Household Leverage and Fiscal Multipliers*

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Abstract

We study the size of fiscal multipliers in response to a government spending shock under different household leverage conditions in a general equilibrium setting with search and matching frictions. We allow for different levels of household indebtedness by changing the intensive margin of borrowing (loan-to-value), as well as the extensive margin, defined as the number of borrowers over total population. The interaction between the consumption decisions of agents with limited access to credit and the process of wage bargaining and vacancy posting delivers two main results: (a) higher initial leverage makes it more feasible to find output multipliers higher than one; (b) a positive government expenditure shock always produces a positive multiplier for vacancies and employment. The latter result is in sharp contrast with models in which some households do not have access to the financial market (RoT consumers), in which the implied labor market responses to fiscal shocks are inconsistent with the empirical evidence. In the model with indebted impatient households we also observe that output (employment) multipliers decrease (increase) markedly with the degree of shock persistence and increase with the degree of price stickiness.

Keywords: fiscal multipliers, private leverage, labour market search.
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1. Introduction

The current economic crisis has stirred a renewed interest in fiscal policy as a stabilization tool. For many years the predominant view of pundits in the field, as represented by the so called Jackson Hole consensus (Bean et al, 2010), held that discretionary fiscal stimuli had an effect on output and employment ranging from weakly positive to negative. The

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only relevant use for this instrument ought to be then confined to role of the automatic stabilizers. This view changed rapidly during the early days of the financial turmoil when most academic and policy makers called for strong spending hikes and/or tax cuts to keep the world economy from plunging into an even deeper recession. Two years later many countries are struggling to undo those fiscal actions, fearing the reaction of financial markets to the rapid surge of public debt all over the developed world. The discussion on the real effects on the economy of an increase in the government spending -and the likely reaction of the different economies to their withdrawal- has been central to the political and academic debate in the last two years. A clear example of this can be found in the work of Romer and Bernstein (2009) and the answers of Cogan, Cwik, Taylor and Wieland (2010) and Uhlig (2010) regarding the expected impact of the US fiscal packages.

This discussion has been in fact going on for a long time now at a broader level, accumulating a substantial amount of international empirical evidence in favor of each of the different views as reflected, for instance, in the recent IMF World Economic Outlook (2010) and the results in Alesina and Ardagna (2010). While the IMF report finds that discretionary cuts in the deficit are contractionary with a moderate but significant effect on output and employment, Alesina and Ardagna (2009) argue that fiscal contractions might even be expansionary under fairly general conditions, and specially so if they take place in periods of fiscal stress and high public debt levels.

The positive effects of fiscal impulses that many authors find in the empirical work are difficult to accommodate in macroeconomic models with standard preferences and Ricardian consumers. This empirical evidence has stimulated an interest in theoretical models to overcome that deficiency within the limits of general equilibrium and rational consumers, mainly -though not only- by allowing for features that modify the smoothness of the intertemporal substitution channel in models with unconstrained consumers. In this vein, our paper explores the role of one particular variable that is key in the current recession but that has received little attention so far: private debt. Galí, López-Salido and Vallés (2007) proposed the inclusion of non Ricardian consumers to prompt a strong consumption response to government spending increases that pushes the output multiplier above one. In order to achieve these results it is crucial that a significant proportion of households actually do not participate in the financial market so that their consumption is tied down to their disposable income. One of the key features of the current financial crisis is that it has taken most firms and households highly leveraged with mortgages and other borrowing contracts. Most agents actually participate in the financial market as borrowers and their consumption decisions are likely to be affected by that. For one thing, these agents' consumption is not only related to their labor income but also to their net worth and hence to the evolution of inflation, interest rates, total debt and asset prices.

This channel is potentially important and more so after many years of financial deepening linked to the growing demand for housing.

In this paper we study the size of fiscal multipliers paying special attention to the main determinants of consumption: labor income and net worth and to that end we augment the canonical neo-keynesian model in two directions. Since the dynamics of the labor market variables is key in the transmission of fiscal impulses we allow for two sided market power, wage bargaining and matching frictions in the vein of Andolfatto's (1996) model. The financial structure of our model draws on Iacoviello (2005). All agents in the economy participate in the financial market, but due to differences in their subjective valuation of the future the most impatient of them borrow from the patient ones. Since differences in discount factors are deterministic, the amount of borrowing is limited by the value of the collateral given by the expected value of the household's housing holding. Hence, even constrained consumers keep some room for intertemporal substitution so that a modified version of the Euler condition on consumption still prevails. Andrés and Arce (2010), Boscá, Doménech and Ferri (2011) and Roeger and int Veld (2009) have looked at some of the mechanisms involved in our model. Here we extend this line of research analyzing the interaction between the consumption decisions of agents with limited access to credit and the process of wage bargaining and vacancy posting[1].

The main results of the paper can be summarized as follows. First, under a fairly standard characterization the model delivers impulse response fiscal multipliers in line with the empirical literature. In particular while we obtain positive multipliers, the consumption response is positive but lower than the one predicted by the standard model with rule-of-thumb (RoT) consumers. Second, the higher the borrowing capacity (as measured by a higher loan-to-value ratio) the stronger the impact multiplier of fiscal policy. Impatient households borrow to the limit of their constraint thus increasing their consumption substantially when the loan-to-value ratio is high, contributing to a higher aggregate multiplier. Notice that this result can be read in two ways regarding the current policy debate. With high leverage, multipliers are expected to be large because constrained consumers find it easier to borrow as the value of the collateral improves. By the same token, fiscal expansions loose strength after a credit crunch that makes it more difficult for impatient consumers to borrow. Thus, pre-crisis multipliers might not be a good indicator of the likely effect of fiscal policy after the tightening in lending facilities by banks caused by the disruption in interbank markets and the increase in perceived default risk everywhere. Finally our model predicts that vacancies and employment grow after a fiscal expansion, as observed in the data, while the RoT model predicts the opposite. In the RoT

[1] In a similar model Andrés, Boscá and Doménech (2011) show that changes in financial conditions of the ecomomy may account for the observed pattern of business cycle dynamics of labor market variables.

model the increase in wages is so strong that firms are less inclined to post more vacancies and exploit the intensive margin increasing hours and reducing employment.

The rest of the paper is organized as follows. In section 2 we review the empirical literature; section 3 summarizes the model; section 4 deals with the calibration wheras in section 5 we present the main simulation results. Section 6 concludes.

2. Review of the empirical literature

In this section we present a non exhaustive review of the main results in the literature regarding the impact of fiscal policies (impact multipliers) on the following variables: output, consumption, (un)employment and vacancies. Investment and real wages play an important role in the transmission of fiscal shocks but their response is less controversial and is easily reproduced in a broad class of macroeconomic models.

The empirical analysis of the fiscal multiplier gathered momentum after the work of Blanchard and Perotti (2002) who estimated a VAR for the US economy with a careful identification approach to the effect of discretionary fiscal policy changes. They found that, consistent with a Keynesian view, output and consumption increase while investment falls in response to a positive government spending shock. These results are consistent with those obtained by Burnside, Eichenbaum and Fisher (2004), Fatás and Mihov (2001), Galí, López-Salido and Vallés (2007) and Perotti (1999), among others. Using a similar methodology Perotti (2004) found coincident results for these variables for Australia, Canada, the United Kingdom and Germany. Mounford and Uhlig (2009) use a sign restriction methodology to identify the effects of fiscal shocks and find that private consumption does not change significantly in response to an unexpected increase in government spending. Some authors such as Ramey and Shapiro (1997), Edelberg, Eichenbaum and Fisher (1999) or McGrattan and Ohanian (2003) have focussed on particular and well identified episodes of military spending increases in the United States. The main conclusion of this literature is that there is a significant and positive short-run effect on output of these fiscal expansions that fades away after some years.

In contrast with these results, other stream of the literature has found that contractionary policies have expansionary effects on output, i.e. that fiscal policy may have non-Keynesian effects. Beginning with the work of Giavazzi and Pagano (1990) many studies have analyzed the macroeconomic effect of fiscal consolidations. In their survey to this literature, Hemming, Kell and Mahfouz (2002) conclude that there are many examples in which fiscal contractions have had expansionary effects on output, private consumption and investment. As Perotti (1999) has analyzed the initial conditions of some key variables can explain why fiscal expansions have a positive effect in 'good times' but a negative one in 'bad times', where fiscal consolidations are needed.

This literature has received further impulse in recent years partly as a result of the renewed debate after the financial crisis as the debate among Romer and Bernstein (2009), Cogan, Cwik, Taylor and Wieland (2010) and Uhlig (2010) demonstrates. Alesina and Ardagna (2010) find that the effect of fiscal stimuli may result in an output expansion almost with the same probability as in a contraction, and that the outcome depends crucially on the particular components of government spending and taxes that change. Barro and Redlick (2009) measure the impact fiscal policy by looking at very long series for the US and a careful identification procedure focusing on the role of military spending. They find small consumption multipliers leading to lower than 1 output multipliers around 0.4-0.7. Interestingly they find that changes in tax revenue have a smaller impact on output than variations in the marginal tax rate; they conclude that the labor supply channel dominates the standard aggregate demand one in the transmission mechanism of fiscal shocks. Romer and Romer (2009, 2010), following a narrative approach, find strong output responses to tax changes in the US. The same approach has inspired the recent work by Leigh, Devries, Freedman, Guajardo, Laxton, and Pescatori (WEO, 2010) who have looked to many episodes in a broad sample of developed countries and find that, albeit small, output multipliers are unambiguously positive and that a 1% fiscal contraction reduces output by 0.5% on average.

Some authors have looked at other determinants of the effectiveness of fiscal policies. Recently, Auerbach and Gorodnichenko (2010) estimate state-dependent fiscal multipliers, documenting a higher effectiveness of government spending shocks in recessions than in expansions. Still, important differences among historical episodes are lumped together by these authors. There is widespread consensus about the importance of the monetary policy reaction to fiscal shocks as a major determinant of the size of the multipliers (Woodford, 2010), that become unusually large if the economy hits the zero bound of the nominal interest rate (Christiano, Eichenbaum and Rebelo, 2009).

Our reading of the literature is that fiscal expansions have a positive albeit small effect on output. Beyond that, the precise value of the fiscal multiplier is difficult to gauge. The recent works by Caldara et al. (2008), Coenen et al. (2010), Cogan et al. (2010), are cited by Leeper (2010) as a proof of the difficulty of coming up with a simple answer to the question of whether or to what extent fiscal policy is effective as a stabilization tool, what he calls the "fiscal morass".

Less attention has been paid to two issues that we discuss at length with our theoretical model: the role of financial conditions and the response of output and vacancies the fiscal innovations. As regards the role of financial conditions, Afonso, Baxa and Slavik (2011) report evidence of nonlinearities in the effects of fiscal shocks on economic activity depending on a set of initial conditions determined by the existence of financial stress, diverse levels of government indebtedness, and different implicitly assumed monetary policy behavior.

The ultimate effects of fiscal expansions on the economy crucially depend on the reaction of employment. Despite that, the response of labor market variables to fiscal shocks has received less attention in the literature but the scant empirical literature on the issue points towards a positive effect of a government spending shock on vacancies and employment and a negative effect on unemployment (see Monacelli, Perotti and Trigari, 2010, and Ravn and Simonelli, 2008). Using a different sample span Brückner and Pappa (2010) find a positive effect on employment but a negative impact on unemploymnet driven by an increase in the participation rate.

[TBC]

3. Theoretical framework

3.1 Patient households

Patient households in our economy are characterized by discounting the future less heavily than impatient ones. The representative household faces the following maximization program:

$$\max_{c_t^l, k_t^l, j_t^l, b_t^l, x_t^l} E_t \sum_{t=0}^{\infty} (\beta^l)^t \left[\begin{array}{c} \ln\left(c_t^l\right) + \phi_x \ln\left(x_t^l\right) + n_{t-1}^l \phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} \\ +(1-n_{t-1}^l)\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} \end{array} \right] \tag{1}$$

subject to

$$c_t^l + j_t^l \left(1 + \frac{\phi}{2}\left(\frac{j_t^l}{k_{t-1}^l}\right)\right) + q_t\left(x_t^l - x_{t-1}^l\right) - b_t^l - b_t^p =$$

$$w_t l_1 n_{t-1}^l + r_t k_{t-1}^l + d_t^l - (1 + r_{t-1}^n)\left(\frac{b_{t-1}^l}{1+\pi_t} + \frac{b_{t-1}^p}{1+\pi_t}\right) + trh_t^l - \zeta_t^l \tag{2}$$

$$k_t^l = j_t^l + (1-\delta)k_{t-1}^l \tag{3}$$

$$n_t^l = (1-\sigma)n_{t-1}^l + \rho_t^w(1 - n_{t-1}^l) \tag{4}$$

All lower case variables in the maximization problem above are normalized by the working-age population (N_t). In our notation, variables and parameters indexed by b and l respectively denote impatient and patient households. Non-indexed variables apply indistinctly to both types of households. Thus, c_t^l, x_t^l,n_{t-1}^l and $(1-n_{t-1}^l)$ represent, consumption, housing holdings, the employment rate and the unemployment rate of patient households. The time endowment is normalized to one. l_{1t} and l_2 are hours worked per employee and hours devoted to job seeking by the unemployed. Note that while the household decides over l_{1t}, time dedicated to job search (l_2) is assumed to be exogenous, so that individual households take it as given.

Several parameters are present in the utility function of Ricardian households. Future utility is discounted at a rate of $\beta^l \in (0,1)$. The parameter $-\frac{1}{\eta}$ measures the negative of the Frisch elasticity of labor supply. ϕ_x is the housing weight in life-time utility. In general $\phi_1 \neq \phi_2$, i.e., the subjective value of leisure imputed by workers may vary across employment statuses[2].

Maximization of (1) is constrained as follows. First, the budget constraint (2) describes the various sources and uses of income. The term $w_t n_{t-1}^l l_{1t}$ captures net labor income earned by the fraction of employed workers, where w_t stands for hourly real wages. There are three assets in the economy. First, private physical capital (k_t^l), which is owned solely by patient households. Return on capital is captured by $r_{t-1}k_{t-1}^l$, where r_t represents the gross return on physical capital. Given that firms make extraordinary profits, we assume lenders households receive these in the form of dividends, d_t^l. Second, there are loans/debt in the economy. Thus, patient households lend in real terms $-b_t^l$ (or borrow b_t^l) to private sector and $-b_t^p$ to public sector. They receive back $-(1+r_{t-1}^n)b_{t-1}^l$ from the private sector, where r_{t-1}^n is the nominal interest rate on loans between $t-1$ and t. Notice that in the budget constraint (2), the gross inflation rate between $t-1$ and t (π_t) in the term $(1+r_{t-1}^n)\frac{b_{t-1}^l}{\pi_t}$ reflects the assumption that debt contracts are set in nominal terms. Third, there is a fixed amount of real estate in the economy[3], although housing investment can be performed by both patient and impatient households. The term $q_t\left(x_t^l - x_{t-1}^l\right)$ denotes housing investment by patient households, where q_t is the real housing price.

Consumption and investment are respectively given by c_t^l and $j_t^l\left(1+\frac{\phi}{2}\left(\frac{j_t^l}{k_{t-1}}\right)\right)$. Note that total investment outlays are affected by increasing marginal costs of installation. There are also adjustment costs stemming from changing the housing stock that we model as:

$$\zeta_t^l = \phi_h\left(\left(x_t^l - x_{t-1}^l\right)/x_{t-1}^l\right)^2 q_t x_{t-1}^l/2$$

[2] Notice, that there are two differences in the utility function with respect to a standard search model as in Andolfatto (1996); the presence of habits in consumption and the presence of housing services.

[3] As in Iacoviello (2005), the assumption of an aggregate fixed housing stock is not crucial to the propagation mechanism of shocks in the economy.

Households receive (pay) lump sum transfers (taxes) from (to) the government $\left(trh_t^l\right)$.

The remaining constraints faced by Ricardian households concern the laws of motion for capital and employment. Each period private capital stock k_{t-1}^l depreciates at the exogenous rate δ and is accumulated through investment, j_t^l. Thus, it evolves according to (3). Employment obeys the law of motion (4), where n_{t-1}^l and $(1-n_{t-1}^l)$ respectively denote the fraction of employed and unemployed optimizing workers in the economy at the beginning of period t. Each period, jobs are lost at the exogenous rate σ. Likewise, new employment opportunities come at the rate ρ_t^w, which represents the probability that one unemployed worker will find a job. Although the job-finding rate ρ_t^w is taken as exogenous by individual workers, at aggregate level it is endogenously determined according to the following Cobb-Douglas matching function[4]:

$$\rho_t^w(1-n_{t-1}) = \chi_1 v_t^{\chi_2}\left[(1-n_{t-1})\, l_2\right]^{1-\chi_2} \tag{5}$$

where v_t stands for the number of active vacancies during period t.

Given the recursive structure of the above problem, it may be equivalently rewritten in terms of a dynamic program. Thus, the value function $W(\Omega_t^l)$ satisfies the following Bellman equation:

$$W(\Omega_t^l) = \max_{c_t^l,k_t^l,j_t^l,b_t^l,x_t^l}\left\{\begin{array}{l} \ln\left(c_t^l\right)+\phi_x\ln\left(x_t^l\right)+n_{t-1}^l\phi_1\frac{(1-l_{1t})^{1-\eta}}{1-\eta} \\ +(1-n_{t-1}^l)\phi_2\frac{(1-l_2)^{1-\eta}}{1-\eta}+\beta^l E_t W(\Omega_{t+1}^l)\end{array}\right\} \tag{6}$$

where maximization is subject to constraints (2), (3) and (4).

The solution to the optimization program above generates the following first-order conditions for consumption, capital stock, investment, loans and the holdings of housing:

$$\lambda_{1t}^l = \frac{1}{c_t^l} \tag{7}$$

$$\frac{\lambda_{2t}^l}{\lambda_{1t}^l} = \beta^l E_t\frac{\lambda_{1t+1}^l}{\lambda_{1t}^l}\left\{r_{t+1}+\frac{\phi}{2}\frac{j_{t+1}^{l2}}{k_t^{l2}}+\frac{\lambda_{2t+1}^l}{\lambda_{1t+1}^l}(1-\delta)\right\} \tag{8}$$

$$\lambda_{2t}^l = \lambda_{1t}^l\left[1+\phi\left(\frac{j_t^l}{k_{t-1}^l}\right)\right] \tag{9}$$

[4] This specification presumes that all workers are identical to the firm.

$$1 = \beta^l E_t \frac{\lambda^l_{1t+1}}{\lambda^l_{1t}} \left\{ \frac{r^n_t + 1}{1 + \pi_{t+1}} \right\} \tag{10}$$

$$\lambda^l_{1t} q_t \left[1 + \phi_h \left(\frac{x^l_t}{x^l_{t-1}} - 1 \right) \right] = \frac{\phi_x}{x^l_t}$$
$$+ \beta^l E_t q_{t+1} \lambda^l_{1t+1} \left[1 + \frac{1}{2} \phi_h \left(\frac{x^l_{t+1}}{x^l_t} - 1 \right) \left(\frac{x^l_{t+1}}{x^l_t} + 1 \right) \right] \tag{11}$$

According to condition (7) the current marginal utility of consumption is the inverse of actual consumption. Expression (8) ensures that the intertemporal reallocation of capital cannot improve the household's utility. Equation (9) states that investment is undertaken to the extent that the opportunity cost of a marginal increase in investment in terms of consumption is equal to its marginal expected contribution to the household's utility. First-order condition (10) means that variations across periods in the marginal utility of consumption are coherent with the discount rate and existing real interest rates. Finally, expression (11) makes it possible to obtain optimal housing demand.

Now it is convenient to derive the marginal value of employment for a worker $(\frac{\partial W^l_t}{\partial n^l_{t-1}} \equiv \lambda^l_{ht})$, given that later we will use this to obtain the wage and hours equation in the bargaining process.

$$\lambda^l_{ht} = \lambda^l_{1t} w_t l_{1t} + \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} \right) + (1 - \sigma - \rho^w_t) \beta^l E_t \frac{\partial W^l_{t+1}}{\partial n_t} \tag{12}$$

where λ^l_{ht} measures the marginal contribution of a newly created job to the household's utility. The first term captures the value of the cash-flow generated by the new job in t, i.e. the labor income measured according to its utility value in terms of consumption (λ^l_{1t}). The second term on the right-hand side of (12) represents the net utility arising from the newly created job. Finally, the third term represents the "capital value" of an additional employed worker, given that the employment status will persist into the future, conditional to the probability that the new job will not be lost.

3.2 Impatient households

Impatient households discount the future more heavily than patient ones so their discount rate satisfies $\beta^b < \beta^l$. We will also assume that these households do not hold physical capital, so they face the following maximization program:

$$\max_{c_t^b, b_t^b, x_t^b} E_t \sum_{t=0}^{\infty} (\beta^b)^t \left[\begin{array}{c} \ln\left(c_t^b\right) + \phi_x \ln\left(x_t^b\right) + n_{t-1}^b \phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} \\ +(1-n_{t-1}^b)\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} \end{array} \right] \tag{13}$$

subject to the specific liquidity constraint, a borrowing limit and the law of motion of employment, as reflected in:

$$c_t^b + q_t\left(x_t^b - x_{t-1}^b\right) - b_t^b = w_t l_{1t} n_{t-1}^b - \frac{(1+r_{t-1}^n) b_{t-1}^b}{1+\pi_t} + trh_t^b - \zeta_t^b \tag{14}$$

$$b_t^b \leq m^b E_t \left(\frac{q_{t+1}\left(1+\pi_{t+1}\right) x_t^b}{1+r_t^n} \right) \tag{15}$$

$$n_t^b = (1-\sigma) n_{t-1}^b + \rho_t^w (1-n_{t-1}^b) \tag{16}$$

where $\zeta_t^b = \phi_h \left(\left(x_t^b - x_{t-1}^b\right)/x_{t-1}^b\right)^2 q_t x_{t-1}^b/2$ denotes the housing adjustment cost. As can be appreciated, parameter ϕ_x that accounts for housing weight in life-time utility is the same as for patient households. Later we will allow for random shocks to this parameter that in turn can be interpreted as disturbances to the marginal utility of housing that directly affect housing demand. In this way, we will be able to capture the effects of shocks on house prices.

Notice that restrictions (14) and (16) are analogous to those for patient individuals (with the exception that impatient households do not accumulate physical capital). With respect to the borrowing constraint (15), parameter m^b is the loan-to-value ratio. As is well known in the mortgage market the amount lent by an individual is limited to a fraction of the value of the asset. If, for example, m^b takes a value of 1, this means that the whole value of the house acts as collateral. However, if $m^b = 0$ this implies a situation where housing is not collaterizable at all, meaning that the household is excluded from the financial market. As shown in Iacoviello (2005), without uncertainty the assumption $\beta^b < \beta^l$ guarantees that the borrowing constraint holds with equality.

In the case of impatient households, the value function $W(\Omega_t^b)$ satisfies the following Bellman equation:

$$W(\Omega_t^b) = \max_{c_t^b, b_t^b, x_t^b} \left\{ \begin{array}{c} \ln\left(c_t^b\right) + \phi_x \ln\left(x_t^b\right) + n_{t-1}^b \phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} \\ +(1-n_{t-1}^b)\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} + \beta^b E_t W(\Omega_{t+1}^b) \end{array} \right\} \tag{17}$$

where maximization is subject to constraints (14), (15) and (16).

The solution to the optimization program is characterized by the following first-order conditions:

$$\lambda_{1t}^{b} = \frac{1}{c_t^b} \tag{18}$$

$$\lambda_{1t}^{b} = \beta^b E_t \lambda_{1t+1}^{b} \left(\frac{1+r_t^n}{1+\pi_{t+1}} \right) + \mu_t^b \left(1+r_t^n\right) \tag{19}$$

$$\begin{aligned} \lambda_{1t}^{b} q_t \left[1 + \phi_h \left(\frac{x_t^b}{x_{t-1}^b} - 1 \right) \right] &= \frac{\phi_x}{x_t^b} + \mu_t^b m^b q_{t+1} \left(1+\pi_{t+1}\right) \\ &+ \beta^b E_t q_{t+1} \lambda_{1t+1}^{b} \left[1 + \frac{1}{2} \phi_h \left(\frac{x_{t+1}^b}{x_t^b} - 1 \right) \left(\frac{x_{t+1}^b}{x_t^b} + 1 \right) \right] \end{aligned} \tag{20}$$

where μ_t^b is the Lagrange multiplier of the borrowing constraint.

The marginal value of employment for an impatient household worker ($\frac{\partial W_t^b}{\partial n_{t-1}^b} \equiv \lambda_{ht}^b$) can be obtained as,

$$\lambda_{ht}^{b} = \lambda_{1t}^{b} w_t l_{1t} + \left(\phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} - \phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} \right) + (1-\sigma-\rho_t^w) \beta^b E_t \frac{\partial W_{t+1}^b}{\partial n_t} \tag{21}$$

which can be interpreted in the same way as that of patient households.

3.3 Aggregation

Aggregate consumption and employment are a weighted average of the corresponding variables for each household type:

$$c_t = \left(1-\lambda^b\right) c_t^l + \lambda^b c_t^b \tag{22}$$

$$n_t = \left(1-\lambda^b\right) n_t^l + \lambda^b n_t^b \tag{23}$$

$$\lambda^b b_t^b + (1-\lambda^b) b_t^l = 0 \tag{24}$$

$$\lambda^b x_t^b + (1-\lambda^b) x_t^l = X \tag{25}$$

where λ^b represents the share of impatient households in the economy and X is the fixed stock of real estate in the economy.

For the variables that exclusively concern patient households, aggregation is merely performed as:

$$k_t = \left(1 - \lambda^b\right) k_t^l \tag{26}$$

$$j_t = \left(1 - \lambda^b\right) j_t^l \tag{27}$$

In addition, we consider an aggregator (trade union) that puts together the surpluses from employment, in terms of consumption, of both types of households and use this aggregate in the negotiation of hours and wages:

$$\lambda_{ht} = \left(1 - \lambda^b\right) \frac{\lambda_{ht}^l}{\lambda_{1t}^l} + \lambda^b \frac{\lambda_{ht}^b}{\lambda_{1t}^b} \tag{28}$$

Lump sum transfers are aggregated in the usual way as

$$trh_t = \lambda^b trh_t^b + \left(1 - \lambda^b\right) trh_t^l$$

where additionally we assume that transfers are distributed according to the population size in each group so that $trh_t^b = trh_t^l = trh_t$.

The aggregate public debt is given by,

$$b_t = \left(1 - \lambda^b\right) b_t^p$$

3.4 Production

The productive sector is organized in three different levels: (1) firms in the wholesale sector use labor and capital to produce a homogenous good that is sold in a competitive flexible price market at a price P_t^w; (2) the homogenous good is bought by firms (indexed by $\widetilde{j}$) and converted, without the use of any other input, into a firm-specific variety that is sold in a monopolistically competitive market, in which prices are sticky; (3) finally there is a competitive retail aggregator that buys differentiated varieties ($y_{\widetilde{j}t}$) and sells a homogeneous final good (y_t) with at price P_t.

The competitive retail sector

There is a competitive retail aggregator that buys differentiated goods from firms in the intermediate sector and sells a homogeneous final good y_t at price P_t. Each variety $y_{\widetilde{j}t}$ is purchased at a price $P_{\widetilde{j}t}$. Profit maximization by the retailer implies

$$Max_{y_{\widetilde{j}t}} \left\{ P_t y_t - \int P_{\widetilde{j}t} y_{\widetilde{j}t} d_{\widetilde{j}} \right\}$$

subject to,

$$y_t = \left[\int y_{\widetilde{j}t}^{(1-1/\theta)} d_{\widetilde{j}} \right]^{\frac{\theta}{\theta-1}} \tag{29}$$

where $\theta > 1$ is a parameter that can be expressed in terms of the elasticity of substitution between intermediate goods $\varkappa \geq 0$, as $\theta = (1+\varkappa)/\varkappa$.

The first order condition gives us the following expression for the demand of each variety:

$$y_{\widetilde{j}t} = \left(\frac{P_{\widetilde{j}t}}{P_t} \right)^{-\theta} y_t \tag{30}$$

Also from the zero profit condition of the aggregator the retailer's price is given by:

$$P_t = \left[\int_0^1 \left(P_{\widetilde{j}t} \right)^{1-\theta} d\widetilde{j} \right]^{\frac{1}{1-\theta}} \tag{31}$$

The monopolistically competitive intermediate sector

The monopolistically competitive intermediate sector is composed of $\widetilde{j} = 1, ...\widetilde{J}$ firms each of which buys the production of competitive wholesale firms at a common price P_t^w and sells a differentiated good at price $P_{\widetilde{j}t}$ to the final competitive retailing sector described above.

Variety producers $y_{\widetilde{j}t}$ set prices in a staggered fashion. Following Calvo (1983) only some firms set their prices optimally each period. Those firms that do not reset their prices optimally at t adjust them according to a simple indexation rule to catch up with lagged inflation. Thus, each period a proportion ω of firms simply set $P_{\widetilde{j}t} = (1+\pi_{t-1})^{\varsigma} P_{\widetilde{j}t-1}$ (with ς representing the degree of indexation and π_{t-1} the inflation rate in $t-1$). The fraction of firms (of measure $1-\omega$) that set the optimal price at t seek to maximize the present value of expected profits. Consequently, $1-\omega$ represents the probability of adjusting prices each period, whereas ω can be interpreted as a measure of price rigidity. Thus, the maximization problem of the representative variety producer can be written as:

$$\max_{P^*_{\widetilde{j}t}} E_t \sum_{s=0}^{\infty} \Lambda_{t,t+s} (\beta\omega)^s \left[P^*_{\widetilde{j}t} \overline{\pi}_{t+s} y_{\widetilde{j}t+s} - P_{t+s} mc_{\widetilde{j}t,t+s} \left(y_{\widetilde{j}t+s} + \kappa_f \right) \right] \tag{32}$$

subject to

$$y_{\tilde{j}t+s} = \left(P^*_{\tilde{j}t} \prod_{s'=1}^{s} (1+\pi_{t+s'-1})^{\varsigma} \right)^{-\theta} P^{\theta}_{t+s} y_{t+s} \tag{33}$$

where $P^*_{\tilde{j}t}$ is the price set by the optimizing firm at time t, $\overline{\pi}_{t+s} = \prod_{s'=1}^{s} (1+\pi_{t+s'-1})^{\varsigma}$, $mc_{\tilde{j}t,t+s} = \frac{P^w_{t+s}}{P_{t+s}} = \mu^{-1}_{t+s}$ represents the real marginal cost (inverse mark-up) borne at $t+j$ by the firm that last set its price in period t, P^w_{t+s} the price of the good produced by the wholesale competitive sector, κ_f is an entry cost which ensures that extraordinary profits vanish in imperfectly-competitive equilibrium, and $\Lambda_{t,t+s}$ is a price kernel which captures the marginal utility of an additional unit of profits accruing to households at $t+s$, i.e.,

$$\frac{E_t \Lambda_{t,t+s}}{E_t \Lambda_{t,t+s-1}} = \frac{E_t(\lambda_{1t+s}/P_{t+s})}{E_t(\lambda_{1t+s-1}/P_{t+s-1})} \tag{34}$$

The solution for this problem is

$$P^*_{\tilde{j}t} = \left(\frac{\theta}{\theta-1}\right) \frac{E_t \sum_{s=0}^{\infty} (\beta\omega)^s \Lambda_{t,t+s} \left[\mu^{-1}_{t+s} (P_{t+s})^{\theta+1} y_{t+s} \left(\prod_{s'=1}^{s} (1+\pi_{t+s'-1})^{\varsigma} \right)^{-\theta} \right]}{E_t \sum_{s=0}^{\infty} (\beta\omega)^s \Lambda_{t,t+s} \left[(P_{t+s})^{\theta} y_{t+s} \left(\prod_{s'=1}^{s} (1+\pi_{t+s'-1})^{\varsigma} \right)^{1-\theta} \right]} \tag{35}$$

Then, taking into account (31) and that θ is assumed time invariant, the corresponding aggregate price level is given by,

$$P_t = \left[\omega \left(P_{t-1} \pi^{\varsigma}_{t-1} \right)^{1-\theta} + (1-\omega) \left(P^*_t \right)^{1-\theta} \right]^{\frac{1}{1-\theta}} \tag{36}$$

As is standard in the literature, equation (36) can be used to obtain an expression for aggregate inflation of the form,

$$\pi_t = \gamma^f E_t \pi_{t+1} + \varrho \widehat{mc}_t + \gamma^b \pi_{t-1}$$

where $\gamma^f = \frac{\beta}{1+\varsigma\beta}$, $\gamma^b = \frac{\varsigma}{1+\varsigma\beta}$ and $\varrho = \frac{(1-\beta\omega)(1-\omega)}{\omega(1+\varsigma\beta)}$.

The competitive wholesale sector

The competitive wholesale sector consists of $j = 1, ...J$ firms each selling a different quantity of a homogeneous good at the same price P^w_t to the monopolistically competitive intermediate sector. Firms in the perfectly competitive wholesale sector carry out the actual production using labor and capital. Factor demands are obtained by solving the cost minimization problem faced by each competitive producer (for simplicity, we drop the firm index *j*)

$$\min_{k_t, v_t} E_t \sum_{t=0}^{\infty} (\beta^l)^t \frac{\lambda^l_{1t+1}}{\lambda^l_{1t}} (r_{t-1}k_{t-1} + w_t n_{t-1} l_{1t} + \kappa_v v_t) \tag{37}$$

subject to

$$y^n_t = Ak^{1-\alpha}_{t-1}(n_{t-1}l_{1t})^\alpha - \kappa_f \tag{38}$$

$$n_t = (1-\sigma)n_{t-1} + \rho^f_t v_t \tag{39}$$

where, in accordance with the ownership structure of the economy, future profits are discounted at the patient household's relevant rate $\left((\beta^l)^t \frac{\lambda^l_{1t+1}}{\lambda^l_{1t}}\right)$.Producers use two inputs, private capital and labor, so technological possibilities are given by a standard Cobb-Douglas constant-returns-to-scale production function. ρ^f_t is the probability that a vacancy will be filled in any given period t. It is worth noting that the probability of filling a vacant post ρ^f_t is exogenous from the firm's perspective. However, from the perspective of the overall economy, this probability is endogenously determined according to the following Cobb-Douglas matching function:

$$\rho^w_t(1-n_{t-1}) = \rho^f_t v_t = \chi_1 v^{\chi_2}_t \left[(1-n_{t-1})\, l_2\right]^{1-\chi_2} \tag{40}$$

It is useful to distinguish between net of cost output y^n_t and gross of cost output y_t

$$y_t = Ak^{1-\alpha}_{t-1}(n_{t-1}l_{1t})^\alpha = y^n_t + \kappa_f \tag{41}$$

Proceeding in the same manner we did with households, we can express the maximum expected value of the firm in state Ω^f_t as a function $V(\Omega^f_t)$ that satisfies the following Bellman equation:

$$V(\Omega^f_t) = \max_{k_t, v_t} \left\{ y_t - r_{t-1}k_{t-1} - w_t n_{t-1} l_{1t} - \kappa_v v_t + \beta^l E_t \frac{\lambda^l_{1t+1}}{\lambda^l_{1t}} V(\Omega^f_{t+1}) \right\} \tag{42}$$

The solution to the optimization program above generates the following first-order conditions for private capital and the number of vacancies

$$r_t = (1-\alpha) mc_{t+1} \frac{y_{t+1}}{k_t} \tag{43}$$

$$\frac{\kappa_v}{\rho_t^f} = \beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \frac{\partial V_{t+1}}{\partial n_t} \tag{44}$$

where the demand for private capital is determined by (43). It is positively related to the marginal productivity of capital $(1-\alpha)\frac{y_{t+1}}{k_t}$ which, in equilibrium, must equate the gross return on physical capital.

Expression (44) reflects that firms choose the number of vacancies in such a way that the marginal recruiting cost per vacancy, κ_v, is equal to the expected present value of holding it, $\beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \rho_t^f \frac{\partial V_{t+1}}{\partial n_{t+1}}$.

Using the Bellman equation the marginal value of an additional employment in t for a firm ($\lambda_{ft} \equiv \frac{\partial V_t}{\partial n_{t-1}}$) is,

$$\lambda_{ft} = \alpha mc_t \frac{y_t}{n_{t-1}} - w_t l_{1t} + (1-\sigma)\beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \frac{\partial V_{t+1}}{\partial n_t} \tag{45}$$

where the marginal contribution of a new job to profits equals the marginal product net of the wage rate, plus the capital value of the new job in t, corrected for the probability that the job will continue in the future.

Now using (45) one period ahead, we can rewrite condition (44) as:

$$\frac{\kappa_v}{\rho_t^f} = \beta^l E_t \left[\frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \left(\alpha mc_{t+1} \frac{y_{t+1}}{n_t} - w_{t+1} l_{1t+1} + (1-\sigma) \frac{\kappa_v}{\rho_{t+1}^f} \right) \right] \tag{46}$$

3.5 Trade in the labor market: the labor contract

The key departure of search models from the competitive paradigm is that trading in the labor market is subject to transaction costs. Each period, unemployed engage in search activities in order to find vacant posts spread over the economy. Costly search in the labor market implies that there are simultaneous flows into and out of the state of employment, so an increase (reduction) in the stock of unemployment results from the predominance of job losses (creation) over job creation (losses). Stable unemployment occurs whenever inflows and outflows cancel out one another, i.e.,

$$\rho_t^f v_t = \rho_t^w (1-n_{t-1}) = \chi_1 v_t^{\chi_2} \left[(1-n_{t-1}) \, l_2 \right]^{1-\chi_2} = \sigma n_{t-1} \tag{47}$$

Because it takes time (for households) and real resources (for firms) to make profitable contacts, some pure economic rent emerges with each new job, which is equal to the sum of the expected transaction (search) costs the firm and the worker will further incur if they refuse to match. The emergence of such rent gives rise to a bilateral monopoly framework.

Once a representative job-seeking worker and vacancy-offering firm match, they negotiate a labor contract in hours and wages. There is risk-sharing at household level but not between households. Although patient and impatient households have a different reservation wage, they delegate the bargain process with firms to trade unions. This trade union maximizes the aggregate marginal value of employment for workers (28) and distributes employment according to their shares in the working-age population. The implication of this assumption is that all workers receive the same wages, work the same number of hours, and suffer the same unemployment rates[5]. Thus, following standard practice, the Nash bargain process maximizes the weighted product of the parties' surpluses from employment.

$$\max_{w_t, l_{1t}} \left(\left(1-\lambda^b\right) \frac{\lambda^l_{ht}}{\lambda^l_{1t}} + \lambda^b \frac{\lambda^b_{ht}}{\lambda^b_{1t}} \right)^{\lambda^w} \left(\lambda_{ft}\right)^{1-\lambda^w} = \max_{w_t, l_{1t}} \left(\lambda_{ht}\right)^{\lambda^w} \left(\lambda_{ft}\right)^{1-\lambda^w} \tag{48}$$

where $\lambda^w \in [0,1]$ reflects the workers's bargaining power. The first term in brackets represents the worker surplus (as a weighted average of borrowers and lenders workers' surpluses) while the second is the firm surplus. More specifically, $\lambda^l_{ht}/\lambda^l_{1t}$ and $\lambda^b_{ht}/\lambda^b_{1t}$ respectively denote the earning premium (in terms of consumption) of employment over unemployment for a patient and an impatient worker. Notice that both earning premia are weighted according to the share of borrowers in the population (λ^b).

The solution of the Nash maximization problem gives the optimal real wage and hours worked (see Boscá, Doménech and Ferri, 2011 for further details):

$$\begin{aligned} w_t l_{1t} = \lambda^w \left(\alpha mc_t \frac{y_t}{n_{t-1}} + \frac{\kappa_v v_t}{(1-n_{t-1})} \right) \\ +(1-\lambda^w) \left[\left(\frac{(1-\lambda^b)}{\lambda^l_{1t}} + \frac{\lambda^b}{\lambda^b_{1t}} \right) \left(\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} - \phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} \right) \right] \\ +(1-\lambda^w)(1-\sigma-\rho^w_t)\lambda^b E_t \frac{\lambda^b_{ht+1}}{\lambda^b_{1t+1}} \left(\beta^l \frac{\lambda^l_{1t+1}}{\lambda^l_{1t}} - \beta^b \frac{\lambda^b_{1t+1}}{\lambda^b_{1t}} \right) \end{aligned} \tag{49}$$

[5] Instead of relying on a trade union, we could have used the notion of collective bargaining on a single contract to avoid multi-person Nash bargaining with asymmetric information on outside options. In any case, our approach allows to circumvent problems associated with incentives for workers to reveal preferences and firms to perform screening. In addition, as Thomas and Stähler (2011) show in a model with *RoT* consumers, assuming individual bargaining between each worker and the firm does not change the steady-state results at all and only changes slightly the dynamics of wages.

$$\alpha mc_t \frac{y_t}{n_{t-1} l_{1,t}} = \left[\frac{1-\lambda^b}{\lambda_{1t}^l} + \frac{\lambda^b}{\lambda_{1t}^b} \right] \phi_1 (1 - l_{1t})^{-\eta} \tag{50}$$

Unlike the Walrasian outcome, the wage prevailing in the search equilibrium is related (although not equal) to the marginal rate of substitution of consumption for leisure and the marginal productivity of labor, depending on worker bargaining power λ^w. Putting aside the last term on the right hand side, the wage is a weighted average between the highest feasible wage (i.e., the marginal productivity of labor plus hiring costs per unemployed worker) and the outside option (i.e., the reservation wage as given by the difference between the utility of leisure of an unemployed person and an employed worker). This reservation wage is, in turn, a weighted average of the lowest acceptable wage of both type of workers. They differ in the marginal utility of consumption (λ_{1t}^l and λ_{1t}^b). If the marginal utility of consumption is high, the workers are ready to accept a relatively low wage.

The third term on the right hand side of (49) is part of the reservation wage that depends only on the existence of impatient workers (only if $\lambda^b > 0$ this term is different from zero). It can be interpreted as an inequality term in utility. The economic intuition is as follows: impatient consumers are constrained by their collateral requirements, so that they are not allowed to use their entire wealth to smooth consumption over time. However, they can take advantage of the fact that a match today continues with some probability $(1-\sigma)$ in the future, yielding a labor income that in turn will be used to consume tomorrow. Therefore, they use the margin that hours and wage negotiation provide them to improve their lifetime utility, by narrowing the gap in utility with respect to patient consumers. In this sense, they compare the discounted intertemporal marginal rate of substitution had they not been income constrained $\left(\beta^l \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l}\right)$ with the expected rate given their present rationing situation $\left(\beta^b \frac{\lambda_{1t+1}^b}{\lambda_{1t}^b}\right)$. For example if, *caeteris paribus*, $\beta^l \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} > \beta^b \frac{\lambda_{1t+1}^b}{\lambda_{1t}^b}$ all the third term in (49) is positive, which indicates that impatient workers put additional pressure on the average reservation wage as a way to ease their period-by-period constraint in consumption. The importance of this inequality term is positively related to the earning premium of being matched next period $\left(\frac{\lambda_{ht+1}^b}{\lambda_{1t+1}^b}\right)$, because it increases the value of a match to continue in the future, and negatively related to the job finding probability (ρ_t^w), that reduces the loss of breaking up the match. Finally, notice that when $\lambda^b = 0$, all consumers are patient and, therefore, the solutions for the wage rate and hours simplify to the standard ones (see Andolfatto, 2004).

3.6 Interest rate rule and the accounting identity

We assume the existence of a central bank in our economy that follows a Taylor's interest rate rule:

$$1 + r_t^n = \left(1 + r_{t-1}^n\right)^{r_R} \left(\left(1 + \pi_{t-1}\right)^{1+r_\pi} \left(\frac{y_{t-1}}{\overline{y}}\right)^{r_y} \left(1 + \overline{r}^n\right)\right)^{1-r_R} \tag{51}$$

where $\overline{y}$ and $\overline{r}^n$ are steady-state levels of output and interest rate, respectively. The parameter r_R captures the extent of interest rate inertia, and r_π and r_y represent the weights given by the central bank to inflation and output objectives.

Finally, to close the model, output is defined as the sum of demand components. It is useful to define the gross production as

$$y_t = k_{t-1}^{1-\alpha} (n_{t-1} l_{1t})^\alpha = y_t^n + \kappa_f = c_t + j_t \left(1 + \frac{\phi}{2}\left(\frac{j_t}{k_{t-1}}\right)\right) + g_t + \kappa_v v_t \tag{52}$$

3.7 Government

Government revenues and expenditures each period are made consistent by means of the intertemporal budget constraint

$$b_t = g_t + trh_t + \frac{(1 + r_{t-1}^n)}{1 + \pi_t} b_{t-1} \tag{53}$$

where trh_t stands for lump-sum transfers/taxes.

In order to enforce the government's intertemporal budget constraint, the following fiscal policy reaction function is imposed

$$trh_t = trh_{t-1} - \psi_1 \left[\frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp}\right)}\right] - \psi_2 \left[\frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}}\right] \tag{54}$$

where $\psi_1 > 0$ captures the speed of adjustment from the current ratio towards the desired target $\overline{\left(\frac{b}{gdp}\right)}$. The value of $\psi_2 > 0$ is chosen to ensure a smooth adjustment of current debt towards its steady-state level.

4. Calibration

Parameters from previous studies

The values that have been set up for some parameters of our benchmark model are pretty standard and used widespread in the literature. Thus, we borrow from Iacoviello (2005) the value for the subjective intertemporal discount rate of patient households, $\beta^l = 0.99$, the subjective discount rate of impatient households, $\beta^b = 0.95$ and the adjustment cost for housing capital $\phi_h = 0.0$. Also, according to the estimations in Iacoviello (2005) we choose a value $\lambda^b = 0.36$ for the fraction of impatient consumers in the economy. We initially set a prudentially low loan-to-value ratio $m^b = 0.735$, a bit below the lower value considered by Iacoviello and Neri (2010). This parameter will be increased up to a value of $m^b = 0.985$, slightly above the upper bond considered by Iacoviello and Neri (2010), to show the effects of consumers that become more indebted. From Campbell and Hercowitz (2005 and 2009) we take the Cobb-Douglas parameter $\alpha = 0.7$. From Monacelli *et al* (2010) we take the depreciation rate of physical capital $\delta = 0.025$ and the elasticity of matchings to vacant posts $\chi_2 = 0.5$, whereas the exogenous transition rate from employment to unemployment, $\sigma = 0.15$, relies on Andolfatto (1996) and Cheron and Langot (2004). From these authors we also pick up some average steady-state values, as the probability of a vacant position becoming a productive job, which is assumed to be $\overline{\rho}^f = 0.9$, the fraction of time spent working, $\overline{l_1} = 1/3$, and the fraction of time households spend searching $l_2 = 1/6$. The long run employment ratio is computed to be $\overline{n} = 0.75$ as in Choi and Rios-Rull (2008). Also, we assume that equilibrium unemployment is socially-efficient (see Hosios, 1990) and, as such $\lambda^w = 0.5$ is equal to $1 - \chi_2$. For the intertemporal labor elasticity of substitution, we consider $\eta = 2$ implying that average individual labor supply elasticity is equal to 1, the same as in Andolfatto (1996). The adjustment costs parameter for productive investment, $\phi = 5.95$, is taken from QUEST II, which considers the same function as ours for capital installation costs. Parameters affecting the New Phillips Curve are also very common in the literature. We set a standard value for the elasticity of final goods of $\theta = 6$ implying a steady state markup of $\frac{\theta}{\theta-1} = 1.2$. Hence, the steady state value for the marginal cost is obtained as $\overline{mc} = \frac{\theta-1}{\theta}$. The probability of not changing prices, ω, is set to 0.75, meaning that prices change every four quarters on average whereas we take an intermediate value, $\varsigma = 0.4$, for inflation indexation.

Calibrated parameters from steady-state relationships

We normalize both steady-state output ($\overline{y}$) and real housing prices ($\overline{q}$) to one. Then, steady state government expenditure is set to 17 per cent of output (*BEA* data for 2009). That is, $\overline{g} = 0.17$. From (47) we obtain the long-run value for vacancies $\overline{v} = \sigma\overline{n}/\overline{\rho}^f$. Then, we calibrate the ratio of recruiting expenditures to output $(\kappa_v\overline{v}/\overline{y})$ to represent 0.5 percentage points of output, as in Cheron and Langot (2004) or Choi and Rios-Rull (2008), and very close to the value of 0.44 implied by the calibration of Monacelli *et al* (2010). From this ratio we obtain a value of $\kappa_v = 0.04$, and using the steady state version of equation (46), we can solve for the value of wages ($\overline{w}$). The steady-state value of matching flows in the economy equals the flow of jobs that are lost ($\sigma\overline{n}$) and we use the equality ($\sigma\overline{n} = \chi_1\overline{v}^{\chi_2}\left[(1-\overline{n})\,l_2\right]^{1-\chi_2}$) to solve for the scale parameter of the matching function, $\chi_1 = 1.56$.

In order to obtain A, we first use (3) and (9) to ascertain the steady-state value of Tobin's q (i.e.$\frac{\overline{\lambda}_2^l}{\overline{\lambda}_1^l}$). Hence, we gain the return on capital ($\overline{r}$) using (8) and this allows us to compute the steady-state value for the capital stock ($\overline{k}$) from (43). Therefore the long run value of total factor productivity, $A = 1.521$, is calibrated from the production function (41). The capital stock together with the depreciation rate and the adjustment cost parameter allow us to calculate the value of gross investment for the steady state, and hence, using (52), the level of consumption $\overline{c}$. The steady-state value of the nominal interest rate, $\overline{r}^n$, is related to the intertemporal discount rate of lenders through the steady state version of equation (10). The value for the transfers in the steady state $\overline{trh}$ are such that from (53) the resulting debt to output ratio is 60 per cent on annual terms.

In order to compute κ_f we aggregate the income restriction of both households in the steady-state, to obtain

$$c + j\left(1 + \delta\frac{\phi}{2}\right) + g_t = nwl + rk + \kappa_f$$

where $\kappa_f = \left(1 - \lambda^b\right) d^l$.

Let γ_l be the ratio of assets of patient households in the steady state to total output ($\overline{b}^l = \gamma_l\overline{y}$). Then we can obtain, conditional to the value of γ_l, the following variables in the steady state: from equation (24) we obtain $\overline{b}^b$. Next, we can compute the steady-state level of consumption of borrowers, $\overline{c}^b$, from the budget restriction (14) and the consumption level of lenders, $\overline{c}^l$, from the aggregation equation (22). Our next step consists in calibrating steady-state levels of the marginal utilities of consumption of both types of consumers, $\overline{\lambda}_1^l$ and $\overline{\lambda}_1^b$, from their respective first-order conditions in equations (7) and (18). We can now obtain the steady-state holdings of housing, $\overline{x}^b$, from the borrowing restriction of impatient households (equation (15)). The long-run equilibrium value for the multiplier of impatient households' borrowing constraint, $\overline{\mu}^b$, can now be computed directly from the first-order condition (19). This makes it possible to compute the parameter that accounts for the housing weight in life-time utility, ϕ_x, from the last first-order condition of borrowers' optimization program (equation (20)). The value of the parameter ϕ_x enables us to compute the steady-state holdings of housing for lenders, $\overline{x}^l$, from first order condition (11), and the fixed stock of real estate in the economy, X, from the aggregation rule (25). Notice that the value we will obtain for ϕ_x and X depends on the value we assign to the ratio of assets of patient households in the steady state to total output, γ_l. In order to produce a sensible calibration of this parameter and the steady-state level of the variables, we follow Iacoviello (2005) and choose a value for γ_l, such that the total stock of housing over yearly output is 140 per cent. The resulting value for ϕ_x is 0.10.

As regards preference parameters in the household utility function, $\phi_1 = 1.595$ is calculated from the steady-state version of expression (50). A system of three equations implying the steady state of expressions (12) (21) and (49) is solved for ϕ_2, $\overline{\lambda}_h^b$ and $\overline{\lambda}_h^l$. The resulting value for ϕ_2 is 1.043. Therefore the calibrated values for ϕ_1 and ϕ_2 are similar to those in Andolfatto (1996) and other related research in the literature. Such values imply that the imputed value for leisure by an employed worker is situated well above the imputed value for leisure by an unemployed worker.

Shocks and policy rule parameters

The parameters $r_R = 0.73$ and $r_\pi = 0.27$ in the interest rate rule are taken from Iacoviello (2005). For the parameter measuring the interest rate reaction to output, r_y, we choose a value of 0. For the fiscal rule, we assume $\psi_1 = 0.01$ and $\psi_2 = 0.2$. Finally, the government expenditure shock persistence ρ_g is equal to 0.75 , as in Brückner and Pappa (2010).

5. Results

5.1 Fiscal policy in models with financially restricted consumers.

In this subsection we present impulse-response functions to a (one per cent of GDP) transitory public expenditure shock (persistence = 0.75) on some key macroeconomic variables: output, consumption, real wages, hours per worker unemployment and vacancies. The aim of this exercise is to compare the effects of the fiscal shock under three different modeling strategies: a basic search model with homogeneous consumers[6], a search model with a 0.36 share of RoT consumers[7] and a search model with indebted consumers (0.36 share of impatient consumers and a loan-to-value ratio of 0.985). All models share price rigidity that lasts for four quarters.

The results are depicted in Figure 1. The output response to the public consumption shock is positive in all the three models, however the expansionary effect varies substantially across models, ranging from a high impact multiplier near 2 per cent in the RoT model, to approximately 0.8 points in the basic search model with Ricardian consumers and an intermediate value around 1.2 per cent in an economy with credit constrained indi-

[6] Our benchmark model with impatient consumers that are credit contrained can be tranformed into a standard search and matching model with homogeneous consumers by setting $\lambda^b = 0$.

[7] Eliminating preferences for housing from the utility function ($\phi_x = 0$), setting the temporal discount rate $\beta^b = \beta^l$ and assuming that a share of hosueholds, λ^b ,consume just their current income converts the bencharmack model into a serch model with a λ^b share of RoT consumers.

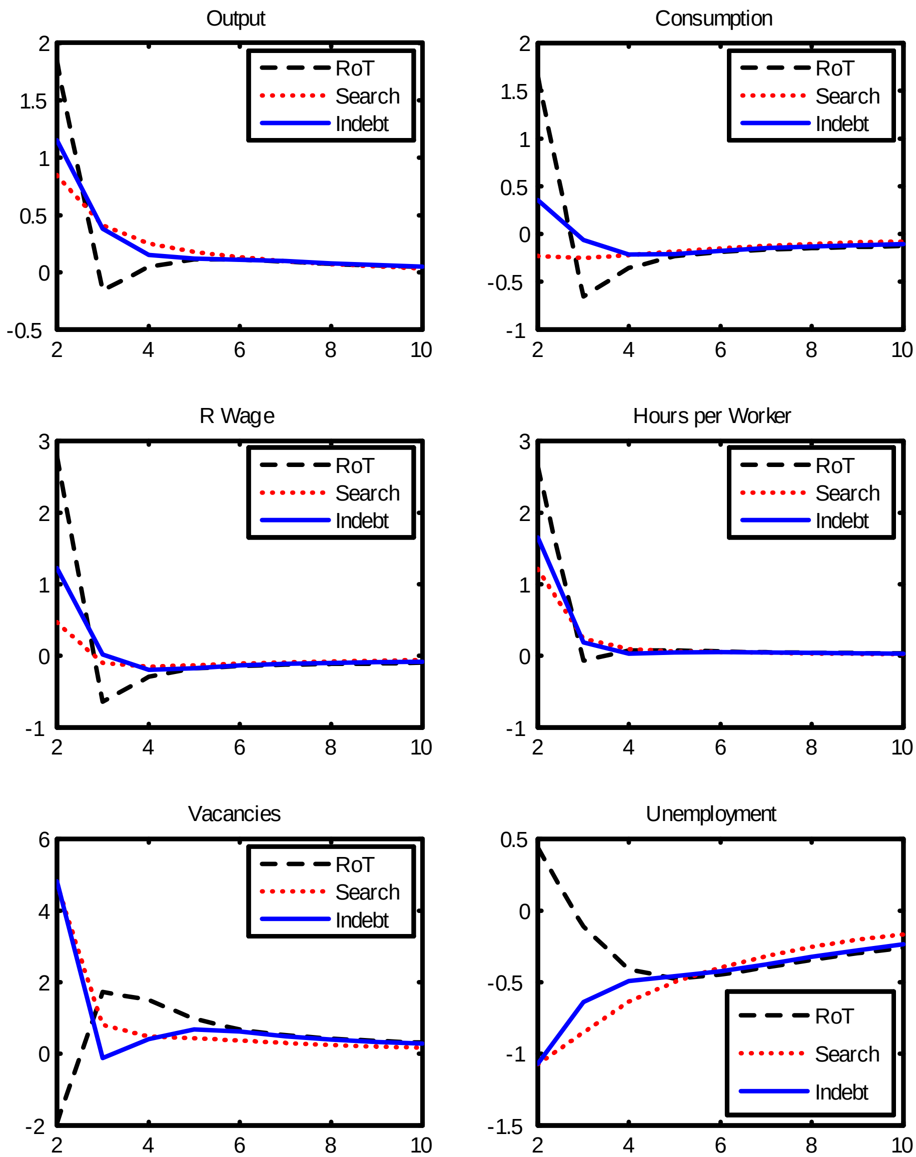


Figure 1: *Effects of a transitory public consumption shock: basic search model, search model with RoT's, and search model with borrowers and lenders.*

viduals. These differences in output multipliers are explained by the different responses of consumption across models. In a standard search model, populated only with optimizing individuals, the consumption response to the fiscal shock is negative (impact consumption multiplier around -0.2), due to the negative wealth effect associated with expectations of future tax raises to finance the increase in government expenditure. On the contrary, the consumption response in the search model augmented with RoT consumers is highly positive (approximately 1.8 per cent on impact). This should come not to any surprise since RoT consumers were introduced in general equilibrium models (see Galí et al., 2007) to account for the empirical fact that consumption generally increases after a positive fiscal shock, given that these individuals consume every period all their disposable income. Finally, in the model with borrowing restrictions, the impact on consumption is positive (around 0.4 points), but more modest than in the presence of fully constrained households. This is due to the fact that the consumption possibilities of impatient households are conditioned to the value of their collateral assets. Thus, although these impatient individuals would increase their consumption in response to the raise in current income, in a similar manner as RoT consumers do, they suffer a drop in the the value of their collateral asset (due to a fall in housing prices) that mitigates partially the effect on consumption. Whereas consumption by RoT consumers responds one-to-one to changes in their labor income ($w_t l_1 n_{t-1}^l$), that of indebted consumers reacts to changes in their net worth, NW_t which also includes the value of their asset (housing) holdings net of debt,[8]

$$NW_t = w_t l_{1t} n_{t-1}^b + q_t x_{t-1}^b - \frac{(1 + r_{t-1}^n) b_{t-1}^b}{1 + \pi_t} \approx w_t l_{1t} n_{t-1}^b + x_{t-1}^b \left[q_t - m^b \frac{E_{t-1} \left(q_t \left(1 + \pi_t \right) \right)}{\left(1 + \pi_t \right)} \right] \tag{55}$$

The opposite movements of q_t and π_t in (55) partially offset the increase of labor income after the fiscal shock. The negative wealth effect on lenders pulls the price of assets down, dominating the sluggish positive response of inflation, thus making the net worth of borrowers less responsive than the labor income of RoT households to the shock. Alternatively we can explain this result looking at the reaction of the borrowing limit (15) after the fiscal shock. Both the deterioration in the relative price of houses, q_t, (current and expected) and the increase in the real interest rate reduce the amount of credit that impatient consumers can obtain in the market. This in turn limits the increase in their consumption brought about by the improvement in labor income. More intuitively, the negative financial impact of the fiscal shock on indebted households (either reflected in their net worth or in their borrowing possibilities) dampens the reaction of their consumption.[9]

With respect to real wages and average hours worked, all three models produce

[8] See a derivation of this result in Andrés, Arce and Thomas (2011).

[9] As we shall discuss later, the size of this net worth effect crucially hinges upon the value of m^b.

qualitatively similar positive impact responses. After a positive public expenditure shock both output and consumption increase in the RoT and indebtedness models, while in the basic search model output augments, but consumption drops. The increase of aggregate demand pushes the relative price of the competitive sector up with respect to the non-competitive one $\left(\frac{P_t^w}{P_t} = mc_t\right)$, which tends to generate in all three models higher negotiated wages and average hours worked (recall the equilibrium expressions for wages (49) and hours (50)). In the two models with constrained consumers, the decline in the marginal utility of consumption affects the bargaining process reinforcing the demand for higher wages and lower hours worked (that nonetheless does not fully offset the rise in hours worked caused by the increase in $\frac{P_t^w}{P_t}$). In the basic search model, given that consumption decreases after the fiscal shock, the raise in the marginal utility of consumption reinforces the marginal cost channel in increasing hours per worker while diminishing the final impact on wages.

The final row of plots in figure 1 shows a qualitatively different response of vacancies and unemployment to the fiscal shock, depending on the model. Whereas vacancies increase and unemployment falls both in the pure search and the private indebtedness models, the opposite happens when constrained consumers do not have access to the credit market (RoT model). To understand these different responses we must look at the dynamic response of the $\frac{P_t^w}{P_t}$ ratio which is a key determinant of the vacancy posting decision. The RoT model generates large swings in this ratio that first increases, due to the sluggish response of aggregate prices, P_t, and then falls sharply as aggregate prices start increasing following the strong increase of consumption on impact. This reduces the incentive to post vacancies (see equation (46)), which in turn contributes to generate higher unemployment.[10] The response of this marginal cost is much more muted in the other two models due to the modest reaction of aggregate consumption and hence of P_{t+1}. Thus, although $\frac{P_{t+1}^w}{P_{t+1}}$ also falls once the upward adjustment of prices is underway, it remains above the steady state value encouraging vacancy posting and reducing unemployment.

The previous analysis can be summarized as follows. First, it is possible to obtain a Keynesian output multiplier for government expenditure (a multiplier higher than one) and a positive response of aggregate private consumption in a model characterized by the presence of impatient consumers that participate in financial markets. In that case, the consumption response is positive but lower than the one predicted by the standard model with rule-of-thumb (RoT) consumers. Therefore, macroeconomic models that use RoT consumers may be exacerbating the effects of fiscal policy. Second, whereas the use

[10] This is so because P_{t+1} will augment as prices in the non-competitive sector begin to adjust. Additionally, P_{t+1}^w will drop due to a sharp decrease in wages and an increase in unemployment that pull consumption down and therefore aggregate demand.

of RoT consumers has become accepted in DSGE models on the basis of their ability to match a positive correlation between consumption and government spending, they may generate results in terms of the reaction of some labor market variables, as vacancies and unemployment, that are at odds with what is observed in the data. Thus, although some departure from the pure intertemporal substitution model is needed to generate sound effects of fiscal innovations, the role of private leverage is key to improve our understanding of the output and unemployment fiscal multipliers. Neither too much nor the absence of intertemporal substitution seem realistic settings to study complex issues such as those involved in the reaction to fiscal shocks. In what follows we look at the role of the determinants of private indebtedness in more detail.

5.2 Fiscal policy and private indebtedness.

Having delimited the relative merits of our benchmark model, we turn now our attention to analyze the importance of the degree of private indebtedness in the magnitude of fiscal multipliers. Figure (2) displays the impact fiscal multipliers of our variables of interest as a function of the share of borrowers (λ^b) and for two different values of the loan to value (a low $m^b = 0.735$ and a high $m^b = 0.985$). With this exercise we aim at capturing the changing volume of household indebtedness in the economy, allowing for changes in the intensive margin of borrowing (loan-to-value) and in the extensive margin, defined as the number of borrowers over the total population. We define the fiscal multiplier on a variable x (ϱ_x) as the ratio between the initial change in the variable from its steady state, $\dot{x}_0$, and the initial variation of government spending, $\dot{g}_0$, that is, $\varrho_x = \frac{\dot{x}_0}{\dot{g}_0}$.

The results in Figure 2 suggest that the fiscal multipliers to a transitory government expenditure shock depend very much on the degree of indebtedness of the economy. Let us first concentrate on the evolution of the output fiscal multiplier (first column, second row in the figure). When the borrowing capacity of borrowers is high (high loan-to-value) the fiscal multiplier is less than one only if the share of borrowers in the population is very low (less than 25 per cent). However, increasing the share of restricted consumers makes the output multiplier grow steadily to values around 1.75 when half of the population is subject to borrowing constraints. On the contrary, if the loan to value is low ($m^b = 0.735$), the impact output multiplier is always lower than one, no matter which is the share of borrowers in the economy. Output behavior can be better understood by looking at the response of aggregate consumption to the shock. The borrowing capacity of an impatient household, and hence its consumption possibilities, increases with the loan-to-value, which is reflected in the vertical distance, for a given share of borrowers, between the two lines depicting borrowers consumption. Additionally, the share of impatient households in the population, λ^b, affects positively the response of aggregate consumption to

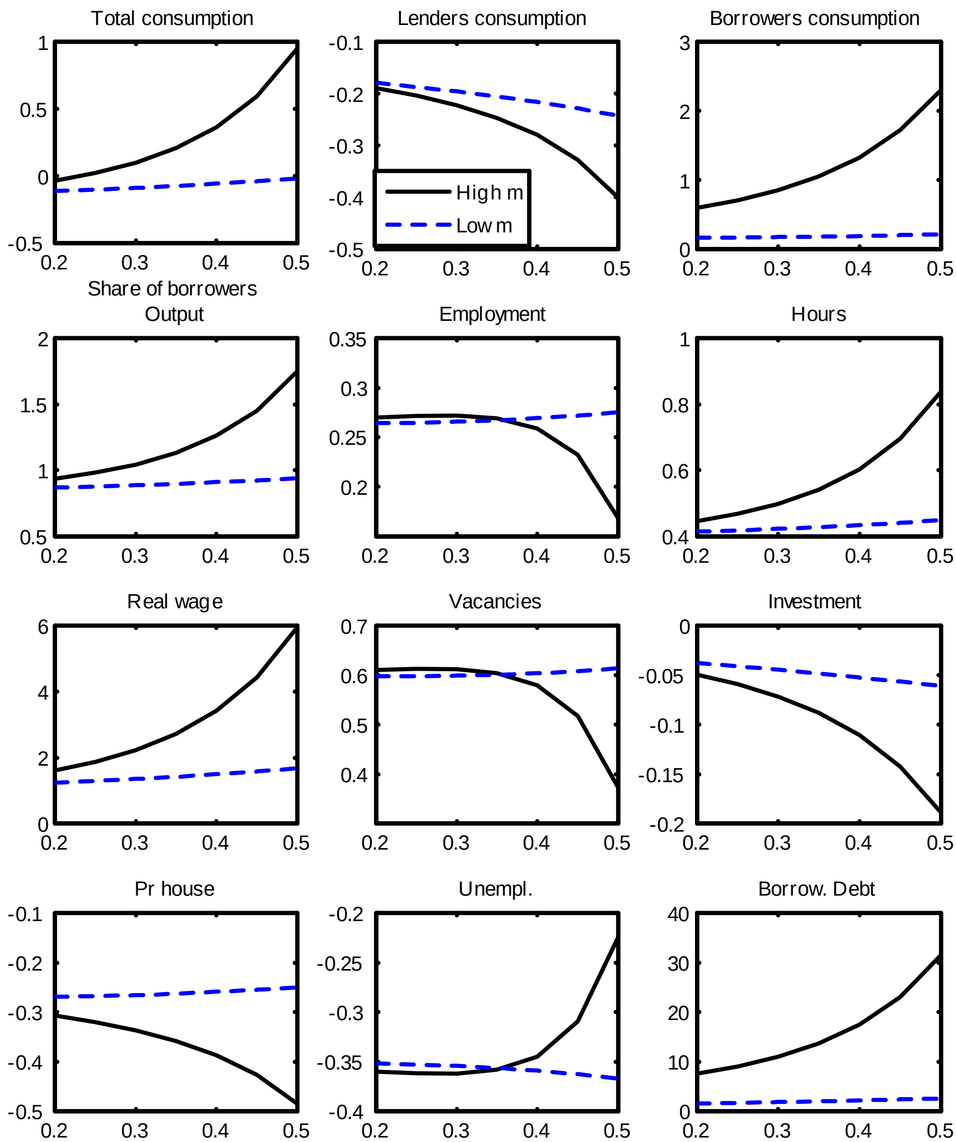


Figure 2: *Impact multiplier as a function of the share of borrowers*

the shock. This is due to a double effect. On the one hand, a higher λ^b puts additional pressure on wages, increasing borrowers income and consumption. On the other hand, λ^b affects directly the weight of borrowers consumption in aggregate consumption. Notice that in the wage equation the influence of λ^b is more intense the higher m^b is, because λ^b is multiplying the inverse of the marginal utility of consumption, $\frac{1}{\lambda^b_{1t}}$, which also increases with m^b. As a result the impact of the fiscal shock on wages, consumption and output increases faster with λ^b when m^b is high. Again to understand the role of m^b in explaining variations in consumption multipliers we can look at the expression for the borrowers net worth (55). The fiscal shock induced rise in inflation erodes the real value of the existing level of debt (b_{t-1}) that is increasing in m^b; this dampens the downward reaction of net value of housing holdings, and induces a stronger consumption response by these households.

Looking at the plot for impact multipliers of average hours we can observe a similar pattern as in the case of aggregate consumption when the degree of private leverage, measured either by the extensive or the intensive margin, changes in the economy. The reason is that when the impact multiplier on consumption is high it comes along with a sharp increase in aggregate demand that pushes relative prices $\frac{P^w_t}{P_t}$ up[11]. This behavior of relative prices (the marginal cost) translates into higher impact multipliers on hour per worker.

Interestingly, a positive government expenditure shock always produces a positive multiplier in terms of vacancies and employment (negative multiplier for unemployment). In this case, the impact multiplier function is very similar for a high and a low loan-to value and very flat for a share of borrowers lower than approximately 0.4. This happens because vacancy posting at period t, and hence (un)employment, depends crucially on expectations about tomorrow's relative prices ($\frac{P^w_{t+1}}{P_{t+1}} = mc_{t+1}$) and labor costs ($w_{t+1}l_{1t+1}$). However, the relative movements of tomorrow's mc_{t+1} and $w_{t+1}l_{1t+1}$ are very similar for high and low loan-to-values, except when the share of borrowers in the economy is high enough in the economy.

Regarding housing prices we observe a negative multiplier following the fiscal expansion in all the cases. However, the effect is stronger for a high loan to value, the higher the share of borrowers. The explanation for this fact is related to the expected value of next period real interest rate, which increases by more with higher values of both m^b and λ^b. This makes savers substitute away present for future consumption and to reduce their willingness to hold houses.

All the previous results refer to impact multipliers, which are the most commonly used in the literature. Recently Uhlig (2010) has argued that short run multipliers can be

[11] On impact P_t does not fully adjust given price stickiness in the non-competitive sector, whereas P^w_t reacts completely to movements in aggregate demand.

misleading. Thus, in figure A.1 (Appendix 1) we check the sensitivity of our results to calculate the present value fiscal multipliers at four and twenty quarters[12], and we find for them a similar pattern to the impact multiplier.

5.3 Fiscal multipliers, price stickiness and persistence.

The degree of private indebtedness conditions the extent of response of macroeconomic variables, including labor market variables, to fiscal policy shocks. However, fiscal multipliers depend also on other characteristics of the economy that interact with the magnitude of the financial friction. We investigate further two other different issues that may have a direct bearing on the impacts of fiscal policy on economic activity. First, we focus on the degree of price stickiness that has been analyzed in a search and matching framework to study its relevance in explaining business cycle properties of the US economy (Krause and Lubik, 2007 or Andrés et al, 2010). Second, we will show how fiscal multipliers depend on the degree of persistence of fiscal shocks, an effect that has already deserved some attention in the literature (Harms, 2002, Galí et al., 2007 and Mayer, 2010). This is an important policy issue because the persistence of the government expenditure shock is a key policy parameter that determines the effects on output or unemployment of expansionary or consolidation fiscal packages.

Figure 3 represents the impact multipliers as a function of the price rigidity parameter (ω) for the benchmark calibration of the share of borrowers (0.36) and for the two regimes related to the loan-to-value ratio. The first important result is that the impact multipliers for high and low loan-to-value ratios are very similar when the value of ω is lower than 0.5. Second, the impact multipliers become stronger as price stickiness increases above the 0.5 threshold, in particular in an economy with high m^b. Therefore, in highly leveraged economies these multipliers can be considerably higher than in low leveraged economies if price rigidity is important. Third, the model is able to generate a crowding-in in consumption (and a Keynesian output multiplier) for values of the price rigidity parameter higher than 0.6 (when $m^b = 0.985$) or higher than 0.8 (when $m^b = 0.735$). Fourth, the vacancies and (un)employment multipliers are always positive (negative) for any degree of price rigidity.

The main intuition behind all these results is that increasing price rigidity dampens

[12] We define the net present value fiscal multiplier for variable x at date t as

$$\varrho_{xt} = \frac{\sum\limits_{s=0}^{t} (1+r_t^n)^{-s} \dot{x}_s}{\sum\limits_{s=0}^{t} (1+r_t^n)^{-s} \dot{g}_s}$$

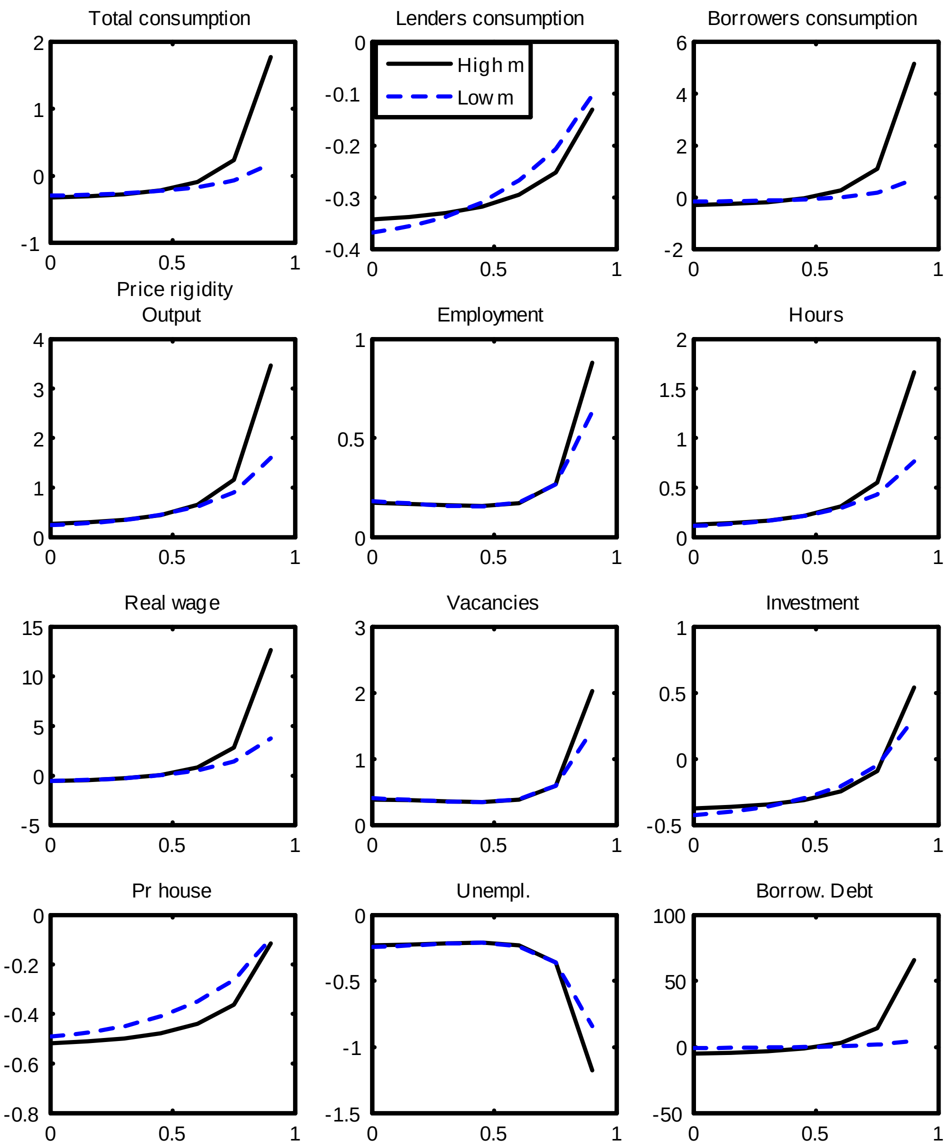


Figure 3: *Impact multiplier as a function of price rigidity*

the positive response of the expected real interest rate and cushions the reduction in next period's marginal cost (as compared to the present period). The former effect dampens the fall in lenders consumption and housing prices. Because the borrowing capacity of impatient households depends on the value of their collateral, the milder reaction of housing prices also helps to increase the consumption of borrowers (as compared with an economy with larger swings in asset prices). The latter effect, i.e. the one related to the behavior of relative prices $\frac{P^w_{t+1}}{P_{t+1}}$, explains why vacancies and employment increase by more with price rigidity.

To finish this subsection in figure 4 we present the effects of the degree of persistence of fiscal shocks on the impact multipliers of the variables of interest. In coherence with previous figures, results are shown for a high and a low loan-to-value and keeping our benchmark calibration for the share of borrowers and the degree of price rigidity. As can be seen, in an economy with a low loan-to-value ratio and, thus, with a limited indebtedness capacity of impatient consumers, aggregate consumption impact multipliers are always negative and do not vary notably with the degree of persistence of fiscal shocks. This crowding-out effect on consumption translates into output multipliers that are always lower than 1 in this scenario. For a high m^b the effects of the persistence of fiscal policy are more visible. Generally speaking the multipliers obtained in a high leverage regime are more pronounced than the ones for a low leverage regime, whatever the value of the persistence parameter. However, the value of the multipliers in both regimes tend to converge when the fiscal stimulus is highly persistent. In other words, when $m^b = 0.985$ consumption, output, wage and hours multipliers decrease sustantially with the degree of persistence, whereas vacancies and employment multipliers increase. Thus, when ρ_g is close to one multipliers are very similar in both leverage regimes.

To understand the economics behind these results, we have again to appeal for reactions in real interest rates $\frac{r^n_t+1}{1+\pi_{t+1}}$ and relative prices, $\frac{P^w_{t+1}}{P_{t+1}}$. In our model, the degree of persistence of fiscal shocks affects consumption of savers in the same manner as occurs with Ricardian consumers in Galí *et. al* (2007): higher persistence is associated with stronger negative wealth effects that lower consumption. In our model, there is an additional mechanism at work, that operates mainly *vía* consumption of indebted households. Higher persistence of fiscal policy means that public expenditure remains high tomorrow, implying higher real interest rates tomorrow and lower housing prices now. These two effects erode the borrowing and consumption capacities of impatient households that also translate into lower aggregate output and consumption multipliers.

What happens in the labor market? First, the mechanism explained above, operating through the marginal utility of consumption, is reponsible for the reduction of the impact multipliers on wages and hours when persistence increases. Second, a more persis-

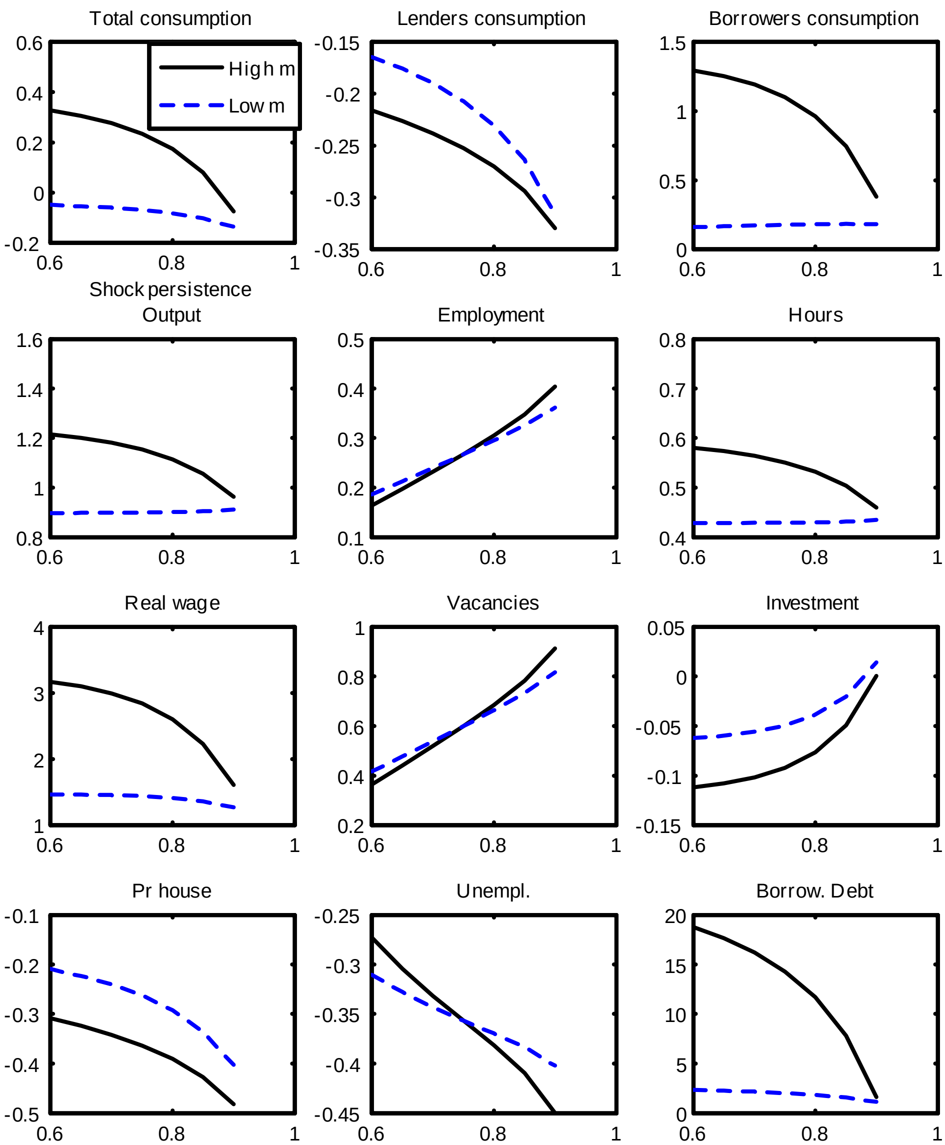


Figure 4: *Impact multiplier as a function of the shock persistence*

tent government spending shock implies that aggregate demand in $t+1$ remains higher and thus, relative prices tomorrow fall by less, improving the willingness of firms to posting vacancies. As a consequence, in a high leveraged economy, if fiscal policy is more persistent the impact multipliers of (un)employment are (reduced) increased.[13]

5.4 Keynesian fiscal multipliers?

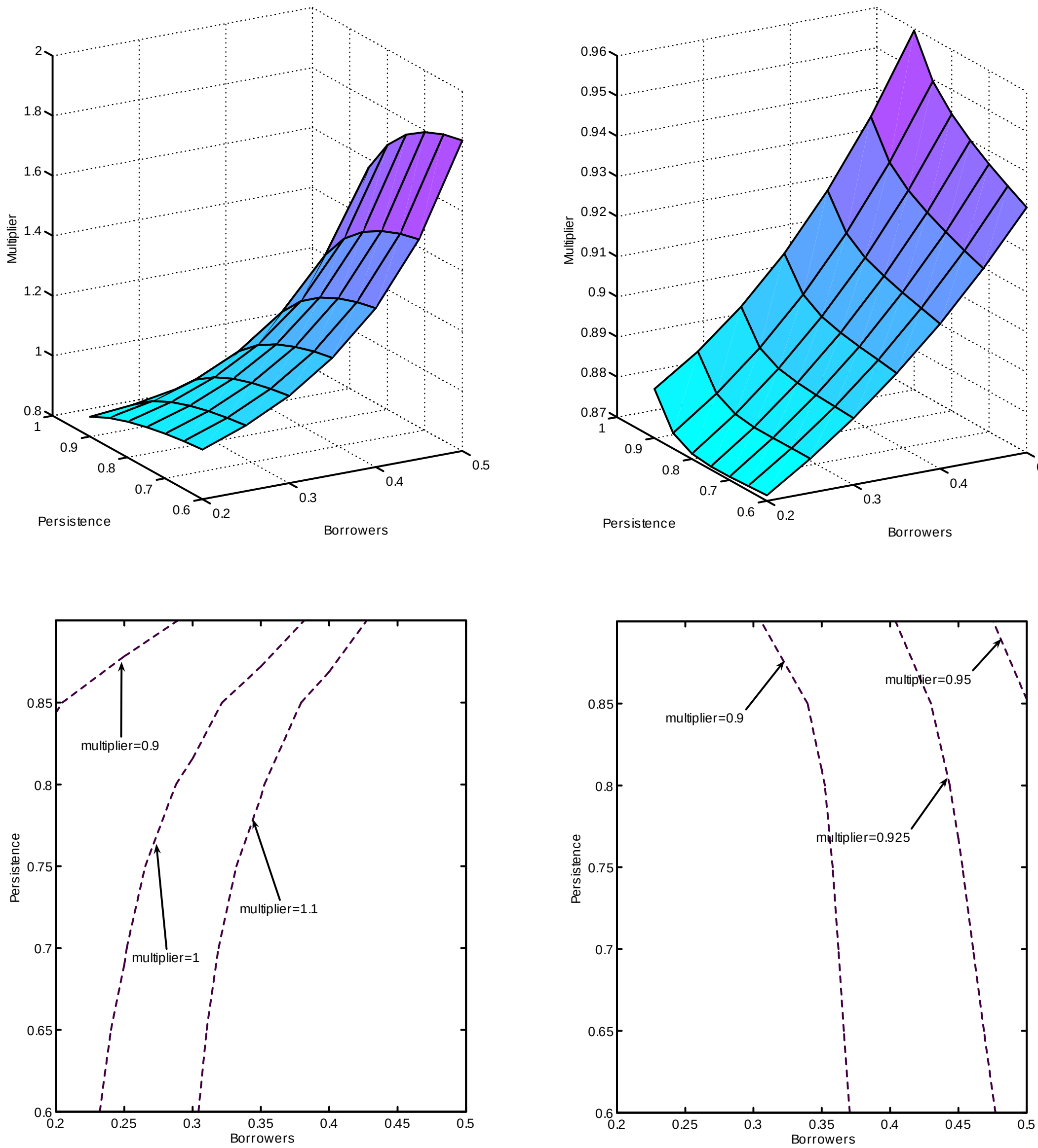
In this section we present some additional results about the impact output multiplier in terms of the interaction of three key parameters in our model. Figure 5 shows the values of the output multiplier as a function of the share of borrowers and the degree of persistence of the fiscal shock, keeping price rigidity at the benchmark value and $m^b = 0.985$. In the first panel in the top of the figure we depict a tridimensional plot showing the value of the multiplier along the two dimensions. This allows us to have at first sight an idea of how likely are output multipliers higher than one (the so-called Keynesian multipliers). To be more precise, in the second panel of the figure we represent contours of the previous figure for three different values of the output multiplier (0.9, 1.0 and 1.1). As it is clear from this graph, a Keynesian multiplier can be obtained for a wide range of combinations of number of borrowers and government spending shock persistence. For instance, if the share of borrowers is higher than 0.4, we obtain a multiplier higher than one independently of the degree of persistence. However, if the share of borrowers is around 0.25, we need shock persistence to be lower than 0.6 to get the Keynesian multiplier. The last panel in the figure, displays similar contours, but coming now from a tridimensional picture for an economy with a lower borrowing capacity ($m^b = 0.735$). As we can see in this case there are no combinations of reasonable values of both parameters that generate Keynesian output multipliers.

In the case of Figure 6 the graphs present similar information as the previous figure, but related to the interaction of the multiplier with the share of borrowers and the degree price rigidity. We keep persistence at its baseline value. As a general result, for parameters of price rigidity higher than 0.8 we obtain always Keynesian output multipliers, as can be observed in the contour plots in the lower panels of Figure 6. Interestingly, changes in the share of borrowers only affect the values of the output multiplier if the price rigidity parameter is above a threshold near 0.6. The combination of a very high loan-to-value with high price rigidity and a long number of borrowing constrained consumers makes the fiscal multiplier to rocket.

Finally, Figure 7 analyzes the effect on output multipliers of considering changes in the combination of persistence of the shock and price stickiness, keeping the share of

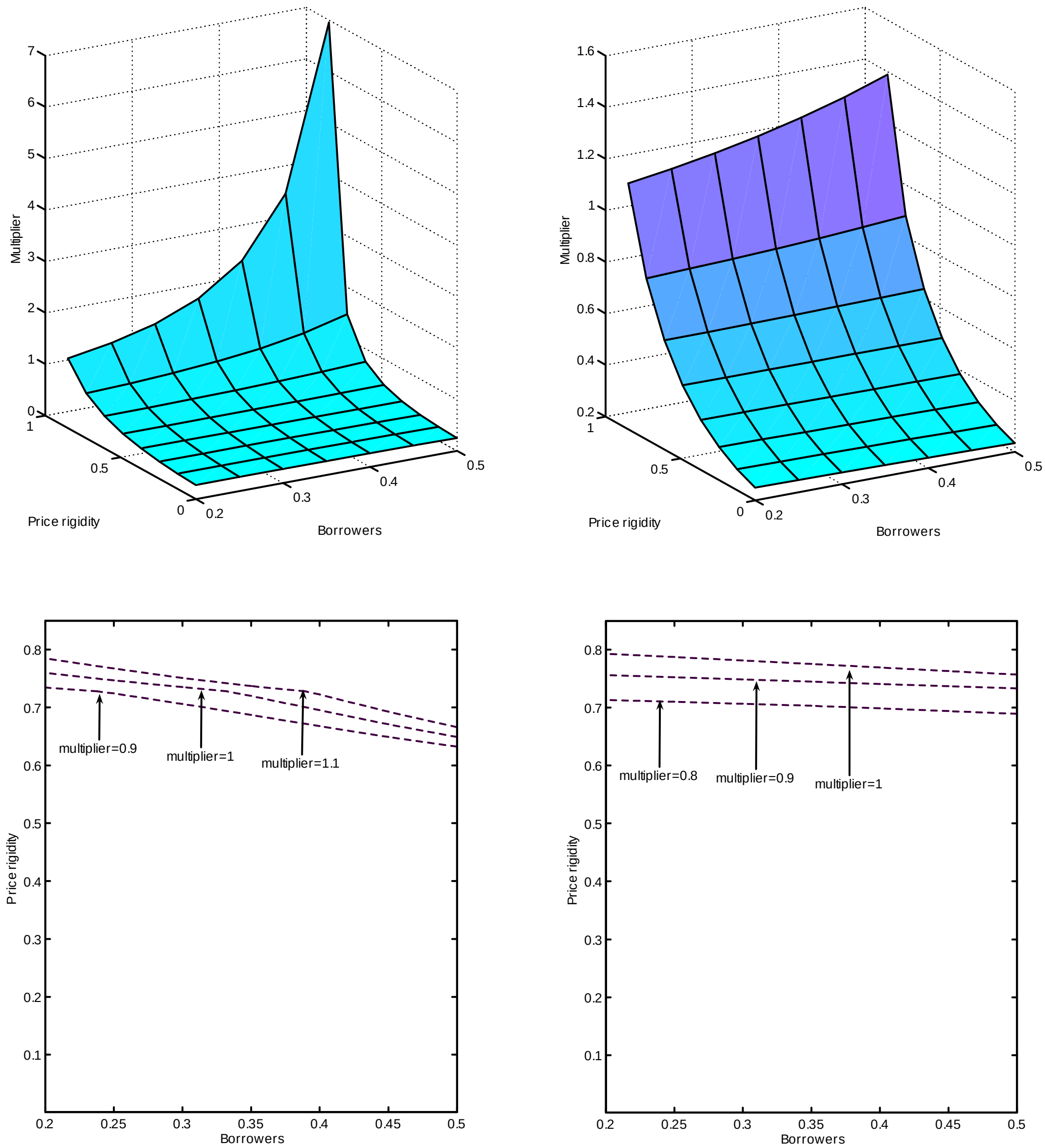
[13] A sensitivity analysis of the results in this subsection to the time span considered to calculate the fiscal multipliers can be found in Figures A.2 and A.3 in Appendix 1.

borrowers at its standard level. The graphs show that a price rigidity parameter roughly above 0.75 always generates a Keynesian multiplier whatever the persistence of the fiscal shock is. Also, when price rigidity is approximately above 0.6, increasing the persistence of the shock reduces the value of the multiplier. However, the opposite is true when prices are very flexible. In that case higher persistence contributes to increase the multiplier. Again, in the low leverage regime ($m^b = 0.735$) persistence does not interact with price rigidity to produce significant changes in the multiplier.



High loan-to-value High loan-to-value

Figure 5: *Impact fiscal multiplier as a function of the share of borrowers and persistence*



High loan-to-value   Low loan-to-value

Figure 6: *Impact fiscal multiplier as a function of the share of borrowers and price rigidity*

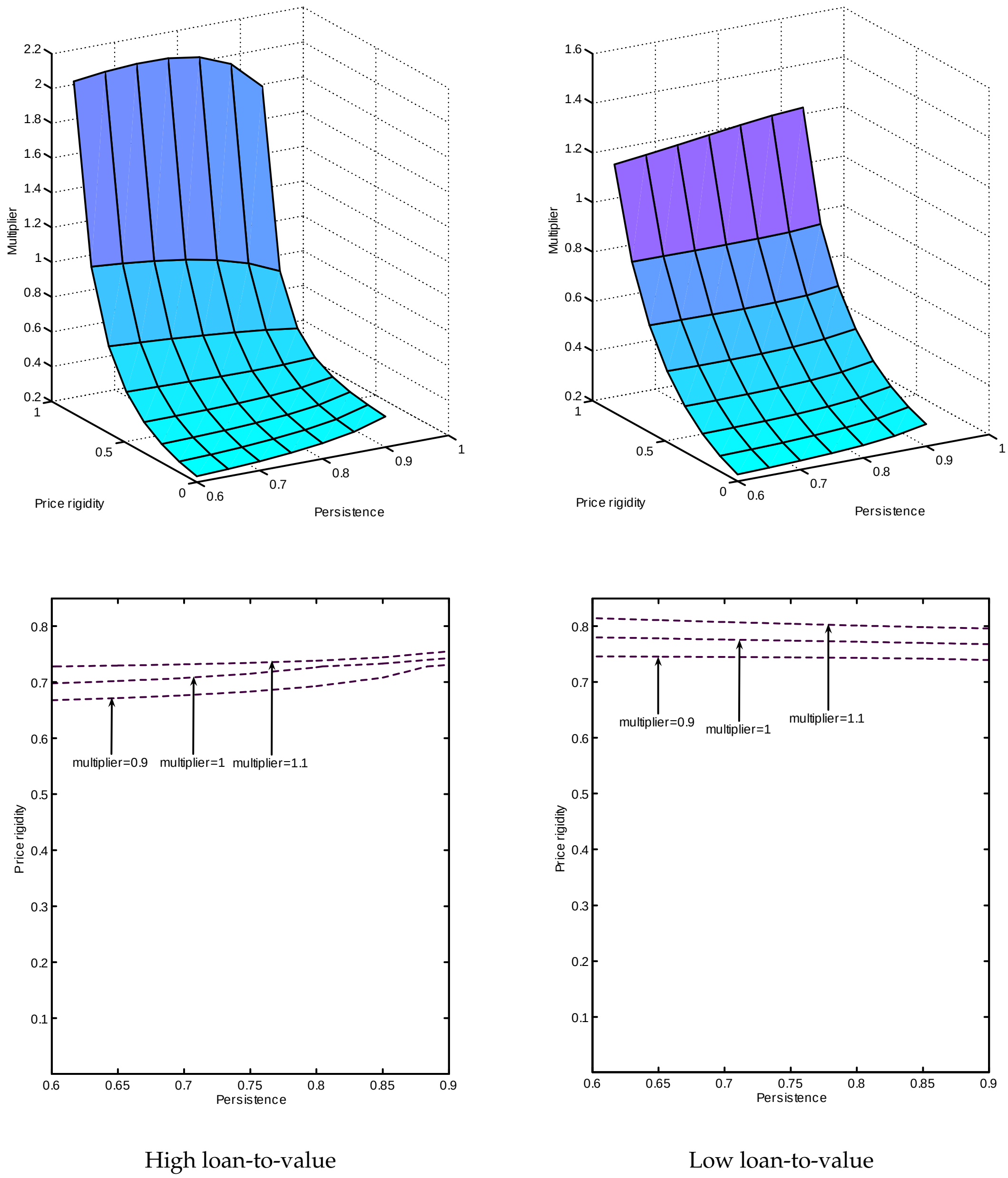


Figure 7: *Impact fiscal multiplier as a function of persistence and price rigidity*

5.5 Credit crunch and fiscal consolidation.

In this section we use our model to examine the effects of a fiscal consolidation driven by a cut in public expenditure in an environment where at the same time there is a credit crunch. We consider two strategies. In the first one, the government reduces government spendings by a little amount in the present, but announces that it will be reduced by more in the future. In the second one, it is assumed that most of the government spending reduction takes place in the first periods. Using Hall's words we name the first scenario as a "back-loading consolidation strategy" and the second as a "front-loading consolidation strategy"[14]. In both cases we assume that the total cut in government expenditure is the same, although the timing along a period of five years is quite different. More precisely, to stick to real numbers we simulate a five years back-loaded fiscal consolidation which is the inverse of the fiscal stimulus in the American Recovery and Reinvestment Act, as calculated by Cogan et. al. (2010, Figure 2). In the case of the front-loaded consolidation strategy, government expenditure reductions follow an autorregressive pattern, with our benchmark persistence parameter $\rho_g = 0.75$.

Figure 5 depicts the temporal pattern of government spending cuts for the two scenarios considered at a quarterly frequency. We feed our model with each of the strategies displayed in the figure and calculate the effects on GDP under our two values of the loan-to-value ($m^b = 0.985$ and $m^b = 0.735$). We interpret a fall in m^b as a credit crunch, so that by comparing the results for both values of the loan-to-value we intend to establish the influence of a credit crunch on the output effects of a fiscal consolidation.

Table 1 presents the results at a yearly frequency. According to the left-hand side panel of the table, when the fiscal consolidation follows a back-loading strategy, borrowing opportunities in the economy do not seem to play an important role in affecting GDP effects of the consolidation. However, when government follows a very agressive strategy of fiscal consolidation, reducing government spending very much in the initial quarters, the effects on GDP are very dependent on households' borrowing oportunities. In particular, fiscal consolidation is less harmful under a low indebtedness capacity situation. After five years, a fiscal consolidation in a situation of a low loan-to-value ratio saves around 0.7 percent of lost GDP, with respect to an scenario of high indebtedness capacity. Finally, the results also indicate that in the presence of a credit crunch, the front-loading strategy is less harmful compared to an hypothetical back-loaded policy.

[14] See Hall (2009)

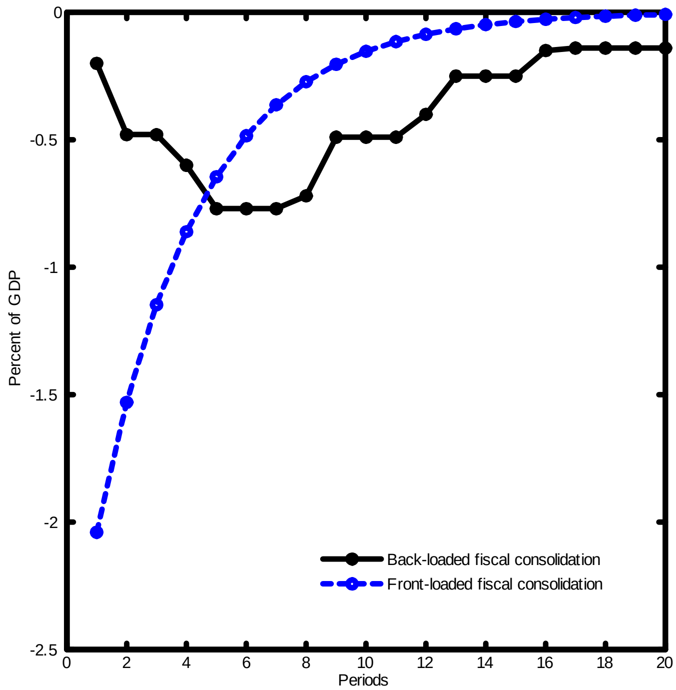


Figure 5: *Back-loaded fiscal consolidation and front-loaded fiscal consolidation*

TABLE 1 — OUTPUT EFFECTS OF FISCAL CONSOLIDATION

	Back-loaded fiscal consolidation			Front-loaded fiscal consolidation		
Year	Reduction[1] in g_t	Effect[2] on GDP		Reduction[1] in g_t	Effect[2] on GDP	
		Low m^b	High m^b		Low m^b	High m^b
2012	-0.44	-1.12	-1.00	-1.29	-3.44	-3.72
2013	-0.76	-1.68	-1.68	-0.44	-0.56	-0.72
2014	-0.47	-0.88	-0.88	-0.14	-0.16	-0.28
2015	-0.23	-0.36	-0.40	-0.04	-0.04	-0.12
2016	-0.14	-0.28	-0.36	-0.01	-0.01	-0.04
Sum	-2.03	-4.32	-4.32	-2.03	-4.21	-4.88

[1]As a percentage of yearly GDP. [2]Accumulated gains (percent of initial GDP).

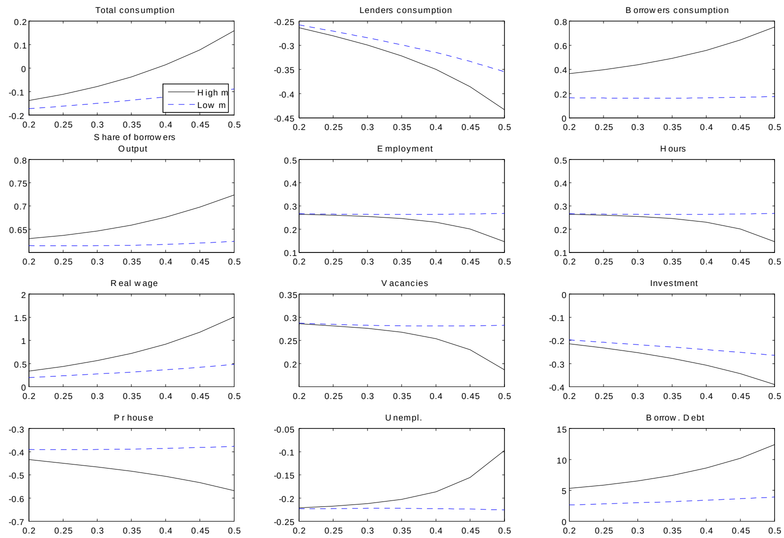
6. Conclusions

Fiscal policy is non-keynesian even in neo-keynesian models with many Ricardian features. The intertemporal substitution mechanisms wipes out the expansionary effects of fiscal stimuli depressing investment and consumption. Alternatively, models with consumers that do not participate in the financial market are capable of producing strong fiscal responses of output. Unfortunately these models have two important caveats, one in terms of the assumptions and the other empirical. These model overlook an important feature of modern economies in which many households make their consumption decisions neither on the basis of their permanent income nor of their labor income only, since they have a limited but non-zero borrowing capacity. This implies that some of these agents carry a given amount of debt, and presumably some asset holdings, that affect their consumption possibilities. The current recession that has occurred after a period of easy financial conditions that has caught many households highly leveraged is a good case in point. On empirical grounds, under fairly general conditions the ROT model fails to deliver theoretical impulse responses of vacancies and employment to fiscal shocks consistent with those in the data.

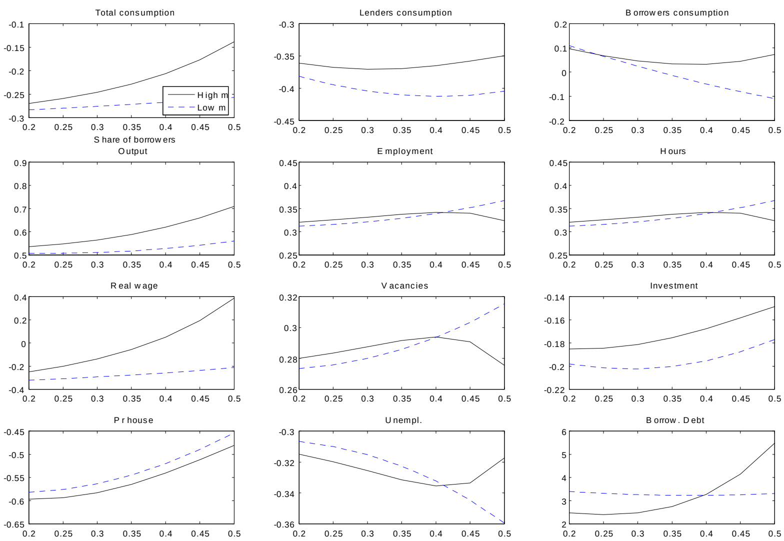
In this paper we augment the search and matching model with a proportion of total households who are more impatient than others and who borrow up to a limit given by the expected collateral value of their asset (housing) holdings. The interaction between the consumption decisions of agents with limited access to credit and the process of wage bargaining and vacancy posting delivers three main results: (a) higher initial leverage makes it more likely to find output multipliers higher than one; (b) a positive government expenditure shock always produces a positive multiplier for vacancies and employment; and, (c) output (employment) multipliers decrease (increase) markedly with the degree of shock persistence and increase with the degree of price stickiness.

Although we do not exploit all policy implications of this enlarged framework, the asymmetries obtained in the response of consumption and output to fiscal shocks depending on the access to credit, implies that the size of fiscal multiplier might be severely affected by the depth of the credit crunch in some developed economies after the financial crisis. In fact, a simple fiscal consolidation exercise shows that GDP effects are less harmful in a situation of a low loan-to-value ratio than in an scenario of high indebtedness capacity.

Appendix 1: One-year and five-year multipliers

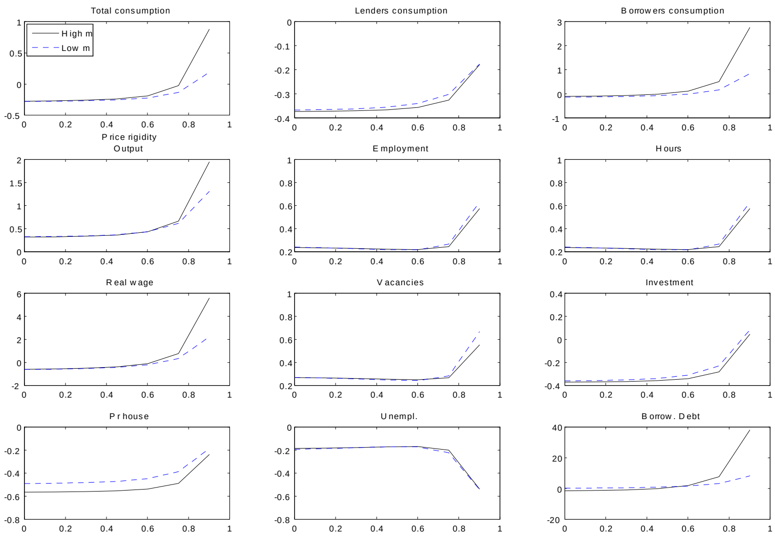


One-year multiplier as a function of the share of borrowers

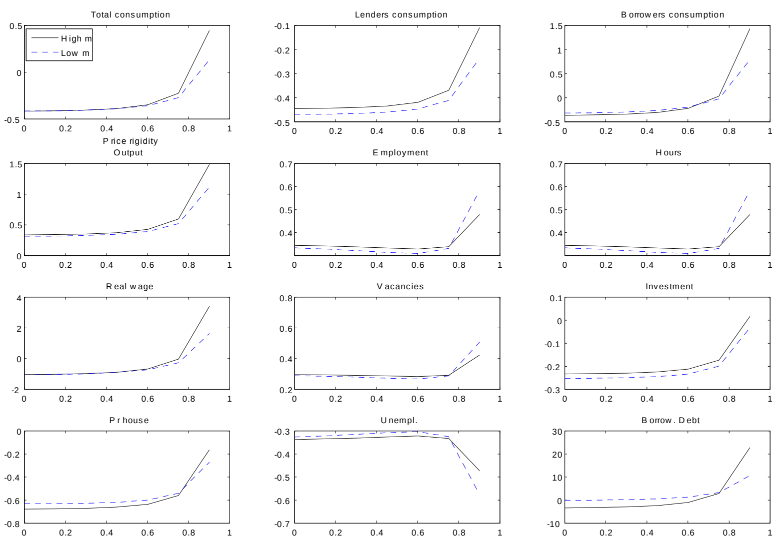


Five-year multiplier as a function of the share of borrowers

Figure A.1: Multipliers as a function of the share of borrowers

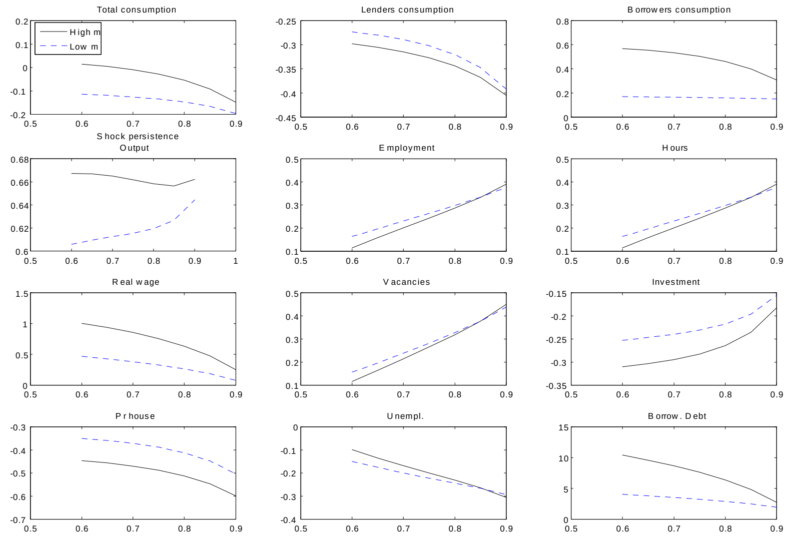


One-year multiplier as a function of price rigidity

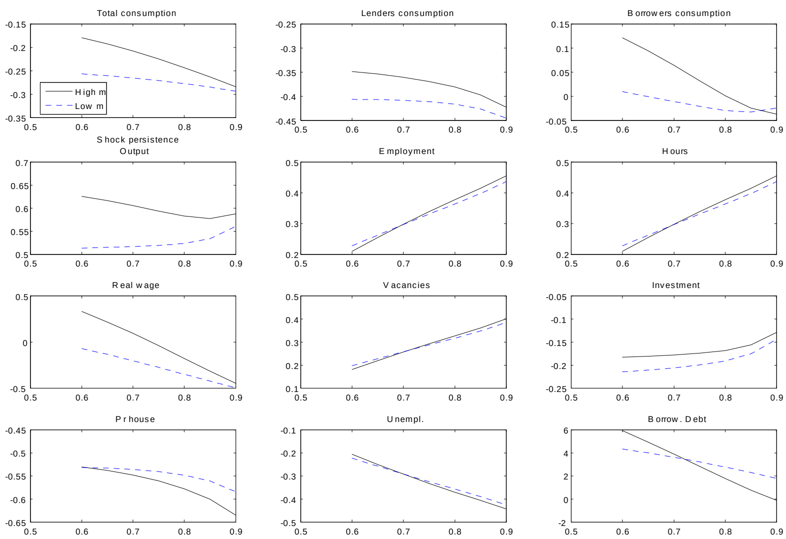


Five-year multiplier as a function of price rigidity

Figure A.2: Multipliers as a function of price rigidity



One-year multiplier as a function of the shock persistence



Five-year multiplier as a function of the shock persistence

Figure A.3: Multipliers as a function of the shock persistence

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