Working Paper

Fiscal stimulus in a credit crunch: the role of wage rigidity

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Fiscal Stimulus in a Credit Crunch: the Role of Wage Rigidity[1]

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April 2009

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Abstract

In this paper we study the impact of an expansion in public spending in a credit constrained economy with sticky wages. The flexible wage version of the model implies strong expansionary effects on output and consumption but also a counterfactual increase in real wages. The introduction of sticky wages, besides being a realistic addition, solves these problems and preserves the expansionary effects on output and consumption. Moreover, once we introduce segmentation in the labor market, sticky wages are even essential to obtain expansionary effects.

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1   Introduction and motivation

The recent financial turmoil has sparked renewed widespread interest in the effectiveness of fiscal policy as a stabilization tool. Many countries have launched ambitious fiscal packages whose objective is to stimulate a weak macroeconomic environment. In policy circles, the use of fiscal policy has been justified on the basis of essentially two arguments (cf. Feldstein (2009) and Spilimbergo et al. (2008) among others). The first relies on the possible ineffectiveness of monetary policy in the current situation in which the interest rate is approaching the zero lower bound in several countries. When standard monetary policy is ineffective, as in a liquidity trap situation, a standard IS-LM analysis would suggest a major role for fiscal policy intervention. The second argument is based on the possible presence of a credit crunch reducing household access to credit. When financial frictions are tight, as could be the case in the current period, a fiscal stimulus can reduce credit constraints by increasing current income for credit constrained agents. Of course, the structure of the labor market is crucial in this analysis since labor income is the largest component of current income for credit constrained agents.

In this paper we focus on this second argument used to justify the usefulness of a fiscal package and we investigate its validity and robustness in a dynamic stochastic general equilibrium model (DSGE) across different specifications of the labor market. Interestingly, the IMF report by Spilimbergo et al. (2008) recommends a fiscal package based on an increase in public spending and on tax cuts or transfers towards liquidity constrained consumers. Our model is perfectly consistent with this policy recommendation and provides a theoretical rationale for such a measure.

While the IS-LM model easily generates expansionary effects (i.e. an output multiplier larger than one and a positive response of consumption) from an increase in government spending, it is surprisingly difficult to generate the same effects in DSGE

models where agents optimize their decisions in an intertemporal set-up. This is so because agents are subject to a wealth effect: when government spending increases, they rationally anticipate an increase in taxes and they cut consumption and increase labor supply (cf. Baxter and King (1993) for a standard Real Business Cycle (RBC) model). The same mechanism applies in models with monopolistic competition and sticky prices (Linnemann and Shabert (2003)). However, in all these models agents can borrow and lend freely.

Instead, Galí, Lopez-Salido and Valles (GLV) (2007) have proposed a model where fiscal shocks can generate expansionary effects in a world where financial frictions are tight.[1] Following the suggestion in Mankiw (2000), GLV introduce "rule-of-thumb consumers" (ROT) into the basic New Keynesian model to explain the excessive dependence of aggregate consumption on current income compared to the predictions of the "permanent income theory". These consumers cannot optimize intertemporally because of borrowing constraints or lack of access to financial markets. In each period, they consume their current disposable income and do not save; they coexist with optimizing agents (OPT), who take consumption decisions according to the "permanent income hypothesis". OPT agents are more sophisticated because they can hold bonds, rent capital to firms and receive profits derived from firm ownership. This kind of financial friction, although somewhat ad hoc, is a very simple device to represent the current economic situation and to limit the strength of the wealth effect.[2] In the GLV model it is possible to generate an output multiplier larger than

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[1] In the literature, other models have been proposed to obtain expansionary effects of fiscal shocks on output and consumption (cf. Bouakez and Rebei (2007), Linnemann and Shabert (2005), Linnemann (2006), Ravn et al. (2006) and Monacelli and Perotti (2008)). However, none of these models includes financial frictions. Estimated models based on GLV (2007) are presented in Forni et al. (2009), Coenen and Straub (2005) and Lopez-Salido and Rabanal (2008). None of these papers relates the model to the current crisis. In Furlanetto and Seneca (2007) we show that ROT consumers are also extremely useful in explaining productivity shocks.

[2] Since ROT agents do not optimize intertemporally, they are not affected by the wealth effect. Note that Ricardian equivalence does not hold in the model. In fact, it matters for ROT agents whether an increase in government spending is financed through an increase in taxation or through a budget deficit. In the first case their current income decreases, whereas in the second case it is

one and a positive response of consumption as long as the government spending shock is financed, at least in part, through a budget deficit and as long as there are sticky prices and monopolistic competition in the labor market. Importantly, output and consumption multipliers are strongly increasing in the degree of financial frictions, i.e. in the number of constrained agents, as can be seen in Figure 1[3]. Therefore, this kind of model could justify the approval of a fiscal package in a credit crunch situation. The objective of this paper is to test the validity and the robustness of this conclusion across different specifications of the labor market.

We believe that this exercise is interesting for two reasons. First, in the baseline GLV model wages are assumed to be flexible. However, substantial empirical evidence indicates a large degree of nominal wage rigidity in micro data (Dickens et al. (2007), Holden and Wulfsberg (2008 and 2009), Lebow et al. (2003)). Moreover, sticky wages are essential to reproduce plausible dynamics in aggregate variables responding to a wide variety of economic shocks in estimated macroeconomic models (Christiano et al. (2005) and Smets and Wouters (2003 and 2007) where sticky wages are modelled as in Erceg et al. (2000)). All these papers find strong evidence in favor of sticky wages and estimate a degree of nominal wage rigidity much higher than the degree of price rigidity. Finally, Shimer (2009) and Hall (2005) argue strongly in favor of wage rigidities to reproduce plausible dynamics in models with labor market frictions.

The second reason to introduce wage rigidities in the GLV model comes from visual inspection of impulse responses in the baseline model in Figure 1. Expansionary effects on output and consumption rely on a big increase in real wages that pushes up the current income of ROT consumers. This is not a desirable property of the model because the large positive response of the real wage is counterfactual.

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not affected. Hence, this model enables us to study the impact of fiscal shocks that are not budget balanced, i.e. the kind of fiscal shocks that are more plausible in reality.

[3]In Figure 1 the dashed line represents the standard New Keynesian model (100% of OPT agents), the solid line relates to the same model (under the same calibration) but with 50% of OPT agents and 50% of ROT agents (GLV (2007)).

Vector Autoregression (VAR) studies on the effects of fiscal shocks are instead consistent with the assumption of wage rigidity. The estimated response of the real wage is around one fifth of the one implied by the GLV model and in some cases it is not significant on impact (cf. Caldara and Kamps (2008) for a comprehensive study comparing different methods and specifications).[4] Not any study finds a large response such as the one implied by the model. Some studies find even a negative response, although not statistically significant (cf. Ramey (2008) for a comprehensive study using the narrative approach and Mountford and Uhlig (2008) using sign restrictions)[5]. Furthermore, as argued by Bilbiie and Straub (2004), this large reaction of the real wage is not consistent with the "Lucas less famous critique", saying that real wages are roughly acyclical. Real wages are procyclical in their response to productivity shocks. If they are also strongly procyclical with respect to government spending shocks, it seems difficult to reproduce the aggregate acyclicality observed in the data.

The introduction of wage stickiness in the model prevents the counterfactual swing in real wages almost by construction. However, wage rigidity could make it difficult to confirm the expansionary effects on output and consumption because it prevents the large increase in current income that pushes up ROT consumption. Thus, intuitively, we could imagine a tension between wage stickiness and expansionary effects on output and consumption. The goal of this paper is to check this conjecture in the GLV model augmented with sticky wages and in a more general model where we allow for segmented labor markets.

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[4]A non exaustive list of studies finding a limited real wage response includes Blanchard and Perotti (2002), Perotti (2005 and 2007), Fatas and Mihov (2001), Galí et al. (2007) among many others.

[5]In the empirical literature there is a lively debate on the sign of the consumption response. Most papers find a positive and significant response. Ramey (2008) argues that this is the case because the VAR in not able to capture anticipation effects. Kriwoluzky (2009) and Mertens and Ravn (2009) find that the positive consumption response is confirmed even when pre-announcement effects are taken into account but we acknowledge that this question is still to finally settled in the literature.

Our main result is that sticky wages and expansionary effects on output and consumption can coexist. Output and consumption multipliers are affected only marginally by the presence of wage rigidities. The mechanism is as follows. As expected, nominal wage rigidity implies that wage inflation is much lower and thus the reaction of real wages is also low (it is almost fixed). In fact, ROT consumption increases less, tracking current income closely. However, a second effect is at work. Lower wage inflation implies a lower impact on marginal costs, less price inflation and a much lower increase in the interest rate by the monetary authority. This lower increase in the interest rate crucially affects OPT consumption and investment: both decrease less than in the flexible wage case. It turns out that for realistic calibrations the magnitude of two effects is almost the same, and thus the expansionary effects on output and consumption are preserved.

Finally, we relax the common wage assumption and we introduce segmentation in the labor market. In GLV (2007) all agents earn the same wages and work the same number of hours, irrespective of their consumption behavior. A plausible alternative is a model where ROT and OPT agents are allowed to choose their own wage optimally and to work a different number of hours. Our second result is that in a model with flexible wages the positive response of consumption and the output multiplier larger than one are not preserved once we depart from the common wage assumption. However, the results are rescued when sticky wages are introduced. Under sticky wages the impact of wage heterogeneity in the model is strongly reduced and the dynamics are similar to the model with a common wage. Therefore, not only sticky wages and expansionary effects on output and consumption can coexist, but the former can even be a necessary assumption to obtain the latter.

The rest of the paper is organized as follows. In section 2 we present the model, in section 3 we show the results of our numerical simulations and we check the strength of our results under different calibrations. In section 4 we propose the extension with

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segmented labor markets. Our conclusion is presented in section 5.

2   The model

The economy is composed of a continuum of households and a continuum of firms producing intermediate goods that are transformed into a final good by a perfectly competitive firm. The central bank fixes the nominal interest rate following a simple "Taylor rule". The fiscal authority collects taxes, buys a fraction of the final good and issues one-period bonds. Wages are set by a continuum of unions, whereas hours worked are determined by labor demand. In the next subsections we analyze the behavior of each agent.

2.1   Households

The model is composed of a continuum of agents indexed on $[0, 1]$: a fraction $[0, \lambda]$, the "rule-of-thumb" agents, consume their disposable income each period and a fraction $(\lambda, 1]$, the "optimizing" agents, optimize intertemporally and behave according to the permanent income hypothesis. OPT agents can trade a full set of Arrow-Debrew securities in complete financial markets. The generic household is indexed by $i \in [0, 1]$.

2.1.1   Optimizing households

A typical optimizing household, indexed by the superscript o, derives utility from consumption (C_t^o) and disutility from hours worked (N_t^o), and maximizes the sum of expected future utilities discounted at the rate of time preference $\beta \in (0, 1)$:

$$E_0 \sum_{t=0}^{\infty} \beta^t U^o \left(C_t^o, N_t^o \right)$$

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subject to the sequence of budget constraints

$$P_t \left(C_t^o + I_t^o \right) + R_t^{-1} B_{t+1}^o + P_t T_t^o + F_t = W_t N_t^o + + R_t^k K_t^o + B_t^o + D_t^o \tag{1}$$

and the capital accumulation equation

$$K_{t+1}^o = (1 - \delta) K_t^o + \phi \left(\frac{I_t^o}{K_t^o} \right) K_t^o$$

where P_t is a price index, I_t^o is investment, R_t is the gross nominal interest rate, B_{t+1}^o is the quantity of one-period nominal bonds bought at the beginning of the period, T_t^o are lump-sum taxes and F_t is a membership fee to the union. The four sources of income are labor income $(W_t N_t^o)$, capital income $\left(R_t^k K_t^o \right)$, bond holdings paying one unit of the consumption index (B_t^o) and dividends derived from the ownership of monopolistically competitive firms (D_t^o). δ is the rate of depreciation, and $\phi(.)$ is an adjustment cost function satisfying $\phi(\delta) = \delta$, $\phi' > 0$, $\phi'(\delta) = 1$ and $\phi'' \leq 0$.

The utility function is given by

$$U^o \left(C_t^o, N_t^o \right) = \log C_t^o - \frac{N_t^{o1+\varphi}}{1+\varphi}$$

where φ is a parameter ≥ 0.

The household maximizes utility over consumption, investment and bond holdings. Its choice is summarized by the following first-order conditions that we write in log-linear form:[6]

$$c_t^o = E_t c_{t+1}^o - \left(r_t - E_t \pi_{t+1} \right) \tag{3}$$

$$k_{t+1} = (1 - \delta) k_t + \delta i_t \tag{4}$$

[6]The reader can find a detailed derivation in GLV (2007). Lowercase variables denote log-deviations from the steady state of the corresponding uppercase variables.

$$q_t = -\left(r_t - E_t\left[\pi_{t+1}\right]\right) + \left[1 - \beta\left(1 - \delta\right)\right] E_t\left[r_{t+1}^k - p_t\right] + \beta E_t\left[q_{t+1}\right] \tag{5}$$

$$i_t - k_t = \eta q_t \tag{6}$$

where $\eta \equiv -1/\left(\phi''\left(\delta\right)\delta\right)$. Here, (3) is the Euler equation, (4) is the capital accumulation equation, while (5) and (6) represent the dynamics of Tobin's q, denoted q_t, and its relation to investment, respectively.

The household does not maximize with respect to labor because we assume monopolistic competition in the labor market. The wage is fixed by unions and hours worked are determined by labor demand. We assume that the wage mark-up is sufficiently high to ensure that both types of households are willing to supply the quantity of labor demanded by firms.

2.1.2 Rule-of-thumb agents

ROT agents, indexed by the superscript r, have the same utility function as OPT consumers, $U^r\left(C_t^r, N_t^r\right) = \log C_t^r - \frac{N_t^{r1+\varphi}}{1+\varphi}$ but they do not choose consumption intertemporally. They simply consume their disposable income each period

$$P_t C_t^r = W_t N_t^r - P_t T_t^r - F_t \tag{7}$$

ROT agents differ from OPT agents because they cannot smooth consumption through bond holdings and because they do not receive dividends. A first-order log-linear approximation around the steady state with constant consumption equalized across households gives

$$c_t^r = \Phi\left(rw_t + n_t^r\right) - \frac{1}{\gamma_c}t_t^r \tag{8}$$

where $rw_t = w_t - p_t$, $\Phi = \frac{WN}{PC} = \frac{1}{\gamma_C \mu_p}\left(1 - \alpha\right)$, μ_p represents the mark-up and $\gamma_c = \frac{C}{Y}$. Omission of time subscripts indicates steady-state variables. Note that the union membership fee drops out because the fee is assumed to be a quadratic

function of wage inflation, which is zero in the steady state, cf. below.

2.1.3 Aggregation

Aggregate consumption is the average of both kinds of consumption weighted by the percentage of rule-of-thumb consumers (λ) in the economy

$$c_t = \lambda c_t^r + (1 - \lambda) c_t^o \tag{9}$$

Similarly, for aggregate hours

$$n_t = \lambda n_t^r + (1 - \lambda) n_t^o$$

2.2 Firms

2.2.1 Final good producer

The final good Y_t is produced by a perfectly competitive firm that combines intermediate inputs $Y_t^d(j)$ into a final output through a constant returns to scale technology. The production function is given by

$$Y_t = \left(\int_0^1 Y_t^d(j)^{\frac{\epsilon_p - 1}{\epsilon_p}} \, dj \right)^{\frac{\epsilon_p}{\epsilon_p - 1}}$$

where ε_p represents the elasticity of substitution among intermediate goods indexed by $j \in [0, 1]$.

Profit maximization and the assumption of perfect competition imply the following set of demand schedules for the intermediate goods

$$Y_t^d(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\epsilon_p} Y_t$$

where $P_t(j)$ represents the price of the good produced by firm j. The zero-profit condition yields $P_t = \left(\int_0^1 P_t(j)^{1-\epsilon_p} dj\right)^{\frac{1}{1-\epsilon_p}}$.

2.2.2 Intermediate goods producers

A typical monopolistically competitive firm operates through the following technology

$$Y_t(j) = K_t(j)^\alpha N_t(j)^{1-\alpha}$$

where $K_t(j)$ is the capital stock owned by firm j and $N_t(j)$ is an aggregator of the different labor varieties indexed by z

$$N_t(j) = \left[\int_0^1 N_t(j,z)^{\frac{\varepsilon_w-1}{\varepsilon_w}} dz\right]^{\frac{\varepsilon_w}{\varepsilon_w-1}}$$

$N_t(j,z)$ represents the quantity of variety z labor employed by firm j. We assume that a fraction λ of type z workers is composed of ROT consumers and the rest of OPT consumers. The firm allocates labor demand proportionally.

Cost minimization yields a set of demand schedules for labor varieties z that after aggregation looks like

$$N_t(z) = \left(\frac{W_t(z)}{W_t}\right)^{-\varepsilon_w} N_t \tag{10}$$

where the wage index W_t is given by $\left(\int_0^1 W_t(z)^{1-\epsilon_w} dz\right)^{\frac{1}{1-\epsilon_w}}$ and ε_w represents the elasticity of substitution across labor types.

Each firm maximizes the sum of expected future discounted profits

$$\max \sum_{k=0}^\infty E_t \left\{Q_{t,t+k} \left[P_{t+k}(j) Y_{t+k}^d(j) - W_{t+k} N_{t+k}(j) - R_{t+k}^k K_{t+k}(j)\right]\right\}$$

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where $Q_{t,t+k}$ is the stochastic discount factor of optimizing consumers who own firms. It sets contingency plans for $P^*_{t+k}(j)$ subject to a set of constraints

$$P_{t+k+1}(j) = \left\{ \begin{array}{l} P^*_{t+k+1}(j) \text{ with probability } (1 - \theta_p) \\ \quad P_{t+k}(j) \text{ with probability } \theta_p \end{array} \right\}$$

$$Y^d_{t+k}(j) = \left(\frac{P_{t+k}(j)}{P_{t+k}} \right)^{-\epsilon_p} Y_{t+k} \tag{11}$$

Prices are set according to a Calvo mechanism.[7] A time t price setter chooses the price for its good $P_t(j)$ equal to $P^*_t(j)$, $P^*_t(j)$ being the price that maximizes the discounted value of dividends over the expected duration of the selected price. The firm takes into account that this price will stay in place the next period with probability θ_p, and that it will be allowed to reoptimize with probability $(1 - \theta_p)$. Firm j is monopolistically competitive in the market for its good and thus is also constrained by the demand curve for good j (11).

As is well known, the optimality conditions from this problem imply the New Keynesian Phillips curve (NKPC)

$$\pi^p_t = \beta E_t \left(\pi^p_{t+1} \right) + \kappa_p mc_t \tag{12}$$

where $\kappa_p = (1 - \beta\theta_p)(1 - \theta_p)\theta_p^{-1}$, $\pi^p_t = p_t - p_{t-1}$ is price inflation, and where mc_t is real marginal costs given by

$$mc_t = rw_t - (y_t - n_t) \tag{13}$$

In addition, cost minimization implies that relative factor inputs satisfy the condition

$$k_t + n_t = \left(r^k_t - p_t \right) + rw_t \tag{14}$$

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[7]For a detailed explanation of the Calvo (1983) mechanism see Woodford (2003).

To a first-order approximation, production is given by

$$y_t = \alpha k_t + (1 - \alpha) n_t \tag{15}$$

2.3 Unions

The economy has a continuum of unions, each representing a continuum of workers, a fraction $(1 - \lambda)$ are OPT agents, and a fraction λ are ROT agents. Each union sets the wage rate for its members, who stand ready to satisfy firms' demand for their labor services at the chosen wage. The workers in a union provide the same type of labor (irrespective of their consumption behavior) differentiated from the type of labor services provided by members of other unions. Firms do not discriminate between consumer types in its labor demand, and so it follows from the unions' problems that $n_t^r = n_t^o = n_t$. These assumptions imply that all the workers earn the same wage and work the same number of hours.

Each period, unions choose $W_t(z)$ to maximize the present value of an average of its member's current and future period utility functions, that is,

$$\max_{W_t(z)} E_t \sum_{k=0}^{\infty} \beta^{t+k} \left[\lambda U_{t+k}^r + (1 - \lambda) U_{t+k}^o \right] \tag{16}$$

subject to the labor demand functions (10) and the budget constraints of its members (1) and (7), thus taking the effect of the wage decision on the income of its members into account. Wage adjustments are assumed to be costly. In particular, it is assumed that the wage adjustment cost is a quadratic function of the increase in the wage demanded by the union as modelled in Rotemberg (1982) for prices. For simplicity, the adjustment cost is proportional to the aggregate wage bill in the economy (this parallels the specification of price adjustment costs in Ireland (2003)). Though the wage bargaining process is not explicitly modelled, one way of thinking of this cost

is that unions have to negotiate wages each period and that this activity demands economic resources; the larger the increase in wages obtained, the more effort unions would have needed to put into the negotiation process. Each member of the union covers an equal share of the wage adjustment cost by paying a union membership fee. Hence the nominal fee paid by a member of union z at time t is given by

$$F_t(z) = \frac{\phi_w}{2} \left(\frac{W_t(z)}{W_{t-1}(z)} - 1 \right)^2 W_t N_t$$

where the size of the adjustment costs is governed by the parameter ϕ_w. In the special case where $\phi_w = 0$, the model effectively collapses to the model in GLV (2007).

The first-order condition with respect to $W_t(z)$ is given by

$$
\begin{aligned}
0 &= \left(\frac{\lambda}{C_t^r} + \frac{(1-\lambda)}{C_t^o} \right) \frac{W_t}{P_t} \left[(\varepsilon_w - 1) + \phi_w (\Pi_t^w - 1) \Pi_t^w \right] - \varepsilon_w N_t^\varphi \\
&\quad - \beta E_t \left[\left(\frac{\lambda}{C_{t+1}^r} + \frac{(1-\lambda)}{C_{t+1}^o} \right) \phi_w (\Pi_{t+1}^w - 1) \Pi_{t+1}^w \frac{W_{t+1}}{P_{t+1}} \frac{N_{t+1}}{N_t} \right]
\end{aligned}
$$

whose log-linearized version is a NKPC for wage inflation (Π^w)

$$\pi_t^w = \beta E_t \left(\pi_{t+1}^w \right) + \kappa_w \left(mrs_t - (w_t - p_t) \right) \tag{17}$$

where mrs_t is the average marginal rate of substitution given by

$$mrs_t = c_t + \varphi n_t \tag{18}$$

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and the slope coefficient κ_w is[8]

$$\kappa_w = \frac{\varepsilon_w - 1}{\phi_w}$$

Unions are essential in the model to avoid different wages among type z agents. If a household was free to choose its wage, it would choose it as a mark-up over its marginal rate of substitution. And since consumption levels are different between ROT and OPT agents, marginal rates of substitution and wages would also be different. In section 4 we relax the common wage assumption, introducing two different wages for ROT and OPT agents.

2.4 Monetary and fiscal policy

Monetary policy is set by the central bank according to a simple interest rate rule that is a special case of the well-known "Taylor rule"

$$r_t = r + \phi_\pi \pi_t \tag{19}$$

where $r_t = R_t - 1$, r is the steady state value of the nominal interest rate and ϕ_π measures the reaction of monetary policy to current inflation.

The government has to satisfy the following budget constraint

$$b_{t+1} = (1 + \rho)(b_t + g_t - t_t) \tag{20}$$

where $\rho = \frac{1}{\beta} - 1$.

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[8]Instead of wage adjustment costs, we may assume that a union is allowed to reset its wage rate each period with a fixed probability $1 - \theta_w$ as in Calvo (1983). But to undo the implications of the implied heterogeneity across unions, a risk-sharing arrangement between unions must be in place. This follows since rule-of-thumb consumers are barred from sharing risk through financial markets. Results, however, are very similar. In particular we would get a Phillips curve with $\kappa_w = (1 - \beta\theta_w)(1 - \theta_w)\theta_w^{-1}(1 + \varphi\varepsilon_w)^{-1}$. Alternatively, each household must be assumed to provide all types of labor simultaneously in (as in Schmitt-Grohe and Uribe (2006)). However, this formulation is, in our opinion, in contrast to the assumption of monopolistic competition in the labor market since labor variety z would be supplied by all agents.

Taxes are set according to the fiscal rule

$$t_t = \phi_b b_t + \phi_g g_t \tag{21}$$

where $g_t = \frac{G_t - G}{Y}$, $t_t = \frac{T_t - T}{Y}$ and $b_t = \frac{\left(\frac{B_t}{P_{t-1}}\right) - \left(\frac{B}{P}\right)}{Y}$. ϕ_b and ϕ_g are positive constants reflecting the weights assigned by the fiscal authority to debt and current government spending. The condition $\phi_b > \frac{\rho}{1+\rho}$, rules out explosive debt dynamics.

Government spending (normalized by steady state output and expressed in deviations from steady state) evolves exogenously according to the following first-order autoregressive process

$$g_t = \rho_g g_{t-1} + \epsilon_t \tag{22}$$

where $0 < \rho_g < 1$ measures the persistence of the shocks and ϵ_t measures the size of the shock.

2.5 Market clearing and steady state

The clearing of labor and goods markets requires for all t

$$N_t(z) = \int_0^1 N_t(z, j)\, dj \text{ for all } z$$

$$Y_t(j) = Y_t^d(j) \text{ for all } j$$

$$Y_t = C_t + I_t + G_t + F_t$$

whose log-linearized version is

$$y_t = \gamma_c c_t + \gamma_I i_t + g_t \qquad (23)$$

where $\gamma_I = \frac{I}{Y} = \frac{\alpha\delta}{(\rho+\delta)\mu_p}$. As GLV (2007), we look at a steady state with zero inflation, zero public debt and a balanced primary deficit. To simplify the solution of the model, it is convenient to impose $C^o = C^r$. Since we are interested in the dynamic responses to shocks, and not in the characterization of the steady state, we see this assumption as a useful simplification. However, in steady state ROT and OPT agents differ because the latter earn dividends and capital income. Therefore, to achieve the same steady state consumption, OPT agents must be taxed more than ROT agents. For simplicity, and to facilitate comparability of results, we do not depart from GLV and we set different tax levels in steady state. Moreover, Natvik (2008) shows that, provided that wages are sticky, equilibrium dynamics are not affected by the assumption on steady state consumption. Equations (3) to (6), (8), (9), (12) to (15) and (17) to (23) form a system of stochastic difference equations that can be solved using standard techniques.

3   Results

As a baseline calibration we choose the same parameter values as GLV (2007). We made this choice to facilitate the comparability of the results. As GLV (2007), we set $\delta = 0.025$, $\alpha = 0.33$, $\eta = 1$, $\beta = 0.99$, $\lambda = 0.5$, $\gamma_g = 0.2$, $\phi_\pi = 1.5$, $\phi_b = 0.33$, $\phi_g = 0.1$, $\varepsilon_p = 6$, $\theta_p = 0.75$, $\rho_g = 0.9$ and $\varphi = 0.2$.

We need to fix a value for ϕ^w (the adjustment costs parameter) and ε_w (the elasticity of substitution between labor varieties) that are not present in GLV where wages are flexible. We set ε_w equal to 4 (the implied wage mark-up in the case of flexible wages is $\frac{\varepsilon_w}{\varepsilon_w - 1}$) and $\phi^w = \frac{\varepsilon_w - 1}{(1-\beta\theta_w)(1-\theta_w)\theta_w^{-1}(1+\varphi\varepsilon_w)^{-1}} = 62.9$. This choice yields

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the same NKPC for wages as in a Calvo setting à la Erceg et al. (2000) with four quarters of wage stickiness ($\theta_w = 0.75$).

3.1 The effect of sticky wages

In Figure 2 we can see the effects of sticky wages on model dynamics. The dashed line represents the GLV model with flexible wages, the solid line represents the extension with sticky wages. The size of the shock is a one per cent increase in the government spending to output ratio. The first result of this paper is that even though the response of the real wage is flat under sticky wages, the consumption response is still positive whereas the output response is almost unaffected.[9] This is so because the investment response is now slightly positive instead of negative.

The mechanism that rationalizes these results is the following. It is true that, as expected, lower wage inflation (implied by the wage stickiness) lowers the increase in ROT consumption since current labor income increases less than in the flexible wage case. However, a second effect goes in the opposite direction. In fact, lower wage inflation implies a lower increase in the marginal cost that in turn implies a lower increase in price inflation. But lower inflation translates into a lower increase in the interest rate by the central bank, and a lower increase in the interest rate has an expansionary effect on OPT consumption and investment. Hence, expansionary effects on output and consumption (i.e. output multiplier larger than one and positive consumption response) depend on the strengths of the two effects. In our model, the latter (the interest rate effect) almost offsets the former (the real wage effect), and aggregate consumption can still rise after a government spending shock. Moreover, the lower increase in the interest rate favors investment, thereby leaving the output response almost unaffected. Thus, our initial conjecture was not correct:

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[9]Interestingly, Romer and Bernstein (2009) calculate also a peak output multiplier around 1.5 in their scenario analysis on the effects of a fiscal plan in the US.

the crowding-in of consumption and the large output multiplier do not rely on the assumption of flexible wages and on the counterfactual increase in the real wage. Instead, they are robust results that are preserved under a more realistic specification of the labor market.

As a corollary, we see that in the model with sticky wages the reaction of ROT and OPT consumption is less asymmetric. It is still true that ROT consumers increase their consumption while OPT consumers decrease it, but the quantitative difference is now much lower.

The effect on all the other variables is summarized in Figure 3. The first three panels show that we are dealing with a government spending shock that does not maintain a balanced budget. This is crucial in a model with ROT agents: with OPT agents alone, Ricardian equivalence would hold and therefore the presence of a budget deficit would be irrelevant. With ROT agents, the occurrence of a budget deficit crucially changes the spending multipliers. The introduction of sticky wages affects by construction the inflation rate and the interest rate response: the lower impact of the shock on marginal costs implies a lower increase in inflation through the NKPC, and in the interest rate through the Taylor rule, in keeping with empirical evidence (cf. Perotti (2005) among others). The lower increase in the interest rate favors consumption and investment and the increase in aggregate demand pushes up output. This mechanism would be amplified by the presence of an interest rate smoothing term in the Taylor rule. Therefore, our results would be reinforced under a perhaps more realistic monetary policy rule.

Note that our irrelevance result for sticky wages does not mean that the specification of the labor market is not important. As in GLV (2007) the assumption of monopolistic competition in the labor market is crucial to our analysis.

To sum up, sticky wages can correct the weaknesses we identified in the GLV model while preserving the expansionary effects on output and consumption.

3.2 Sensitivity analysis

In Figures 4 and 5, we conduct a sensitivity analysis on the impulse response functions for consumption and output with respect to some key parameters in the model with sticky wages.

The parameter φ deserves special attention: in the traditional business cycle literature it represents the elasticity of the marginal disutility of labor and it is inversely related to the Frisch elasticity of labor supply. GLV (2007) fix it at 0.2 to be consistent with an elasticity of the real wage with respect to output (for a given level of consumption and employment) of 0.3. This value, however, is very low when we interpret φ in terms of the inverse of labor supply elasticity: in the literature the standard calibration goes from 1 to 3. GLV use a much lower value because for higher values of φ the model exhibits indeterminacy. However, under sticky wages the determinacy region is larger (Colciago (2008)) and thus we can lower the labor supply elasticity towards more realistic values. In Figures 4.1 and 5.1, we see that the expansionary effects on output and consumption are strongly confirmed, even when labor supply becomes quite inelastic ($\varphi = 3$).

In contrast to GLV (2007), expansionary effects are preserved with only two quarters of price stickiness (Figures 4.2 and 5.2), consistent with the lower bound on the empirical evidence on price stickiness (Bils and Klenow (2005)). This is the case because wage stickiness can partially substitute for price stickiness by lowering the marginal cost reaction.

The third parameter we consider is the percentage of rule-of-thumb consumers (λ). This parameter is especially important for policy purposes because it governs the size of expansionary effects. In our baseline model, the threshold that reproduces a zero response in consumption and a unit output multiplier is given by λ equal to 0.25 (Figures 4.3 and 5.3). However, this threshold can be lowered substantially by

introducing a few additional realistic features in the model. In Furlanetto and Seneca (2009), we show that real rigidities (in the form of habit persistence, firm-specific capital and Kimball demand curves) can dramatically reduce the percentage of ROT consumers in the model. We can obtain the same consumption multiplier as in GLV (2007) with only 25% of constrained agents, instead of 50%, and two quarters of price stickiness, instead of four.

Following the RBC literature (King and Watson (1996)), GLV choose the value of 1 for η, the elasticity of the investment to capital ratio with respect to Tobin's Q. A higher value of η reduces the size of capital adjustment costs and allows investment to fluctuate more. In Figures 4.4 and 5.4 we see that even when this value is raised to 11 the response of output and consumption is almost unaffected.

In Figures 4.5 and 5.5 we consider the parameter ϕ_g in the fiscal rule: when it is fixed at zero the increase in government spending is entirely deficit-financed, whereas when it is fixed at one the shock is budget-balanced. In the baseline calibration the shock is almost entirely deficit-financed $\left(\phi_g = 0.1\right)$. When the shock is budget-balanced $\left(\phi_g = 1\right)$, the response of consumption becomes significantly negative. We insist on the fact that this model enables us to study deficit-financed shocks that have very different implications with respect to budget-balanced shocks: in a model with only Ricardian consumers, this difference vanishes.

In Figures 4.6 and 5.6 we show that the output and consumption responses are independent of the form and the degree of wage rigidity. To see this point we consider the rather extreme case of a fixed nominal wage (dashed line): even in this case the positive response of consumption is preserved. An alternative way to model wage rigidity can be found in Blanchard and Galí (2007). They propose the following (admittedly ad hoc) wage schedule modelled as a partial adjustment mechanism:

$$rw_t = \gamma rw_{t-1} + (1 - \gamma)\left(c_t + \varphi n_t\right)$$

In this framework, real wages react only in part to changes in the marginal rate of substitution, and the parameter γ is considered as an index of real wage rigidity. We consider the case of partial real wage rigidity ($\gamma = 0.75$, dotted line). The response of consumption is still positive and hence our result is independent of the postulated wage rigidity (either nominal or real).[10]

4 An extension with segmented labor markets

In the baseline version of our model we keep the assumption of a common wage between ROT and OPT agents to facilitate the comparison with GLV (2007). A legitimate question is to test whether the results are affected by the common wage assumption. In this section we allow both kinds of agents to choose their own wage, while being ready to supply the quantity of labor demanded by firms. The form of the wage rigidity (à la Rotemberg) implies that all ROT agents choose the same wage. Nevertheless, this wage is different from the one chosen by OPT agents, who have a different marginal rate of substitution. A similar modeling choice can be found in Bilbiee and Straub (2004), where wages are flexible instead of sticky and there is perfect competition in the labor market. The GEM model developed at the IMF incorporates ROT consumers and a similar specification of the labor market (Faruquee et al. (2006)). This modeling choice implies a forward-looking wage equation for OPT agents and a static wage equation for ROT agents:

$$\pi_t^{wo} = \beta E_t \pi_{t+1}^{wo} - \kappa_{wo} \left(rw_t^o - c_t^o - \varphi n_t^o \right)$$

[10] Although in this model nominal wage rigidity and real wage rigidity share the same properties, it is not always the case. Blanchard and Gali (2007) study the optimal monetary policy problem: under real wage rigidity it is not possible to stabilize the output gap and inflation at the same time, whereas it is the case under nominal wage rigidity (if inflation is considered as a weighted average of price inflation and wage inflation).

$$\pi_t^{wr} = -\kappa_{wr} \left(rw_t^r - c_t^r - \varphi n_t^r \right)$$

A detailed derivation of these two equations can be found in the appendix.

In figure 6 we plot the responses to a government spending shock under the baseline calibration. The dashed line indicates the model with flexible wages. We now identify a different response in OPT wages and in ROT wages. OPT wages decline slightly because of the wealth effect that lowers the marginal rate of substitution of OPT agents (MRS^o). MRS^r does not decline since the wealth effect does not hit ROT agents. The ROT wage increases, whereas the OPT wage declines, essentially because of the wealth effect and the different marginal rates of substitutions. At the same time firms have the incentive to hire more OPT labor since the costs are lower. OPT hours increase considerably and ROT hours increase only slightly. Moreover, the delayed response of taxes explains the hump-shaped response of ROT hours. Current income of ROT agents increases only slightly and the response of ROT consumption is low. The effect on aggregate consumption is almost negative and the output multiplier is lower than one.

This result is important because it shows that the expansionary effects on output and consumption are lost once we depart from the common wage assumption. However, the expansionary effects are rescued when sticky wages are introduced (the dashed line): under four quarters of wage stickiness, the two wages react in similar ways and the same for hours worked. Under sticky wages the impact of wage heterogeneity in the model is strongly reduced and the dynamics are similar to the model with a common wage. Thus, our initial conjecture on the impact of sticky wages is completely reversed. In section 3 we showed that sticky wages can coexist with expansionary effects on output and consumption under the common wage assumption. Here, we have just shown that sticky wages are even essential to obtain these effects

when wages are different. Therefore, sticky wages confirm and generalize the validity of the GLV result.

5 Conclusion

In this paper, we study how expansionary fiscal policy effects and financial frictions are related in a model with wage rigidities and we provide a rationale for a fiscal expansion when financial frictions are tight. We show that the sticky wage assumption, even if this intuitively was not the case, is compatible with large positive effects on output and consumption.

Therefore, we generalize the validity of previous results by GLV (2007) on several dimensions and we relate them to the context of the current crisis. In contrast to GLV (2007), our model can reproduce expansionary effects under low labor supply elasticity and a low degree of price stickiness. Moreover, once we relax the common wage assumption, sticky wages are even essential to reproduce expansionary effects.

From a policy perspective, our model supports the argument that a fiscal stimulus can be more beneficial when financial frictions are tight, even though wage rigidities are pervasive. Of course, this conclusion should be investigated in models where financial frictions are modelled in a more rigorous way. In a follow-up project (Furlanetto and Natvik (2009)) we investigate the effectiveness of a fiscal package in the context of a model with savers and borrowers where borrowing is limited by collateral constraints. The collateral is given by a durable good that can be interpreted as housing (cf. Monacelli (2009)).

Furthermore, since the structure of the labor market is crucial (although not the details of wage setting), we believe that it would be of paramount importance to introduce unemployment in the model. We plan to investigate this issue in the near future.

Appendix

In this appendix we extend the baseline model letting each household choose its wage under adjustments costs à la Rotemberg. Each household supplies one variety of labor indexed by z and is a monopolistic competitor on this market.

Firms. Each firm, indexed by j, aggregates ROT and OPT labor in the following way:

$$N_t(j) = \left[(\lambda)^{\frac{1}{\varepsilon_w}} N_t^r(j)^{1-\frac{1}{\varepsilon_w}} + (1-\lambda)^{\frac{1}{\varepsilon_w}} N_t^o(j)^{1-\frac{1}{\varepsilon_w}} \right]^{\frac{\varepsilon_w}{\varepsilon_w - 1}} \tag{24}$$

where ε_w denotes the elasticity of substitution between the two labor bundles that are defined as follows:

$$N_t^r(j) = \left[\left(\frac{1}{\lambda} \right)^{\frac{1}{\varepsilon_{wr}}} \int_{(1-\lambda)}^{1} N_t^r(j,z)^{1-\frac{1}{\varepsilon_{wr}}} dz \right]^{\frac{\varepsilon_{wr}}{\varepsilon_{wr} - 1}} \tag{25}$$

$$N_t^o(j) = \left[\left(\frac{1}{1-\lambda} \right)^{\frac{1}{\varepsilon_{wo}}} \int_{0}^{(1-\lambda)} N_t^o(j,z)^{1-\frac{1}{\varepsilon_{wo}}} dz \right]^{\frac{\varepsilon_{wo}}{\varepsilon_{wo} - 1}} \tag{26}$$

$N_t^o(j)$ denotes the quantity of OPT labor used by the firm in the production process, $N_t^o(j,z)$ is the quantity of OPT labor of variety z and ε_{wo} is the elasticity of substitution between different varieties of OPT labor. The same notation is used for ROT agents.

The wage indexes corresponding to the labor bundles (25) and (26) are given by the following aggregators:

$$W_t^r = \left[\frac{1}{\lambda} \int_{(1-\lambda)}^{1} W_t^r(z)^{1-\varepsilon_{wr}} dz \right]^{\frac{1}{1-\varepsilon_{wr}}} \quad W_t^o = \left[\frac{1}{1-\lambda} \int_{0}^{1-\lambda} W_t^o(z)^{1-\varepsilon_{wo}} dz \right]^{\frac{1}{1-\varepsilon_{wo}}}$$

Each firm takes the wages $W_t^r(z)$ and $W_t^o(z)$ as given and chooses the optimal

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demand for each labor variety by minimizing costs subject to the aggregation constraints (25) and (26). The demand functions for each variety of both kinds of labor read as follows:

$$N_t^r(j, z) = \frac{1}{\lambda} \left(\frac{W_t^r(z)}{W_t^r} \right)^{-\varepsilon_{wr}} N_t^r(j) \tag{27}$$

$$N_t^o(j, z) = \frac{1}{1 - \lambda} \left(\frac{W_t^o(z)}{W_t^o} \right)^{-\varepsilon_{wo}} N_t^o(j) \tag{28}$$

Next, taking the wage indexes W_t^r and W_t^o as given, each firm chooses the optimal demand for the two labor bundles $N_t^r(j)$ and $N_t^o(j)$ by minimizing labor costs subject to (24). This yields the following demand functions for labor bundles:

$$N_t^r(j) = \left(\frac{W_t^r}{W_t} \right)^{-\varepsilon_w} \lambda N_t(j)$$

$$N_t^o(j) = \left(\frac{W_t^o}{W_t} \right)^{-\varepsilon_w} (1 - \lambda) N_t(j)$$

and the aggregate wage index is defined as:

$$W_t = \left[\lambda W_t^{r1-\varepsilon_w} + (1 - \lambda) W_t^{o1-\varepsilon_w} \right]^{\frac{1}{1-\varepsilon_w}}$$

Households. OPT households maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[U^o \left(C_t^o, N_t^o(z) \right) \right] \tag{29}$$

subject to the budget constraint and labor demand (obtained aggregating (28) across firms):[11]

---

[11]Even if in equilibrium aggregate hours and wages (N_t, W_t) and individual variety hours and wages $(N_t(z), W_t(z))$ are equal, ex-ante it is not the case. Therefore, when we write the maximization problem we index hours and wages to variety z. For sake of simplicity, we dont make this distinction for the other variables.

$$P_t \left(C_t^o + I_t^o \right) + R_t^{-1} B_{t+1}^o + P_t T_t^o + F_t^o = W_t^o \left(z \right) N_t^o \left(z \right) + R_t^k K_t^o + B_t^o + D_t^o \quad (30)$$

$$N_t^o \left(z \right) = \frac{1}{1 - \lambda} \left(\frac{W_t^o \left(z \right)}{W_t^o} \right)^{-\varepsilon_{wo}} N_t^o \quad (31)$$

The first-order condition with respect to $W_t^o \left(z \right)$ reads as follows:

$$
\begin{aligned}
0 = & \left(\frac{1}{C_t^o} \right) \frac{W_t^o}{P_t} \left[\frac{\varepsilon_{wo}}{1 - \lambda} - 1 + \phi_{wo} \left(\Pi_t^{wo} - 1 \right) \Pi_t^{wo} \right] \\
& - \frac{\varepsilon_{wo}}{1 - \lambda} \left(N_t^o \right)^\varphi - \beta E_t \left[\frac{1}{C_{t+1}^o} \phi_w \left(\Pi_{t+1}^{wo} - 1 \right) \Pi_{t+1}^{wo} \frac{W_{t+1}^o}{P_{t+1}} \frac{N_{t+1}^o}{N_t^o} \right]
\end{aligned}
\quad (32)
$$

where Π_t^{ow} denotes OPT wage inflation.

ROT households solve a static problem maximizing:

$$U^r \left(C_t^r, N_t^r \left(z \right) \right) = \log C_t^r - \frac{N_t^r \left(z \right)^{1+\varphi}}{1 + \varphi}$$

subject to the budget constraint and labor demand (derived aggregating (27) across firms):

$$P_t C_t^r + P_t T_t^r + F_t^r = W_t^r \left(z \right) N_t^r \left(z \right)$$

$$N_t^r \left(z \right) = \frac{1}{\lambda} \left(\frac{W_t^r \left(z \right)}{W_t^r} \right)^{-\varepsilon_{wr}} N_t^r$$

The static FOC with respect to $W_t^r \left(z \right)$ is given by

$$0 = \left(\frac{1}{C_t^r} \right) \frac{W_t^r}{P_t} \left[\frac{\varepsilon_{wr}}{\lambda} - 1 + \phi_{wr} \left(\Pi_t^{wr} - 1 \right) \Pi_t^{wr} \right] - \frac{\varepsilon_{wr}}{1 - \lambda} N_t^{r\varphi} \quad (33)$$

The log-linearized model. The extended model is log-linearized around the same steady state as the baseline model: hence, in steady state all agents share the same wages, hours worked and consumption levels. Tax rates are set accordingly. The wage setting equations are given by log-linearized versions of (32) and (33):

$$\pi_t^{wo} = \beta E_t \pi_{t+1}^{wo} - \kappa_{wo} \left(rw_t^o - c_t^o - \varphi n_t^o \right)$$

$$\pi_t^{wr} = -\kappa_{wr} \left(rw_t^r - c_t^r - \varphi n_t^r \right)$$

where $\kappa_{wo} = \frac{\frac{\varepsilon_{wo}}{1-\lambda}-1}{\phi_{wo}}$ and $\kappa_{wr} = \frac{\frac{\varepsilon_{wr}}{\lambda}-1}{\phi_{wr}}$. For simplicity we impose $\varepsilon_w = \varepsilon_{wr} = \varepsilon_{wo} = 4$. We calibrate ϕ_{wo} and ϕ_{wr} to be consistent with 4 quarters of wage rigidity in the Calvo model. Thus, $\phi_{wo} = \frac{\frac{\varepsilon_{wo}}{1-\lambda}-1}{(1-\beta\theta_w)(1-\theta_w)\theta_w^{-1}(1+\varphi\varepsilon_w)^{-1}}$, $\phi_{wr} = \frac{\frac{\varepsilon_{wr}}{\lambda}-1}{(1-\beta\theta_w)(1-\theta_w)\theta_w^{-1}(1+\varphi\varepsilon_w)^{-1}}$ and $\theta_w = 0.75$.

References

[1] Baxter, M., King, R., 1993. Fiscal policy in general equilibrium. American Economic Review 83, 315-334.

[2] Bilbiee, F., Straub R., 2004. Fiscal policy, business cycles and labor market fluctuations. Hungarian National Bank, working paper 2004-06.

[3] Bils, M., Klenow, P., 2004. Some evidence on the importance of sticky prices. Journal of Political Economy 112, 947-985.

[4] Blanchard, O., Perotti, R., 2002. An empirical characterization of the dynamic effects of changes in government spending and taxes on output. Quarterly Journal of Economics 117, 4, 1329-68.

[5] Blanchard, O., Galí, J., 2007. Real wage rigidities and the New Keynesian model. Journal of Money, Credit and Banking 39, 33-65.

[6] Bouakez, H., Rebei, N., 2007. Why does private consumption rise after a government spending shock? Canadian Journal of Economics 40, 954-979.

[7] Caldara, D., Kamps, C., 2008. What do we know about the effects of fiscal policy shocks? A Comparative Analysis. ECB working paper 877.

[8] Calvo, G., 1983. Staggered prices in a utility maximizing framework. Journal of Monetary Economics 12, 383-398.

[9] Christiano L., Eichenbaum, M., Evans, C., 2005. Nominal rigidities and the dynamic effects of a shock to monetary policy. Journal of Political Economy 113, 1-45.

[10] Coenen, G., Straub, R., 2005. Does government spending crowd in private consumption? Theory and empirical evidence for the euro area. International Finance 8, 436-470.

[11] Colciago. A., 2008. Rule-of-thumb consumers meet sticky wages. Mimeo.

[12] Dickens, W., Goette, L., Groshen, E.L., Holden, S., Messina, J., Schwitzer, M.E., Turunen, J., Ward, M., 2007. How wages change: micro evidence from the international wage flexibility project. Journal of Economic Perspectives 21, 195-214.

[13] Erceg, C., Henderson, D.W., Levin, A., 2000. Optimal monetary policy with staggered wage and price contracts. Journal of Monetary Economics 46, 381-413.

[14] Faruqee, H., Laxton, D., Muir, D., Pesenti, P., 2006. Would protectionism diffuse global imbalances and spur economic activity? A scenario analysis. NBER working paper 12704.

[15] Fatas, A., Mihov, I., 2001. The effects of fiscal policy on consumption and employment: theory and evidence. Mimeo.

[16] Feldstein, M.S., 2009. Rethinking the role of fiscal policy. NBER working paper 14684.

[17] Forni, L., Monteforte, L., Sessa, L., 2009. The general equilibrium effects of fiscal policy: Estimates for the euro area. Journal of Public Economics 93, 559-585.

[18] Furlanetto, F., Seneca, M., 2007. Rule-of-thumb consumers, productivity and hours. Norges Bank working paper 2007/5.

[19] Furlanetto, F., Seneca, M., 2009. Fiscal shocks and real rigidities. The B.E. Journal of Macroeconomics: 9 (1) (Topics), Article 2.

[20] Furlanetto, F., Natvik, G.J., 2009. Fiscal stimulus and financial frictions. Mimeo, Norges Bank.

[21] Galí, J., Lopez-Salido, D., Valles, J., 2007. Understanding the effects of government spending on consumption. Journal of the European Economic Association 5, 227-270.

[22] Hall, R.E., 2005. Employment fluctuations with equilibrium wage stickiness. American Economic Review 95, 50-65.

[23] Holden, S., Wulfsberg, F., 2008. Downward nominal real wage rigidity in OECD. The B.E. Journal of Macroeconomics: 8 (1) (Advances), Article 15.

[24] Holden, S., Wulfsberg, F., 2009. How strong is the macroeconomic case for downward real wage rigidity?. Journal of Monetary Economics 56, forthcoming.

[25] Ireland, P., 2003. Endogenous money or sticky prices? Journal of Monetary Economics 50, 1623-1648.

[26] King, R., Watson, M., 1996. Money, prices, interest rates and the business cycle. Review of Economics and Statistics 78, 35-53.

[27] Kriwoluzky, A., 2009. Pre-announcement and timing: the effects of a government expenditure shock. Mimeo, European University Institute.

[28] Lebow, D., Saks, R., Wilson, B., 2003. Downward nominal wage rigidity. Evidence from the employment cost index. The B.E. Journal of Macroeconomics: 3 (1) (Advances), Article 2.

[29] Linnemann, L., 2006. The effect of government spending on private consumption: a puzzle? Journal of Money, Credit and Banking 38, 1715-1736.

[30] Linnemann, L., Schabert, A., 2003. Fiscal policy in the New Neoclassical synthesis. Journal of Money, Credit and Banking 36, 151-175.

[31] Linnemann, L., Schabert, A., 2005. Productive government expenditure in monetary business cycle models. Scottish Journal of Political Economy 53, 28-46.

[32] López-Salido, J.D., Rabanal, P., 2008. Government spending and consumption hours preferences. mimeo "La Caixa".

[33] Mankiw, G., 2000. The savers-spenders theory of fiscal policy. American Economic Review 90, 120-125.

[34] Mertens, K., Ravn, M., 2009. Measuring the impact of fiscal policy in the face of anticipation: a Structural VAR approach. Mimeo, Cornell University.

[35] Mountford, A., Uhlig, H., 2008. What are the effects of fiscal policy shocks? NBER working paper 14551.

[36] Monacelli, T., Perotti, R., 2008. Fiscal policy, wealth effects and markups. NBER working paper 14584.

[37] Monacelli, T., 2009. New Keynesian models, durable goods and collateral constraints. Journal of Monetary Economics 56, 242-254.

[38] Natvik, G.J., 2008. Government spending with rule-of-thumb consumers and steady state inequality. Manuscript, Norges Bank.

[39] Perotti, R., 2005. Estimating the effects of fiscal policy in OECD countries. CEPR working paper 4842.

[40] Perotti, R., 2007. In search of the transmission mechanism of fiscal policy. NBER Macroeconomics Annual.

[41] Ramey, V. A., 2008. Identifying government spending shocks: it' s all about timing. Mimeo University of California San Diego.

[42] Ravn, M., Schmitt-Grohe, S., Uribe, M., 2006. Deep habits. Review of Economic Studies 73, 195-218.

[43] Romer, C., Bernstein, J., 2009. The job impact of the American recovery and reinvestment plan. Mimeo.

[44] Rotemberg, J., 1982. Sticky prices in the United States. Journal of Political Economy 90, 1187-1211.

[45] Schmitt-Grohe, S., Uribe, M., 2006. Comparing two variants of Calvo-type wage stickiness. NBER working paper 12740.

[46] Shimer, R., 2009. Labor markets and business cycles. Princeton University Press, in press.

[47] Smets, F., Wouters, R., 2003. An estimated dynamic stochastic general equilibrium model of the euro area. Journal of the European Economic Association 1(5), 1123-1175.

[48] Smets, F., Wouters, R., 2007. Shocks and frictions in US business cycles: a Bayesian DSGE approach. American Economic Review 97, 586-606.

[49] Spilimbergo, A., Symansky, S., Blanchard, O., Cottarelli, C., 2008. Fiscal policy for the crisis. IMF staff position note 08/01.

[50] Woodford, M., 2003. Interest and prices: foundations of a theory of monetary policy. Princeton University Press.
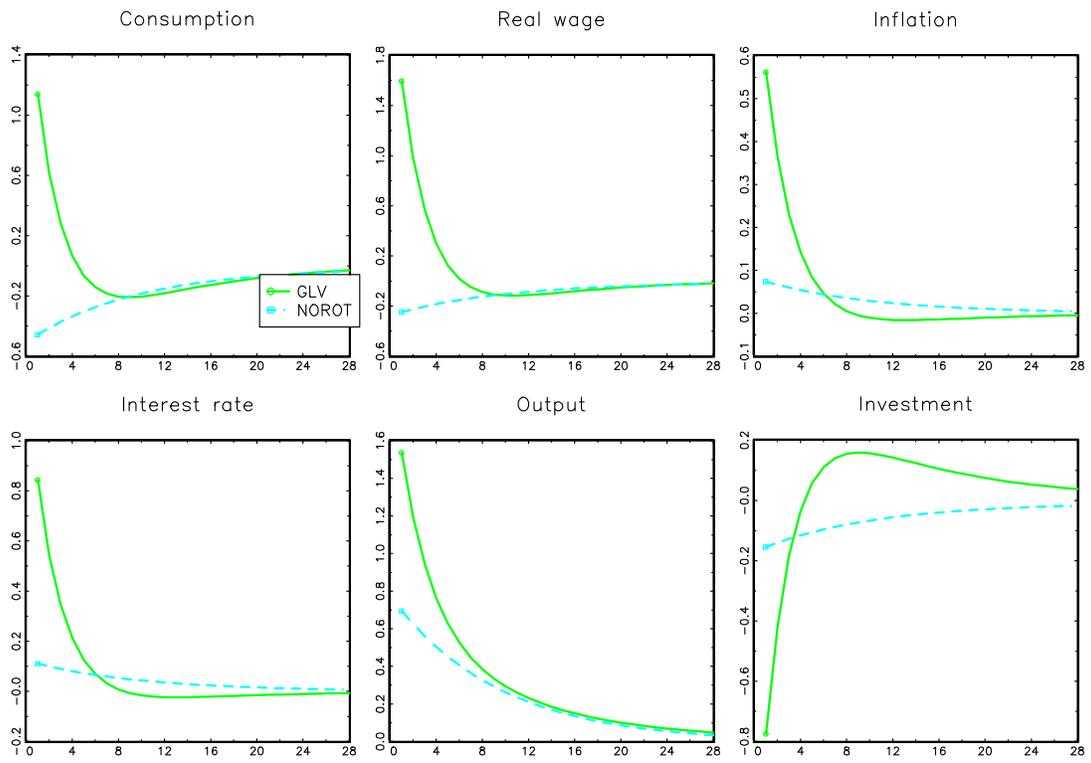
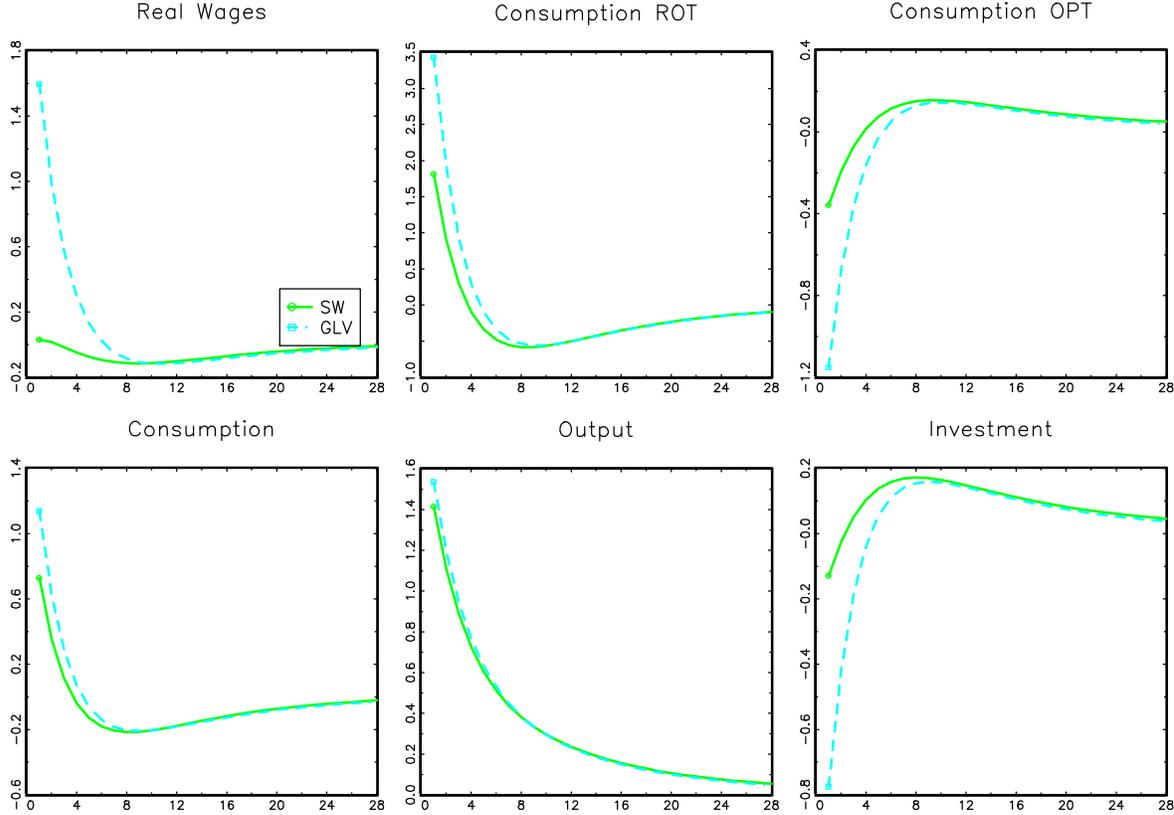Figure 1 Key Results in GLV (2007)

Figure 2 GLV Model + Sticky Wages
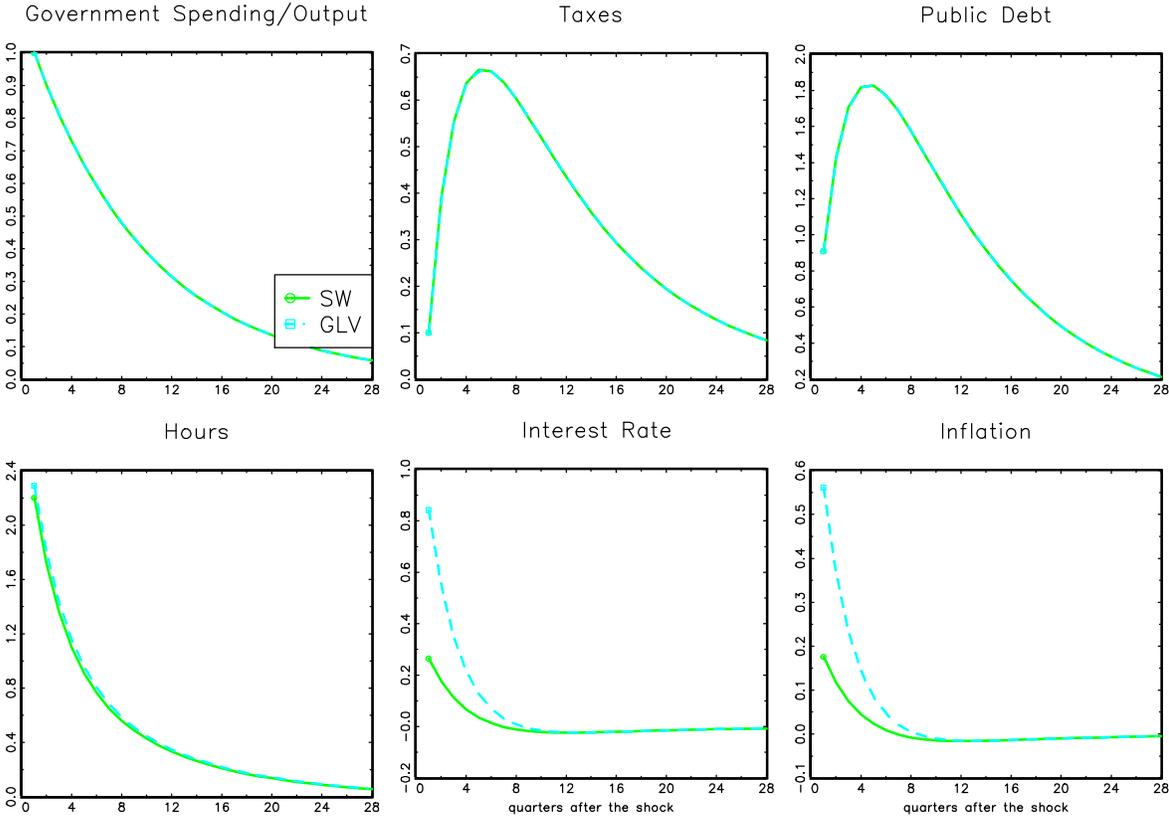
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Figure 3 GLV Model + Sticky Wages

Figure 4 Sensitivity Analysis

4.1 Consumption

4.2 Consumption

4.3 Consumption

4.4 Consumption

4.5 Consumption

4.6 Consumption

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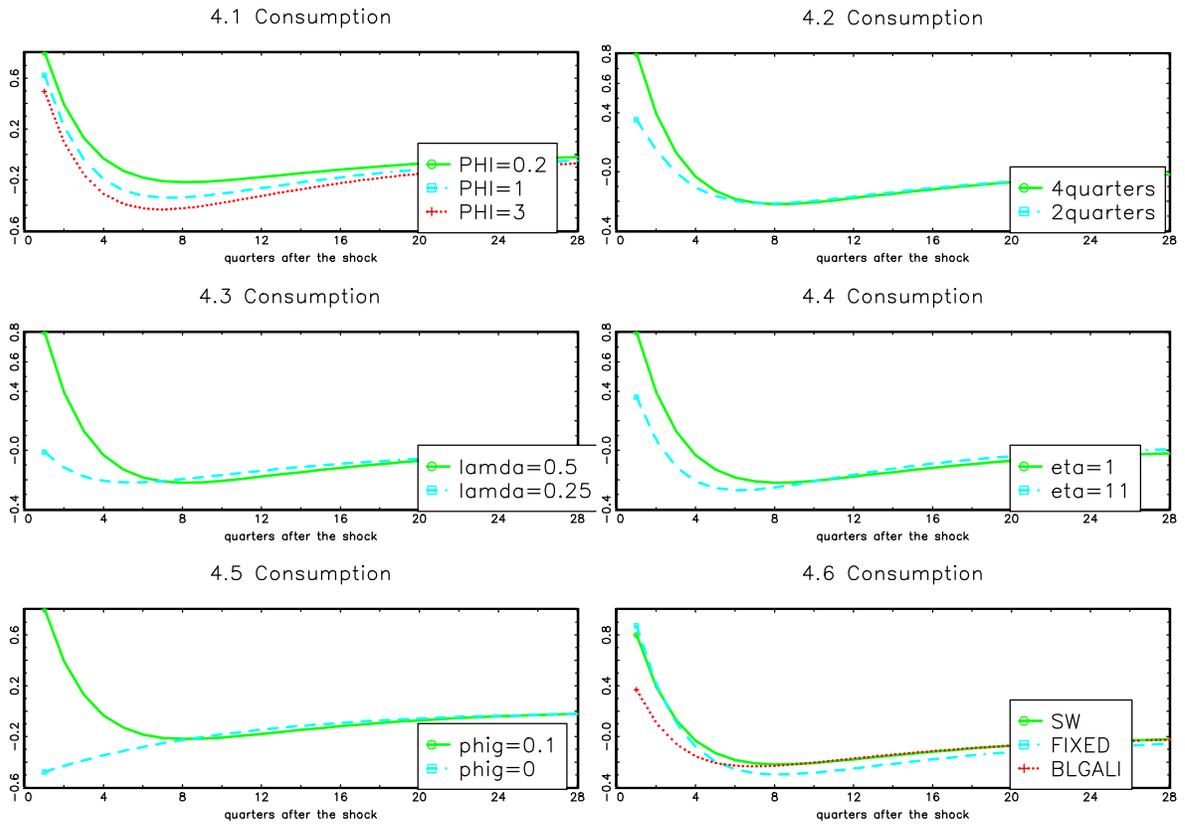
Figure 5 Sensitivity Analysis

5.1 Output

PHI=0.2
PHI=1
PHI=3

quarters after the shock

5.2 Output

4quarters
2quarters

quarters after the shock

5.3 Output

lamda=0.5
lamda=0.25

quarters after the shock

5.4 Output

eta=1
eta=11

quarters after the shock

5.5 Output

phig=0.1
phig=0

quarters after the shock
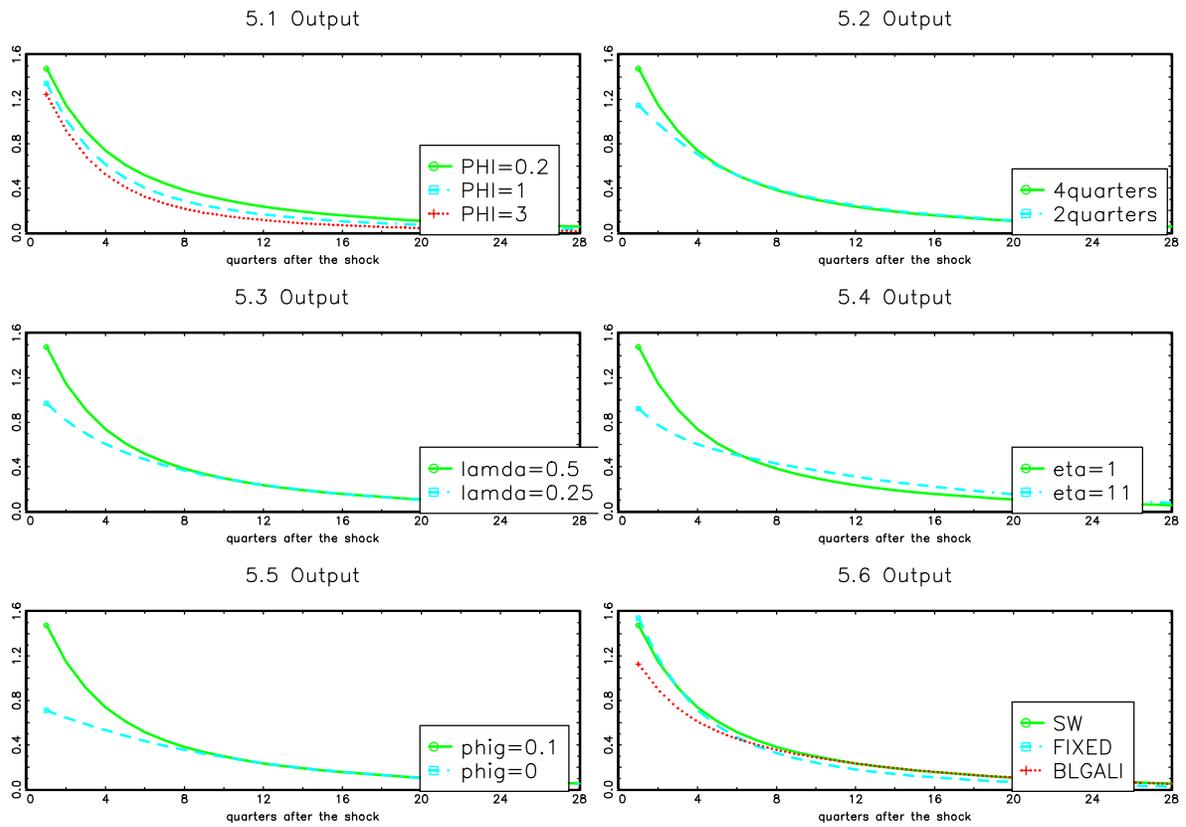
5.6 Output

SW
FIXED
BLGALI

quarters after the shock

Figure 6 The Model with Heterogeneity in Wages

Output

Consumption

SW
FLEX

Consumption ROT

Consumption OPT

Real Wages ROT

quarters after the shock

Real Wages OPT

quarters after the shock

Hours ROT

quarters after the shock

Hours OPT

quarters after the shock

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