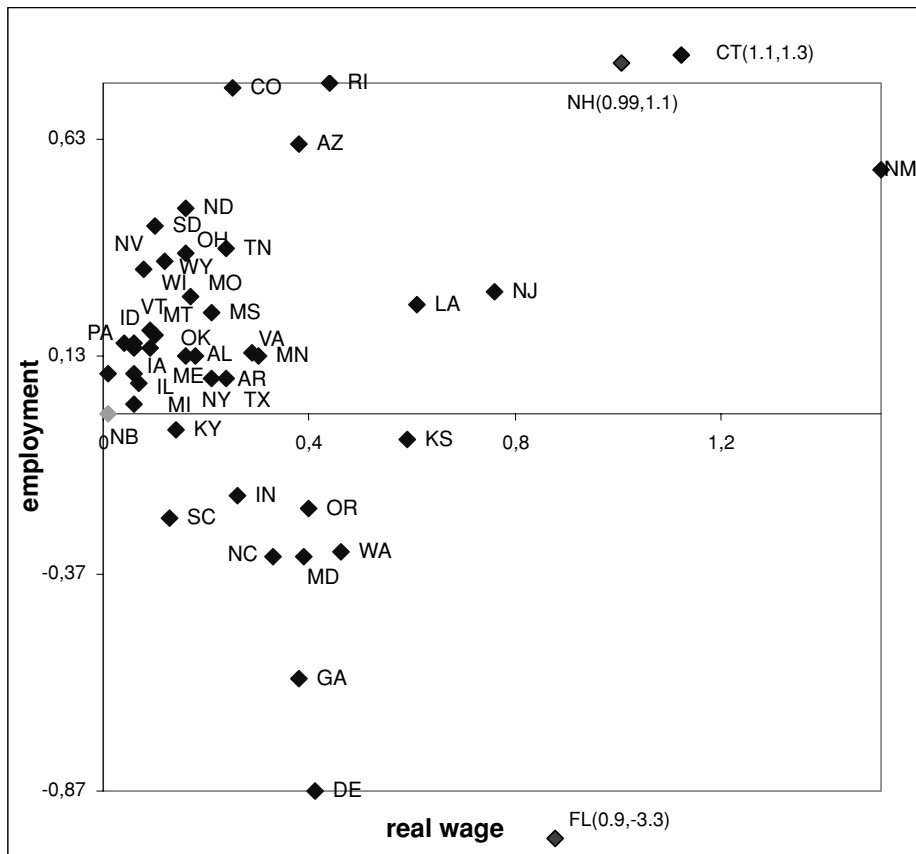


FIGURE 6

INSTANTANEOUS MULTIPLIERS TO GOVERNMENT EMPLOYMENT SHOCKS, STATE DATA

response to these shocks both real wages and total employment contemporaneously increase. Figure 6 indicates that such a pattern occurs in 32 states (with significant responses in 29 states), whereas in the remaining 12 states total employment falls after the shock (and in 9 states 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: They vary from -3.33 in Florida to 1.3 in Connecticut.

One may wonder how these results would change when rather than using theory-based sign restrictions one employs the more familiar scheme that lists the component of government expenditure last in the recursive casual ordering of the VAR. Such a scheme has no justification from the point of view of our model. Nevertheless, it is useful to discuss the results obtained with this atheoretical scheme since they clearly highlight that without a link with theory applied work is unable to reach any conclusions. Table 3 presents the responses of output, employment, and

TABLE 3
INSTANTANEOUS MULTIPLIERS: CHOLESKI RESTRICTIONS

	<i>C^s</i> Shocks			<i>I^s</i> Shocks			<i>N^s</i> Shocks		
	Output	Empl.	Wage	Output	Empl.	Wage	Output	Empl.	Wage
AL	0.18	0.27	0.28	0.16	-0.02	0.22	0.12	0.21	-0.05
AR	0.17	0.29	-0.14	0.37	0.11	-0.03	0.29	0.27	0.17
AZ	-0.08	0.16	-0.36	-0.36	-0.34	-0.04	-0.09	0.08	0.07
CA	-0.24	0.10	-0.29	-0.12	-0.27	-0.05	-0.35	-0.27	-0.29
CO	0.42	0.62	0.28	-0.13	-0.02	-0.05	0.13	0.35	-0.09
CT	-0.19	-0.14	-0.16	-0.28	-0.16	-0.11	-0.13	0.008	0.02
DE	-0.01	-0.15	-0.06	0.08	0.01	0.40	0.37	-0.06	0.68
FL	0.20	0.39	-0.07	0.09	0.36	.0004	0.10	0.10	0.06
GA	0.33	0.51	0.05	-0.03	0.02	0.16	0.07	0.09	0.06
ID	0.30	0.36	0.11	-0.08	0.03	-0.11	-0.03	-0.10	0.06
IL	0.38	0.50	0.08	0.10	0.25	0.11	0.36	0.27	0.17
IN	0.14	0.29	0.10	0.20	0.34	0.30	0.33	0.47	0.23
IA	0.07	-0.04	0.02	0.32	-0.06	0.09	0.10	0.42	-0.20
KS	0.19	0.43	0.12	0.10	0.16	-0.07	0.20	0.25	-0.06
KY	0.06	0.49	0.03	0.007	0.16	0.06	0.04	0.43	0.002
LA	0.21	0.15	-0.04	-0.14	0.005	-0.06	0.03	0.17	-0.24
ME	-0.22	-0.08	-0.24	-0.01	-0.003	0.12	-0.007	0.07	-0.10
MD	-0.04	-0.03	0.05	-0.09	-0.16	0.22	0.06	-0.28	0.06
MA	-0.23	-0.24	-0.10	0.14	-0.008	0.19	0.001	-0.42	-0.10
MI	0.28	0.19	0.23	-0.11	0.24	-0.17	-0.11	-0.24	-0.18
MN	0.16	0.31	-0.18	0.009	-0.13	-0.13	0.009	-0.02	-0.07
MS	0.37	0.38	0.24	0.43	0.14	0.37	0.14	0.17	0.05
MO	0.03	0.55	-0.30	-0.32	-0.25	-0.13	-0.11	-0.24	-0.18
MT	0.13	0.23	0.02	0.16	-0.16	0.53	-0.04	-0.002	0.10
NB	-0.16	0.29	0.20	0.43	-0.06	0.20	0.76	0.35	0.17
NV	0.41	0.53	0.10	0.05	0.32	0.14	0.28	0.15	0.48
NH	-0.15	-0.02	-0.34	-0.71	-0.53	-0.16	0.001	0.24	0.10
NJ	-0.23	-0.37	-0.21	0.07	-0.16	0.05	0.02	0.001	0.27
NM	0.30	0.32	-0.39	0.70	0.06	0.10	0.27	0.13	0.06
NY	-0.09	0.19	-0.10	-0.01	-0.09	0.24	-0.20	-0.23	-0.10
NC	0.14	0.35	-0.06	-0.18	0.03	-0.26	-0.39	-0.27	0.003
ND	-0.08	0.05	0.15	0.13	0.15	-0.03	0.10	0.41	-0.10
OH	-0.04	0.14	0.08	-0.08	-0.005	0.27	-0.04	0.12	0.18
OK	0.23	0.47	-0.29	0.59	0.58	0.41	0.19	0.21	0.07
OR	0.40	0.49	0.20	0.02	-0.40	0.30	0.16	0.27	0.17
PA	0.20	-0.12	-0.21	0.05	0.65	0.18	-0.03	-0.14	-0.17
RI	-0.65	-0.20	-0.54	-0.12	-0.05	-0.14	-0.49	-0.08	-0.26
SC	0.17	0.20	0.04	0.14	0.05	-0.10	0.14	0.04	-0.01
SD	0.02	0.01	0.49	-0.16	-0.20	-0.01	0.22	0.25	0.09
TN	0.49	0.60	0.11	0.17	0.09	-0.03	0.29	0.28	-0.02
TX	0.15	0.40	-0.12	0.21	0.15	0.32	-0.06	0.21	-0.17
UT	-0.06	0.20	0.04	-0.08	-0.34	0.23	0.21	0.47	0.10
VT	0.15	0.31	-0.02	-0.28	-0.25	-0.01	-0.18	-0.09	-0.13
VA	-0.14	-0.06	-0.21	-0.11	-0.35	0.02	-0.35	-0.29	-0.20
WA	0.09	0.38	0.09	0.26	0.42	0.18	0.14	0.29	0.10
WV	0.17	0.55	-0.28	-0.03	-0.19	0.13	-0.38	-0.04	-0.22
WI	0.39	0.17	0.28	0.19	0.22	0.38	0.12	0.25	0.16
WY	-0.11	0.04	-0.006	0.07	0.006	0.07	0.02	0.31	-0.01
Aggregate	0.31	0.58	0.14	-0.40	-0.29	-0.20	-0.19	-0.34	-0.06

real wages to a shock in the three components of government expenditure for the 48 U.S. states and for the aggregate U.S. data.

In half of the cases the induced impulse responses make no sense. For example, output falls after a government consumption shock in 18 out of the 48 states, output, or employment, or both, fall after a shock to government investment in 27 states, and in the aggregate and real wages, or output, or both, fall in 28 states and in the aggregate after a shock to government employment. These responses are at odds with all the versions of the model considered and, in fact, go against the predictions of any existing model of fiscal policy in the literature.

5. CONCLUSIONS

We characterized a set of common robust theoretical restrictions on the effects of fiscal shocks on output and the deficit produced by standard RBC and NK models and use them in SVARs to identify fiscal disturbances. We then examined the dynamics they induce on real wages and employment. Real wages and employment contemporaneously increase and significantly so in response to government consumption and investment shocks both in the aggregate and for the majority of the U.S. states we have analyzed. The data are not very informative about the dynamics following a government employment shock: In the aggregate increases in government employment raise the real wage and total employment; in one third of the states the latter falls. Our theoretical framework is too limited to explain this pattern, since it allows for perfect labor mobility between private and public sectors, assumes that the government acts competitively in labor markets, and does not allow for equilibrium unemployment. Clearly, future research aiming at the modification of these somewhat restrictive assumptions would be constructive.

Apart from providing stylized facts regarding the responses of labor market variables to fiscal shocks, the article contributes to the literature by showing how identification restrictions in a VAR can be made uncontroversial—choose restrictions that are robust to parameters and model choice.

Although it is tempting to do so, one should be careful in interpreting the evidence we present as proving or disproving a theory or another, since as shown by Chari et al. (2007) small sample biases in these types of exercises may be very important. However, as it is shown in Canova and Paustian (2007), contemporaneous sign restrictions are less prone to small sample biases than other types of restrictions, and the conclusions one obtains with this methodology are more robust to these problems.

One additional reason for being careful with the interpretation of the results is the fact that the model we have employed for the identification of fiscal shocks is highly stylized. For example, Ramey and Shapiro (1998) presented an example of a two-sector flexible-price RBC economy with imperfect capital mobility in which real wages and total employment both increase after a government spending shock. Although such a model displays some counterfactual implications in response to shocks other than the fiscal ones, we consider it an open question whether RBC style models can produce the pattern of responses we present.

APPENDIX: DATA SOURCES AND DEFINITIONS

The study's data are annual, real, seasonally adjusted, and per capita for the U.S. states from 1969 to 2001. 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, U.S. 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, defined as: direct expenditure—capital outlays—subsidies payments. 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, current transfers, and interest payments from current expenditure.

State debt: Census, total debt outstanding at the beginning of the fiscal year. It includes both guaranteed and nonguaranteed 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 U.S. 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 are independent of the way we deflate state wages.

The data for the U.S. aggregates for interest rates and prices come from Federal Reserve Bank of St. Louis, whereas the rest of the data on expenditures, deficits and debt come from the Census.

The average labor and capital tax rates at state level are calculated following McGrattan (1994) and Jones (2002) using the regional economic accounts data collected by the Bureau of Economic Analysis. In particular we use table SA50,

Personal current taxes, SA30, State economic profiles, and SA04, Income and employment summary, and calculate the average personal income tax rate as $\tau_p = \frac{SA50:70+SA50:120+SA50:180+SA50:230}{SA50:10}$, where the indexes reported correspond to the lines of the tables used. Then the average labor tax rate is calculated using the calculated series for τ_p and items from table SA04 as follows: $\tau_l = \frac{\tau_p(SA04:50+SA04:70/2)+SA04:60}{SA04:50+SA04:70/2+SA04:60}$ and the average capital tax rate is accordingly calculated as: $\tau_k = \frac{\tau_p SA30:90+SA50:230}{SA30:90+SA50:230}$. The table below describes the items.

SA50	SA04	SA30
SA50:10 personal income		
SA50:70 taxes to Federal government	SA04:50 wage and salary disbursements	
SA50:120 taxes to state government	SA04:70 proprietors' income	SA30: 90
SA50:180 taxes to local government	SA04:60 supplements to wages and salaries	investment
SA50:230 personal property taxes		income

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