

**INSTRUMENTS, RULES AND HOUSEHOLD DEBT:
THE EFFECTS OF FISCAL POLICY***

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D-2014-01

May, 2014

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The financial support of CICYT grant ECO2011-29050 is gratefully acknowledged. J. E. Boscá and J. Ferri also acknowledge the financial support through the collaboration agreement between the Ministry of Finance and Public Administration, Ministry of Economy and Competitiveness, Fundación Rafael del Pino, BBVA Research and Fundación de Economía Analítica. Part of this research was conducted while Boscá was visiting the School of Economics at the University of Kent and Ferri the Business School at the University of Glasgow. The hospitality of these institutions is greatly appreciated. All remaining errors are our own responsibility.

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Abstract

In this paper, we look at the interplay between the level of household leverage in the economy and fiscal policy, the latter characterised by different combinations of instruments and rules. When the fiscal rule is defined on lump-sum transfers, government spending or consumption taxes, the impact multipliers of transitory fiscal shocks become substantially amplified in an environment of easy access to credit by impatient consumers, regardless of the primary instruments used. However, when the government reacts to debt deviations by raising distortionary taxes on income, labour or capital, the effects of household debt on the size of the impact output multipliers vanish or even reverse, no matter the primary fiscal instrument used. We also find that differences in multipliers between high and low indebtedness regimes belong basically to the short run, whereas the long-run multipliers associated with fiscal shocks are barely affected by the level of household debt in the economy. Finally, we find that fiscal shocks exert an unequal welfare effect on impatient and patient households that can even be of opposite signs. This points to non-negligible distributional impacts of alternative fiscal strategies, especially in economies with highly indebted households.

Key words: fiscal multipliers, household debt, distortionary taxes.

JEL Classification: E24, E44, E62

1. Introduction

At the onset of the financial crisis, governments around the world reacted by launching a variety of fiscal stimulus packages involving a wide array of fiscal instruments. Today many of these governments are struggling to reverse the process of massive debt accumulation that has occurred over the last few years, by reducing expenditures and/or increasing taxes. These policies have been carried out against the backdrop of economies with heavily leveraged households, which means that fiscal authorities have had to navigate in uncharted territory in terms of the effect of their actions. In this paper we contribute to fill that gap in the literature and explore the effect that high private debt has on alternative fiscal strategies. We study how the conditions of access to mortgaged debt by households shapes both the macroeconomic impact and the welfare costs of alternative fiscal strategies. Such strategies differ in terms of the (primary) instrument used to apply discretionary fiscal stimuli, the persistence of the fiscal shock, and the (secondary) instrument used to stabilise the level of debt to ensure that the debt-to-GDP ratio is stationary (the design of the fiscal rule).

Other papers have also considered some of these dimensions of fiscal policy. Thus, beyond the consideration of the role played by the lower bound of the interest rate on the effects of fiscal policy¹, the recent literature has also focused on a wider variety of fiscal policy instruments, as well as on the undergoing dynamic adjustments of fiscal tools in response to government debt and the level of economic activity. One example of this view is Leeper, Plante and Traum (2010), who conclude that responses of macroeconomic aggregates to fiscal policy shocks under richer and more realistic rules depart considerably from the responses obtained under rules based on non-distortionary transfers. They also find that debt-financed fiscal shocks generate long-lasting dynamics and that short and long-run multipliers can differ markedly. Also, in Coenen et al. (2012) the authors explore the changes in seven fiscal instruments with seven structural policy models (plus two academic models) to conclude that fiscal policy can produce important output multipliers, especially for spending and targeted transfers. They also find non-linear interactions between the duration of the monetary accommodation and the persistence of the fiscal stimulus. For Forni, Monteforte and Sessa (2009), however, reductions in the revenue side of the public budget tend to be more significant than increases in government expenditure. Mountford and Uhlig (2009), using an empirical VAR approach, also conclude that a deficit-financed tax cut stimulates the economy more than a deficit-spending policy.

Other works that aim to evaluate specific programmes implemented in response to the financial crisis find important differences among fiscal multipliers depending, for

¹ See Eggertsson (2011), Christiano et al. (2011), Farhi and Werning (2012), Erceg and Linde (2011), Davig and Leeper (2011), and references in this introduction below.

example, on the instrument used as a fiscal stimulus, the time span considered, the monetary stance, or the expected fiscal consolidation strategy following the fiscal stimuli programme. Examples of this strand include Coenen, Straub and Trabandt (2013), who quantify the impact of the European Economic Recovery Plan on the euro area GDP; Cogan et al. (2010) and Drautzburg and Uhlig (2013), who study the fiscal multipliers in response to the American Recovery and Reinvestment Act (ARRA); and Cogan et al. (2013), who analyse the macroeconomic consequences of the 2013 Budget Resolution passed in March 2012 by the U.S. House of Representatives. Regarding the role that financial frictions in the household sector might play in fiscal multipliers, Eggertsson and Krugman (2012) argue that the presence of constrained borrowers strengthens the effect of fiscal policy. In a similar vein, but in an empirical framework, Hernandez de Cos and Moral Benito (2013) find that the government spending multiplier depends on the degree of credit stress in the economy.

We approach the study of these issues within the framework of a Neo-Keynesian model that emphasises the link between financial constraints and the labour market. The model includes labour market as well as financial frictions drawing on Mortensen and Pissarides (1994) and Iacoviello (2005), respectively. Some households are impatient and borrow from the patient ones up to a limit given by a fraction of the expected value of their housing holdings. The presence of private debt opens up a powerful channel for fiscal stimuli that exerts a direct effect on the value of collateral through its impact on inflation and the price of assets. When the loan to value ratio is sufficiently high, the change in collateral has a strong marginal effect on consumption over and above its reaction to current labour income. This reduces the marginal utility of consumption, thus reinforcing workers' bargaining power in wage negotiations, further increasing labour income. A calibrated version of this model allows us to obtain fiscal multipliers as a function of the level of household leverage in the economy. Using this model, we offer an exhaustive set of results regarding different combinations of primary fiscal instruments and fiscal rules that helps in identifying the strengths and weaknesses of a wide battery of fiscal strategies. To this end, we present both short and long-run present value multipliers, and we distinguish between transitory and permanent fiscal shocks. In all cases, the role played by household debt is highlighted. Finally, we outline the welfare implications of these fiscal combinations for the cases of transitory and permanent shocks. Moreover, distinguishing between welfare effects on lenders and borrowers provides some hints on the distributional effects of fiscal policy.

Our main results can be summarised as follows. First, we find that the macroeconomic impact of fiscal policy becomes substantially amplified in an environment of easy access to credit by impatient consumers or of high borrowers' debt. Impatient consumers

change their consumption and housing demand as a consequence of these shocks more than patient consumers do, and this response is stronger the higher the pledgeability of their collateralisable assets. Second, easy access to credit does not always guarantee higher (positive) multipliers, but rather it depends on the instrument used to stabilise public debt (fiscal rule). In fact, the offsetting effect of some fiscal adjustments needed to keep public debt on a sustainable path is also larger in an environment of high private debt, undoing in some cases the impact of the primary fiscal instrument. In particular, discretionary fiscal shocks that are counteracted by changes in the most distortionary tax rates yield lower fiscal multipliers, both in the short and in the long-run, in an economy with high household leverage. Third, the impact on impatient consumers' welfare is stronger the higher their indebtedness. This is due to the fact that these agents' strong response of consumption spending is also accompanied by significant changes in leisure and housing demand. This suggests that the social costs of choosing an inadequate fiscal package might be quite high and that the distributional impact of alternative fiscal policies is non-negligible. In fact, in some cases the welfare changes for borrowers and lenders display opposite signs. We believe our results support the most recent empirical results regarding the different responses to fiscal policy of those consumers with a large amount of mortgage debt (Cloyne and Surico, 2014) or illiquid assets (Kaplan, Violante and Weidner, 2014). These results are presented in section 4. Sections 2 and 3 introduce the model and its calibration, respectively, and section 5 concludes.

2. The model

In this section we present the basic optimisation problems faced by the different agents modelled in our economy (see the Appendix 1 for the full set of equations)². In our decentralised closed economy households and firms trade one final good and two factors of production: productive capital and labour. Capital is exchanged in a perfectly competitive market but the labour market is non-Walrasian. Besides labour and capital, households own all the firms operating in the economy. Households rent capital and labour services to competitive wholesale firms and receive income in the form of rental rate of capital and wages. These firms post new vacancies every period and pay a fixed cost while the vacancy remains unfilled. Wholesale firms and workers bargain over the monopoly rents associated with each job match in Nash fashion. Households are made up of working-age agents who may be either employed or unemployed. If unemployed, agents are actively searching for a job. Firm investment in vacant posts is endogenously determined and so are job inflows. Job destruction is considered exogenous. Wholesale firms sell their

² In Andrés, Boscá and Ferri (2012) we use a similar model, although with a much simpler tax structure.

production to monopolistically competitive, final goods-producing retail firms that set prices in a staggered way.

There are N households in the economy, N^l of them are patient and N^b are impatient (e.g., Kiyotaki and Moore (1997), Iacoviello (2005), Monacelli (2009), and Andrés and Arce (2012)). All have access to financial markets but patient households are characterised by having a lower discount rate than impatient ones, ensuring that, under fairly general conditions, patient households are net lenders and owners of physical capital, while impatient households are net borrowers. Due to some underlying friction in the financial market, borrowers face a binding constraint in the amount of credit they can take. Let $1 - \tau^b$ and τ^b denote the proportions of lenders and borrowers in the working-age population respectively; these shares, as well as the working-age population, are assumed to be constant over time.

The fiscal structure of the model comprises a full set of revenue and expenditure instruments. Government revenues are made up of direct taxation (personal labour income tax, τ_t^w , employers' social security contributions, τ_t^{sc} , and capital income, τ_t^k), and indirect taxation (consumption tax at the rate τ_t^c). The government spends on public consumption g_t , pays lump sum transfers to households³, trh_t , and offers unemployment benefits (ub_t), as a constant fraction of wages, to unemployed workers. The government deficit is financed by issuing public debt b_t^p , which is optimally bought by patient households (the only savers in the economy). The nominal interest rate is set by a central bank assuming a standard Taylor's rule.

2.1 Patient households

The representative household faces the following maximisation program,

$$\max_{c_t^l, k_t^l, j_t^l, b_t^l, b_t^p, x_t^l} E_t \sum_{t=0}^{\infty} (\beta^l)^t \left[\begin{aligned} & \ln(c_t^l) + \phi_x \ln(x_t^l) + n_{t-1}^l \phi_1 \frac{(1-l_1)^{1-\eta}}{1-\eta} \\ & + (1-n_{t-1}^l) \phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} \end{aligned} \right] \quad (1)$$

subject to

$$\begin{aligned} (1 + \tau_t^c) c_t^l + j_t^l \left(1 + \frac{\phi}{2} \left(\frac{j_t^l}{k_{t-1}^l} \right) \right) + q_t (x_t^b - x_{t-1}^b) - b_t^l - b_t^p = \\ w_t (1 - \tau_t^w) \left(l_1 n_{t-1}^l + \bar{r} (1 - n_{t-1}^l) l_2 \right) + \left(r_t (1 - \tau_t^k) + \tau_t^k \delta \right) k_{t-1}^l \\ - (1 + r_{t-1}^n) \left(\frac{b_{t-1}^l}{1 + \pi_t} + \frac{b_{t-1}^p}{1 + \pi_t} \right) + trh_t^l \end{aligned} \quad (2)$$

³ All households in our model receive the same amount of transfers, so they are proportional to τ^b for impatient households.

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

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

Lower case variables in the maximisation problem above are normalised by the within-group working-age population (N_t^l). Variables and parameters indexed by b and l denote, respectively, 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 normalised to one. l_{1t} and l_2 are hours worked per employee and hours devoted to job seeking by the unemployed. While the household bargains over l_{1t} , the amount of time devoted to job seeking (l_2) is assumed to be exogenous. 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 the labour supply and ϕ_x is the weight of housing in life-time utility. The subjective value attributed to leisure by workers may vary across employment statuses ($\phi_1 \neq \phi_2$).

Maximisation of (1) is constrained according to equations (2) to (4). The budget constraint (2) describes the various sources and uses of income. The term $w_t n_{t-1}^l l_{1t}$ captures net labour 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 who get $r_t k_{t-1}^l$ in return, where r_t represents the gross return on physical capital. Second, there are loans/debt in the economy. Thus, patient households lend in real terms $-b_t^l$ to (or borrow b_t^l from) the private sector and $-b_t^p$ to the public sector. They receive back r_{t-1}^n per unit lent, where r_{t-1}^n is the nominal interest rate on loans between $t - 1$ and t . Note that in the budget constraint (2), the gross inflation rate between $t - 1$ and t in the term $(1 + r_{t-1}^n) \left(\frac{b_{t-1}^l}{1 + \pi_t} + \frac{b_{t-1}^p}{1 + \pi_t} \right)$ reflects the assumption that debt contracts are set in nominal terms. Third, there is a fixed amount of real estate in the economy and $q_t (x_t^b - x_{t-1}^b)$ represents real estate investment by patient households, where q_t is the real housing price. Consumption and investment are respectively given by c_t^l and $j_t^l \left(1 + \frac{\phi}{2} \left(\frac{j_t^l}{k_{t-1}^l} \right) \right)$. Total investment outlays are affected by increasing marginal costs of installation. Households pay different taxes and obtain unemployment benefits parameterised according to the expression $ub_t = \bar{r}l_2 w_t$.

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 destroyed at the exogenous rate σ . Likewise, new employment opportunities arise 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,

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

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

2.2 Impatient households

Impatient households discount the future more heavily than patient ones, so their discount rate satisfies $\beta^b < \beta^l$, and face the following maximisation program,

$$\max_{c_t^b, b_t^b, x_t^b} E_t \sum_{t=0}^{\infty} (\beta^b)^t \left[\begin{aligned} & \ln c_t^b + \phi_x \ln x_t^b + n_{t-1}^b \phi_1 \frac{(1-l_1)^{1-\eta}}{1-\eta} \\ & + (1 - n_{t-1}^b) \phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} \end{aligned} \right] \quad (6)$$

subject to the specific budget constraint, a borrowing limit and the law of motion of employment, as reflected in the following equations

$$\begin{aligned} (1 + \tau_t^c) c_t^b + q_t (x_t^b - x_{t-1}^b - b_t^b) &= (1 - \tau_t^w) w_t l_1 n_{t-1}^b + \bar{r} r (1 - n_{t-1}^b) l_2 \\ &- \frac{(1 + r_{t-1}^n) b_{t-1}^b}{1 + \pi_t} + tr h_t^b \end{aligned} \quad (7)$$

$$b_t^b \leq m^b E_t \frac{q_{t+1} (1 + \pi_{t+1}) x_t^b}{1 + r_t^n} \quad (8)$$

$$n_t^b = (1 - \sigma) n_{t-1}^b + \rho_t^w (1 - n_{t-1}^b) \quad (9)$$

Note that restrictions (7) and (9) are analogous to those for patient individuals (with the exception that impatient households do not accumulate physical capital nor do they lend to government). However restriction (8) is particular to this group of households. In the mortgage market, the maximum loan that an individual can obtain is a fraction of the liquidation value of the amount of housing held by the representative household; thus $m^b \in [0, 1]$ in (8) represents the loan-to-value ratio. As shown in Iacoviello (2005), without

uncertainty the assumption $\beta^b < \beta^l$ guarantees that the borrowing constraint holds with equality. The presence of this borrowing constraint implies that impatient households' intertemporal substitution is limited by the following Euler equation in consumption,

$$\lambda_{1t}^b = \beta^b E_t \lambda_{1t+1}^b \left(\frac{1 + r_t^n}{1 + \pi_{t+1}} \right) + \mu_t^b (1 + r_t^n) \quad (10)$$

where is λ_{1t}^b the current marginal utility of consumption and μ_t^b is the Lagrange multiplier of the borrowing constraint. With respect to patient households, this Euler equation adds the new term $\mu_t^b (1 + r_t^n)$, which captures the tightness of the borrowing constraint.

2.3 Production

The productive sector is organised in three different levels: (1) firms in the wholesale sector (indexed by j) use labour and capital to produce a homogenous good that is sold in a competitive flexible price market at a price P_t^w ; (2) this homogenous good is bought by firms (indexed by \tilde{j}) in the intermediate sector 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 ($y_{\tilde{j}t}$) and sells a homogeneous final good (y_t) at price P_t .

The competitive retail sector

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

$$\text{Max}_{y_{\tilde{j}t}} \left\{ P_t y_t - \int P_{\tilde{j}t} y_{\tilde{j}t} d\tilde{j} \right\}$$

subject to,

$$y_t = \left[\int y_{\tilde{j}t}^{(1-1/\theta)} d\tilde{j} \right]^{\frac{\theta}{\theta-1}} \quad (11)$$

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 monopolistically competitive intermediate sector

The monopolistically competitive intermediate sector comprises $\tilde{j} = 1, \dots, \tilde{J}$ firms, each of which buys the production of competitive wholesale firms at a common price P_t^w and sells a differentiated variety $y_{\tilde{j}t}$ at price $P_{\tilde{j}t}$ to the final competitive retailing sector described

above. Variety producers stagger prices. 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 $P_{jt} = (1 + \pi_{t-1})^\zeta P_{jt-1}$ (with ζ 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 maximise 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 maximisation problem of the representative variety producer can be written as,

$$\max_{P_{jt}^*} E_t \sum_{s=0}^{\infty} \Lambda_{t,t+s} \beta^l \omega^s \left[P_{jt}^* \bar{\pi}_{t+s} y_{jt+s} - P_{t+s} mc_{jt,t+s} y_{jt+s} + \kappa_f \right] \quad (12)$$

subject to

$$y_{jt+s} = \left(P_{jt}^* \prod_{s'=1}^s (1 + \pi_{t+s'-1})^\zeta \right)^{-\theta} P_{t+s}^\theta y_{t+s} \quad (13)$$

where P_{jt}^* is the price set by the optimizing firm at time t , $\bar{\pi}_{t+s} = \prod_{s'=1}^s (1 + \pi_{t+s'-1})^\zeta$, $mc_{jt,t+s} = \frac{P_{t+s}^w}{P_{t+s}} = \mu_{t+s}^{-1}$ represents the real marginal cost (inverse mark-up) borne at $t + j$ by the firm that last set its price in period t , P_{t+s}^w 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.,

$$\frac{E_t \Lambda_{t,t+s}}{E_t \Lambda_{t,t+s-1}} = \frac{E_t (\lambda_{1t+s} / P_{t+s})}{E_t (\lambda_{1t+s-1} / P_{t+s-1})} \quad (14)$$

The competitive wholesale sector

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

$$\min_{k_t, v_t} E_t \sum_{t=0}^{\infty} (\beta^l)^t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} (r_{t-1} k_{t-1} + (1 + \tau_t^{sc}) w_t n_{t-1} l_{1t} + \kappa_v v_t) \quad (15)$$

subject to

$$y_t = Ak_{t-1}^{1-\alpha} (n_{t-1} l_{1t})^\alpha \quad (16)$$

$$n_t = (1 - \sigma)n_{t-1} + \rho_t^f v_t \quad (17)$$

where, in accordance with the ownership structure of the economy, future profits are discounted at the relevant rate $\left((\beta^l)^t \frac{\lambda_{1t}^l}{\lambda_{1t}^l} \right)$ of the patient household. Producers use two inputs, private capital and labour, combined in a standard Cobb-Douglas constant-returns-to-scale production function. From the firms' point of view, labour is homogeneous regardless of the type of household (patient or impatient) that provides it. The firms pay a tax in the form of social contributions (τ_t^{sc}) when employing a worker. ρ_t^f 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_t^f is exogenous from the perspective of the firm. However, as far as the overall economy is concerned, this probability is endogenously determined according to the following Cobb-Douglas matching function:

$$\rho_t^w (1 - n_{t-1}) = \rho_t^f v_t = \chi_1 v_t^{\chi_2} [(1 - n_{t-1}) l_2]^{1-\chi_2} \quad (18)$$

2.4 Trade in the labour market: the labour contract

We assume two-sided market power, wage bargaining and matching frictions à la Mortensen and Pissarides (1994). Each period, the unemployed engage in job-seeking activities in order to find vacant posts spread over the economy. A costly search in the labour market implies that there are simultaneous flows into and out of the state of employment, so an increase in the stock of unemployment results from the predominance of job losses over job creation. Stable unemployment occurs whenever inflows and outflows cancel each other out, i.e.,

$$\rho_t^f v_t = \rho_t^w (1 - n_{t-1}) = \chi_1 v_t^{\chi_2} [(1 - n_{t-1}) l_2]^{1-\chi_2} = \sigma n_{t-1} \quad (19)$$

Since 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-seeker and a vacancy-offering firm match, they negotiate a labour contract in hours and wages. There is risk-sharing at the household level and hence consumption within each household type is independent of the employment

status. As in Boscá, Doménech and Ferri (2011), we assume that, although patient and impatient households may have different reservation wages, they delegate the bargain process with firms to trade unions. This trade union maximises the aggregate marginal value of employment for workers and distributes employment according to their shares in the working-age population. This assumption implies that all workers receive the same wage, work the same number of hours and have the same unemployment rates. Thus, following standard practice, the Nash bargaining process maximizes the weighted product of the parties' surpluses from employment.

$$\max_{w_t, l_{1t}} 1 - \tau^b \frac{\lambda_{ht}^l}{\lambda_{1t}^l} + \tau^b \frac{\lambda_{ht}^b}{\lambda_{1t}^b} \lambda_{ft}^{1-\lambda^w} = \max_{w_t, l_{1t}} (\lambda_{ht})^{\lambda^w} \lambda_{ft}^{1-\lambda^w} \quad (20)$$

where $\lambda^w \in [0, 1]$ reflects workers' bargaining power. The first term in brackets represents the worker's surplus (as a weighted average of borrowers' and lenders' surpluses), while the second term, λ_{ft} , is the firm's surplus. More specifically, $\lambda_{ht}^l/\lambda_{1t}^l$ and $\lambda_{ht}^b/\lambda_{1t}^b$ respectively denote the earning premium (in terms of consumption) of employment over unemployment for a patient and an impatient worker. The solution of the Nash maximisation problem (see the Appendix 1) gives the optimal real wage and hours worked.

2.5 Policy instruments and resources constraint

Output is defined as the sum of demand components plus the cost of posting vacancies

$$y_t = A_t k_{t-1}^{1-\alpha} (n_{t-1} l_{1t})^\alpha = c_t + j_t \left(1 + \frac{\phi}{2} \left(\frac{j_t}{k_{t-1}} \right) \right) + g_t + \kappa_v v_t \quad (21)$$

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

$$1 + r_t^n = (1 + r_{t-1}^n)^{r_R} \left((1 + \pi_{t-1})^{1+r_\pi} \left(\frac{y_{t-1}}{\bar{y}} \right)^{r_y} (1 + \bar{r}^n) \right)^{1-r_R} \quad (22)$$

where \bar{y} and \bar{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.

Government revenues are given by

$$t_t = (\tau_t^w + \tau_t^{sc}) w_t (n_{t-1} l_{1t}) + \tau_t^k (r_t - \delta) k_{t-1} + \tau_t^c c_t + \tau_t^w \bar{r} w_t (1 - n_{t-1}) l_2 \quad (23)$$

Revenues and expenditures are made consistent by means of the government intertempo-

ral budget constraint

$$b_t^p = g_t + \bar{r}w_t(1 - n_{t-1})l_2 + trh_t - t_t + \frac{(1 + r_{t-1}^n)}{1 + \pi_t} b_{t-1}^p \quad (24)$$

Finally, the dynamic sustainability of public debt requires the introduction of a fiscal rule that makes one or several fiscal categories an instrument for debt stabilisation. Later on we will present the different rules we use for simulation purposes.

3. Calibration

The benchmark model is calibrated using standard values in the literature for some parameters and matching some relevant data moments for the US economy. The set of parameters and tax rates is shown in Table 1. Because the nature of the simulation experiments below entails the consideration of two scenarios of low and high household indebtedness, we take the values of 0.20 and 0.50 for the fraction of impatient consumers in the economy, τ^b , whereas for the loan-to-value ratio we distinguish between $m^b = 0.735$ and $m^b = 0.985$, values that are slightly lower and higher than those in Iacoviello and Neri (2010). To calculate the average tax rates we follow Boscá, García and Taguas (2005)⁴. A more detailed description of the procedure followed for calibrating the model can be found in Appendix 2.

4. The effect of alternative fiscal strategies

Some recent papers have established an empirical relationship between the response of households' consumption to fiscal shocks and the size of households' debt and wealth. Kaplan, Violante and Weidner (2014) find that wealthy hand-to-mouth households (i.e. households with little or no liquid wealth but with a sizable amount of illiquid assets, such as houses) display a high propensity to consume out of transitory income changes. Similarly, Cloyne and Surico (2014) find that households with mortgage debt exhibit a large response of consumption to changes in income taxes. Using a structural model, in Andrés, Boscá and Ferri (2012) we show how the interaction between the consumption decisions of agents with limited access to credit and the process of wage bargaining and vacancy posting delivers multipliers that increase with the share of mortgagors in the total population and these households' borrowing capacity. This result was conditional on transitory shocks in government spending with a fiscal rule defined on lump-sum transfers. As Woodford (2011) points out, it might seem a serious omission to discuss the plausibility of

⁴ These authors apply the Mendoza, Razin and Tesar (1994) methodology to an extended period.

TABLE 1 – PARAMETER VALUES

Preferences:			
Discount factor (lenders), β^l	0.99	Discount factor (borrowers), β^b	0.95
Intertemp. labour elasticity of substitution, η	2	Housing weight in utility, ϕ_x	0.11
Leisure preference (empl.), ϕ_1	1.15	Leisure preference (unempl.), ϕ_2	0.89
Houshold's debt:			
Low share of impatient consumers, τ^b	0.20	High share of impatient consumers, τ^b	0.50
Low loan-to-value, m^b	0.735	High loan-to-value, m^b	0.985
Technology:			
labour share in production, α	0.7	Depreciation rate of capital, δ	0.025
Elasticity of final goods, θ	6	Entry fixed cost, κ_f	0.20
Frictions:			
Probability of not changing prices, ω	0.75	Adjustment costs for investment, ϕ	5.5
Inflation indexation, ζ	0.4		
labour market:			
Elasticity of matching to vacant posts, χ_2	0.5	Transition rate from empl. to unempl., σ	0.15
Workers' bargaining power, λ^w	0.5	Cost of vacancy posting, κ_v	0.04
Scale parameter of the matching function, χ_1	1.56		
Policy:			
Consumption's tax rate, τ^c	0.05	Labour's tax rate, τ^w	0.17
Social security contributions, τ^{sc}	0.07	Capital's tax rate, τ^k	0.33
Replacement rate, rr	0.40	Interest rate smoothing, r_R	0.73
Interest rate reaction to inflation, r_π	0.27	Interest rate reaction to output	0

a fiscal policy without taking into account the effects of distorting taxes; in the forthcoming subsections, therefore, we extend and generalise our previous results allowing for a richer menu of fiscal instruments. To this end, we use two versions of our calibrated model: the first, a low indebtedness scenario (LI), in which impatient households face a low loan-to-value and in which there are a low number of mortgagors in the economy; and the second, a high indebtedness scenario (HI), with a large share of borrowers that have high borrowing capacity and that hold a sizable steady state amount of assets (houses). According to the categorization of households in Kaplan, Violante and Weidner (2014) the first scenario would correspond to one with a low number of wealthy hand-to-mouth consumers, while the second would represent a larger amount of wealthier hand-to-mouth consumers. We use the two-scenario calibrated model to assess the interaction among fiscal policy and household debt in three directions. First, we design different fiscal policy strategies and analyse the short run and long-run multiplier effect of temporary changes in an enlarged set of fiscal instruments against the backdrop of alternative fiscal rules⁵. Secondly, we evaluate these multipliers after permanent changes in some fiscal instruments that can be

⁵ We use the term 'primary instrument' to refer to the instrument used to implement the discretionary fiscal policy and 'secondary instrument' for the one that is adjusted to ensure debt stability in the long run. The combination of a particular primary and secondary instrument is called a fiscal strategy.

understood as changes in the fiscal structure or fiscal reforms. Finally, we go beyond the multiplier analysis to gauge the welfare impacts of these policy changes.

4.1 Transitory fiscal shocks

We first study the macroeconomic and welfare effects of transitory shocks to different fiscal instruments. Starting from a benchmark economy that includes distortionary taxes, we simulate the effects of transitory shocks to public spending and different tax rates. To make the results comparable among different instruments, the size of the shock in each case is such that the *ex ante* primary deficit over output ($\frac{PD_t}{y_t}$) increases by one per cent⁶.

Impact multipliers and transitory fiscal shocks

In this section, we present the impact multipliers of shocks to public expenditure (g_t), the consumption tax rate (τ^c), the labour tax rate (τ^w), social security contributions (τ^{sc}) and the capital tax rate (τ^k). All shocks follow an AR(1) process with the same parameter $\rho = 0.75$. More precisely, in each case we calculate for the very first period $\frac{\frac{\Delta z}{z_0}}{\frac{\Delta PD}{y_0}}$, where z stands for the particular macroeconomic variable. The results can be interpreted as a fiscal multiplier.⁷

In Table 2, we summarize the impact multipliers for some key macroeconomic variables, assuming that the fiscal policy reaction function that guarantees that the ratio of debt over GDP comes back to its initial value is defined in non distortionary lump-sum transfers⁸.

$$trh_t = trh_{t-1} - \psi_1 f_t \left[\frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp} \right)} \right] - \psi_2 f_t \frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}} \quad (25)$$

where $\psi_1 > 0$ captures the speed of adjustment from the current ratio towards the desired target $\frac{b}{gdp}$ and the value of $\psi_2 > 0$ is chosen to ensure a smooth adjustment of current debt towards its steady-state level. We assume $\psi_1 = 0.01$ and $\psi_2 = 0.2$ for the fiscal rule. f_t is a dummy variable that controls for the time period in which the fiscal rule is initially inactive. We assume that the fiscal rule starts to act two periods after the fiscal shock, so $f_t = 0$, for $t = 1, 2$ and $f_t = 1$, for $t > 2$.

⁶ This metric is also used by Stähler and Thomas (2012).

⁷ For instance, for the case of the effect on output of a discretionary increase in government expenditure, using the previous expression, we get $\frac{\frac{\Delta y}{y_0}}{\frac{\Delta PD}{y_0}} = \frac{\Delta y}{\Delta PD} = \frac{\Delta y}{\Delta g}$, which coincides with the standard way to compute the output multiplier.

⁸ Lump-sum transfers are distributed among lenders and borrowers according to their relative weight.

TABLE 2 – IMPACT MULTIPLIER AS A FUNCTION OF INDEBTEDNESS
(FISCAL RULE IN LUMP-SUM TRANSFERS. SHOCKS ARE TRANSITORY)

	Δg		$\nabla \tau^c$		$\nabla \tau^w$		$\nabla \tau^{sc}$		$\nabla \tau^k$	
	LI	HI	LI	HI	LI	HI	LI	HI	LI	HI
Output	0.82	1.10	0.80	1.07	0.53	1.02	0.45	0.86	0.59	1.00
Consumption	-0.19	0.28	1.25	1.72	0.40	1.33	0.34	1.12	-0.04	0.68
Employment	0.34	0.43	0.33	0.42	0.52	0.55	0.44	0.46	0.20	0.24
Hours pw	1.18	1.57	1.14	1.53	0.76	1.46	0.64	1.23	0.84	1.43
Vacancies	4.56	5.82	4.40	5.62	7.12	7.40	5.99	6.25	2.75	3.18
Real wage	0.55	1.21	0.54	1.18	-1.09	0.08	0.81	1.82	0.48	1.42
Investment	-0.43	-0.78	-0.42	-0.76	1.41	0.56	1.19	0.48	3.76	3.31

LI: Low private indebtedness regime; HI: High private indebtedness regime

Because we can define primary deficit (PD_t) as

$$PD_t = g_t + (1 - n_{t-1})ub_t + trh_t - (\tau^w + \tau_t^{sc})w_t(n_{t-1}l_{1t}) + \tau_t^k(r_t - \delta)k_{t-1} + \tau_t^c c_t + \tau^w(1 - n_{t-1})ub_t \quad (26)$$

and assuming that, just before the shock, the economy rests at its steady state, we can easily compute the change in the variables necessary to accomplish with the *ex ante* one per cent increase in $(\frac{PD_t}{y_t})^9$. We consider two polar cases in terms of households indebtedness: the low indebtedness scenario (LI: $m^b = 73.5\%$, $\tau^b = 20\%$), and the high leveraged scenario (HI: $m^b = 98.5\%$, $\tau^b = 50\%$).

The results in Table 2 corroborate the importance of household debt in shaping the fiscal multiplier for a wide range of fiscal instruments. As can be seen, the output multiplier is affected by the level of private debt and is always higher in the HI regime, no matter the primary instrument used for stimulation purposes. Multipliers across financial regimes increase from 30% (in the case of τ^c) to almost 100% (for labour taxes). An expansionary fiscal measure that has a positive effect on labour income increases consumption and current housing demand which augments the value of collateral for borrowers. When borrowers have a greater capacity to collateralise their housing holdings (HI scenario), they are able to access larger credit flows, which further reinforces the increase in consumption and output. This in turn triggers a strong reduction in the marginal utility of consumption and, consequently, an increase in the weighted average of the inverse marginal utilities of consumption $\left(\frac{(1-\tau^b)}{\lambda_{1t}^c} + \frac{\tau^b}{\lambda_{1t}^b}\right)$ that strengthens the household's bargaining power in wage negotiations. This increase in wages is an additional channel

⁹ The change required in the different variables is given by the following expressions (in percentage points) $d(g) = 0.01\bar{y}$, $d(\tau^c) = -\frac{0.01\bar{y}}{\bar{c}}$, $d(\tau^w) = -\frac{0.01\bar{y}}{\bar{w}\bar{n}l + (1-\bar{n})\bar{u}b}$, $d(\tau^{sc}) = -\frac{0.01\bar{y}}{\bar{w}\bar{n}l}$, $d(\tau^k) = -\frac{0.01\bar{y}}{(\bar{r}-\delta)\bar{k}}$.

through which impatient households are allowed to further increase consumption. From this point of view, as in Faia, Lechthaler and Merkl (2010), multipliers are also affected by a supply side mechanism (wage bargaining). Given that output and consumption increase more in a high indebtedness regime so do hours, vacancies and employment. In the *HI* case, the crowding out of investment is more pronounced (or the crowding in is weaker) since the rise in the real interest rate, and the corresponding fall in asset prices (housing bonds and capital), is stronger than in the *LI* scenario.

Looking across the columns in Table 2 we observe that the fiscal instrument chosen to shock the economy may have very different effects depending on the variable we look at. Thus, increasing government spending seems to deliver the highest multiplier effect on output and hours worked while reducing consumption tax rates has the strongest effect on consumption. As expected using labour taxes achieves the greatest effect on employment, vacancies and wages whereas investment responds more to a cut in capital tax rates. Various factors help to explain these differences. Although the impact multiplier on output is essentially the same for Δg and $\nabla \tau^c$, the effect on output comes mainly via consumption growth in the latter, while it is produced more directly via public expenditure in the former. In fact, aggregate consumption can even fall in the case of a low indebtedness regime, due to the predominance of Ricardian households in the economy. A reduction in labour tax makes households less demanding in the wage negotiation, so the effect of the shock on wages may be negative or near zero, favouring vacancy creation and hence stimulating employment. Quite the opposite is observed when social security contributions are cut; the effect on wages is the highest, precisely because this makes firms less demanding in the bargaining process.

Given that the pattern observed for the different multipliers across debt regimes basically reproduce in qualitative terms what is observed for the output multiplier, we henceforth focus on this statistic and extend our analysis to the use of alternative fiscal rules or secondary instruments. Specifically, we consider the following feedback rules in government spending,

$$g_t = g_{t-1} - \psi_1 f_t \frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp}\right)} - \psi_2 f_t \frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}} \quad (27)$$

consumption taxes,

$$\tau_t^c = \tau_{t-1}^c + \psi_1 f_t \frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp}\right)} \frac{1}{c^{ss}} + \psi_2 f_t \frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}} \frac{1}{c^{ss}} \quad (28)$$

TABLE 3 – IMPACT MULTIPLIER
TRANSITORY SHOCK

Fiscal rule	Output									
	g		τ^c		τ^w		τ^{sc}		τ^k	
	LI	HI	LI	HI	LI	HI	LI	HI	LI	HI
<i>trh</i>	0.82	1.10	0.80	1.07	0.53	1.02	0.45	0.86	0.59	1.00
g			0.85	1.35	0.56	1.22	0.47	1.03	0.63	1.26
τ^c	0.88	1.38			0.56	1.21	0.47	1.02	0.63	1.25
τ^w	0.34	-0.02	0.33	-0.02			0.19	0.23	0.13	-0.04
τ^{sc}	0.39	0.03	0.38	0.03	0.26	0.31			0.18	0.01
τ^k	0.36	0.30	0.35	0.30	0.21	0.48	0.18	0.40		

LI: Low private indebtedness regime; HI: High private indebtedness regime
Shocks in columns, fiscal rules in rows

labour taxes,

$$\begin{aligned} \tau_t^w &= \tau_{t-1}^w + \psi_1 f_t \frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp}\right)} \frac{1}{w^{ss} n^{ss} l^{ss} + (1 - n^{ss}) u b^{ss}} + \\ &\quad \psi_2 f_t \frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}} \frac{1}{w^{ss} n^{ss} l^{ss} + (1 - n^{ss}) u b^{ss}} \end{aligned} \quad (29)$$

social security contributions,

$$\begin{aligned} \tau_t^{sc} &= \tau_{t-1}^{sc} + \psi_1 f_t \frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp}\right)} \frac{1}{w^{ss} n^{ss} l^{ss}} + \\ &\quad \psi_2 f_t \frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}} \frac{1}{w^{ss} n^{ss} l^{ss}} \end{aligned} \quad (30)$$

and capital taxes,

$$\begin{aligned} \tau_t^k &= \tau_{t-1}^k + \psi_1 f_t \frac{b_t}{gdp_t} - \overline{\left(\frac{b}{gdp}\right)} \frac{1}{(r^{ss} - \delta) k^{ss}} + \\ &\quad \psi_2 f_t \frac{b_t}{gdp_t} - \frac{b_{t-1}}{gdp_{t-1}} \frac{1}{(r^{ss} - \delta) k^{ss}} \end{aligned} \quad (31)$$

In all cases, the way we write the fiscal rule guarantees that for a given deviation in the ratio of public debt to output from its long-run target, the adjustment in public deficit is the same no matter the fiscal instrument used to stabilise debt. As before, we assume that the fiscal rule comes into effect two periods after the fiscal shock¹⁰.

¹⁰ To make our results comparable across different fiscal rules, we set in the steady state the same volume of lump-sum transfers we find in a model with a lump-sum transfer fiscal rule. In this case, however we do not allow them to vary when the economy is hit by the shock. This makes it possible for the steady state level of government expenditure and tax rates to be the same across the experiments.

Table 3 compares the output impact multipliers of the previously analysed fiscal shocks (in columns), with different fiscal rules (in rows), again in our two different scenarios regarding household debt¹¹. As in other recent studies (Coenen et al (2012); Coenen, Straub and Trabandt (2013); Gadastch, Hauzenberger and Stähler (2014)) we also find that stimulating the economy by increasing government spending is more effective than doing so by means of cuts in direct tax rates, and this is especially true in the case of a low-indebted economy. We observe two well-defined patterns comparing the first three rows with the last ones. When government spending and indirect taxes are used to stabilise the debt ratio, the multipliers are not significantly changed in the *LI* regime and increase significantly in the *HI* case compared to the rule in lump-sum transfers. Corsetti *et al.* (2010) and Cogan *et al.* (2013) point to both the future reaction of government spending and the timing in the tax cuts as important determinants of the short run multiplier's value. In our case, the fact that the rule is set in motion with some delay is also important. Consider the rule in g first, after a fiscal expansion engineered through a consumption tax rate cut, the level of government spending is expected to fall from $t + 2$ onwards; this anticipated cut in g exerts an expansionary effect through a reduction in interest rates that augments the fiscal multiplier¹². Likewise, the rule in τ^c "announces" a rise in consumption taxes in the future that favours an increase in current consumption at time t . When consumers are allowed to borrow easily (*HI*) they can make the most of these effects.

Multipliers associated with fiscal rules specified in more distortionary taxes (τ^w , τ^{sc} , τ^k) are always lower than lump-sum financing policies, for both indebtedness scenarios. Interestingly, the increase in the multiplier with the degree of indebtedness reverses in most of the combinations in the last three rows of Table 3. In these cases, the expansionary effect of the fiscal stimulus is compensated by a negative effect of raising distortionary taxes, a distortion which is especially important in the case of high household debt. In fact, multipliers become almost zero or even negative in some cases. The explanation for this lies with the stronger wage response when borrowing access is easy, something that reinforces the distortionary effects of the tax rise.

How important is the delay in the response of the secondary instrument in understanding the size of the impact multiplier? In our benchmark simulations, the rule acts with a two-period delay, but the timing of its implementation is also a policy matter. We have performed a sensitivity analysis¹³ regarding this issue and found that output

¹¹ We keep the first row with a rule on non distortionary lump-sum taxes to facilitate comparisons with the results in table 1.

¹² This reinforcing effect is short-lived and vanishes once the stabilizing rule becomes operative.

¹³ Results are available upon request.

multipliers fall when the government delays the implementation of the rule on either government spending or consumption taxes. The reason is that the positive substitution effect that is produced by the reduction in the interest rate vanishes the longer the time before the rule comes into effect. Contrariwise, when the rule aims to control labour income, social security or capital taxes, postponing the implementation of the rule produces an increase in impact output multipliers since the distortionary effect of the tax rise is also deferred in time. Some authors have emphasised the importance of distinguishing between a back-loading and a front-loading fiscal strategy when analysing the impact effect of debt consolidations (see Hall (2009) or ECB (2014)), implying more or less time of deficit-financed fiscal stimulus. Our results suggest that this issue cannot be properly addressed without taking into consideration the specific fiscal instrument used to stabilise public debt.

The overall picture arising from Table 3 is that comparisons of impact fiscal multipliers among debt regimes display an important variation depending on the fiscal instrument used to stimulate the economy and the fiscal rule applied to stabilise the public debt to output ratio. Thus, obtaining a Keynesian multiplier for output (a multiplier higher than one) is difficult when the level of private debt is below some threshold and is more frequent in economies with a high level of household indebtedness, provided debt stabilisation is accomplished through government spending cuts or consumption tax increases. As a matter of comparison, in a fiscal consolidation context, Erceg and Lindé (2013) have pointed out the benefits of a "mixed strategy" that combines a sharp but temporary rise in taxes with gradual spending cuts. Our results for the output multiplier suggest that the degree of indebtedness and the particular mix between taxes and government spending could also play an important role for better framing the impacts of these kinds of mixed strategies.

Long-run multipliers

Impact multipliers only capture an important but limited aspect of the macroeconomic impact of discretionary fiscal policy. To better grasp the effect of these stimuli, we need to take a longer perspective and consider the complete dynamics of output linked to a particular strategy. Following Mountford and Uhlig (2009) and Leeper, Walker and Yang (2010) we define the present value multiplier as

$$\rho_{xt} = \frac{\sum_{s=0}^t (1 + \bar{r}^n)^{-s} \dot{y}_s}{\sum_{s=0}^t (1 + \bar{r}^n)^{-s} \dot{x}_s}$$

TABLE 4 – LONG-RUN MULTIPLIER
TRANSITORY SHOCK

Fiscal rule	Output									
	g		τ^c		τ^w		τ^{sc}		τ^k	
	LI	HI	LI	HI	LI	HI	LI	HI	LI	HI
trh	0.39	0.56	0.38	0.54	1.38	1.39	1.16	1.17	0.66	0.85
g			0.19	0.31	1.18	1.21	0.99	1.02	0.39	0.53
τ^c	0.20	0.34			1.18	1.22	0.99	1.02	0.39	0.55
τ^w	-3.84	-2.82	-3.68	-2.69			-1.33	-0.82	-3.41	-2.36
τ^{sc}	-3.78	-2.79	-3.63	-2.67	-1.53	-0.96			-3.36	-2.34
τ^k	-1.01	-0.96	-0.98	-0.92	0.23	0.25	0.18	0.20		

LI: Low private indebtedness regime; HI: High private indebtedness regime
Shocks in columns, fiscal rules in rows

where \bar{r}^n is the steady state value of the nominal interest rate, \dot{y}_s is the variation of GDP at time s , and \dot{x}_s stands for the exogenous variation of the fiscal variable (public spending or public revenue) at period s . When $t = 0$ we obtain the impact multipliers of the previous section. When $t \rightarrow \infty$ the above expression returns the long-run multiplier displayed in Table 4.

There is greater dispersion in the value of the long-run multipliers across different fiscal strategies than in the case of impact multipliers. Regarding the role of the policy rule, there is again a clear divide among the rules based on adjustments of either g or τ^c , in which case the long-run multipliers remain positive. They are close to zero or strongly negative when the debt stabilizing condition relies on variations of more distortionary fiscal instruments. We see this result as a generalisation of Uhlig's finding (Uhlig (2010)) that a fiscal stimulus measure displaying a positive impact in the short run can turn to a big loss in the long-run when it is financed by a labour tax rise. Regarding the role of household indebtedness, the differences in the long-run multiplier among financial regimes dwindle or even vanish altogether as in the case of taxes τ^w or τ^{sc} .

Welfare effects under perfect foresight: transitory shocks

Output multipliers are relevant policy statistics but changes in output are accompanied by variations in consumption, hours worked, housing holdings and other macroeconomic variables. The natural metric for assessing the impact of the alternative fiscal packages along these different dimensions in a comprehensive way is to compute their effect on the representative household's welfare function. Under circumstances like those of a Great Depression, Woodford (2011) finds that an increase in government purchases will increase welfare. However, if agents expect future tax increases to bring the level of public debt down, the net welfare gains from the policy might be reduced. Using simulation

experiments, Drautzburg and Uhlig (2013) evaluate welfare in the context of the ARRA and stress the importance of the discount factor of liquidity constrained agents. Here, we follow a similar approach relying on our benchmark calibration regarding the subjective discount rates and turn our attention to the incidence of the indebtedness regime on welfare.

We shall define welfare \bar{V}^i as the discount sum of a household i period utility, conditional on the economy being at the steady state in period 0 (common to all the experiments) and staying there forever

$$\bar{V}^i = \sum_{t=0}^{\infty} (\beta^i)^t \left[\begin{array}{l} \ln \bar{c}_t^i + \phi_x \ln \bar{x}_t^i + \bar{n}_{t-1} \phi_1 \frac{(1-\bar{l}_{1t})^{1-\eta}}{1-\eta} \\ + (1 - \bar{n}_{t-1}) \phi_2 \frac{(1-\bar{l}_{2t})^{1-\eta}}{1-\eta} \end{array} \right],$$

where $i = l, b$ is the index referring to household's type. Now, we define $V^{i,s}$ as the welfare for a household of type i under a shock, conditional on the state of the economy in period $t = 0$ and taking into account the reaction of the variables before returning again to the initial steady state

$$V^{i,s} = \sum_{t=0}^{\infty} (\beta^i)^t \left[\begin{array}{l} \ln c_t^{i,s} + \phi_x \ln x_t^{i,s} + n_{t-1}^s \phi_1 \frac{(1-l_{1t}^s)^{1-\eta}}{1-\eta} \\ + (1 - n_{t-1}^s) \phi_2 \frac{(1-l_{2t}^s)^{1-\eta}}{1-\eta} \end{array} \right], \quad (32)$$

where $c_t^{i,s}$, $x_t^{i,s}$, n_{t-1}^s , l_{1t}^s denotes consumption, housing, employment rate and hours per worker under a transitory fiscal shock.

We can calculate the welfare cost Δ^i associated with a transitory fiscal measure as the fraction of steady state consumption that a household would be willing to give up to be as well off after as before the fiscal shock. That is,

$$V^{i,s} = \sum_{t=0}^{\infty} (\beta^i)^t \left[\begin{array}{l} \ln \bar{c}_t^i (1 - \Delta^i) + \phi_x \ln \bar{x}_t^i + \bar{n}_{t-1} \phi_1 \frac{(1-\bar{l}_{1t})^{1-\eta}}{1-\eta} \\ + (1 - \bar{n}_{t-1}) \phi_2 \frac{(1-\bar{l}_{2t})^{1-\eta}}{1-\eta} \end{array} \right]. \quad (33)$$

Thus, from (32) and (33):

$$\Delta^i = 1 - \exp\{ V^{i,s} - \bar{V}^i \} \quad (1 - \beta^i) \quad (34)$$

Now we define (per capita) social welfare as a weighted sum of the individual welfare for the two different types of households

$$V^s = (1 - \beta^l) (1 - \tau^b) V^l + (1 - \beta^b) \tau^b V^b \quad (35)$$

This expression implies that social welfare takes into account the weight of each group of households in the population and corrects for the subjective discount rate, so that the two groups receive the same level of utility from a constant consumption stream (see Mendicino and Pescatori, 2004 and Ortega, Rubio and Thomas, 2011). Assuming that we take the same fraction of the steady state consumption for both types of household, the welfare cost in terms of consumption from the social welfare can be obtained as

$$\Delta = 1 - \exp\{ V^s - \bar{V} \} \quad (36)$$

Note that a negative value for Δ implies an improvement in welfare after the perturbation of the initial state of the economy, that is, a welfare gain.

Table 5 reports welfare costs for five fiscal shocks in rows and six fiscal rules in columns, distinguishing among lenders, borrowers and the aggregate, and taking into account our two extreme scenarios regarding the level of household leverage in the economy (high indebtedness and low indebtedness). Remember that in all the experiments we are assuming that the ratio of primary deficit to output increases by one percent on impact and then slowly dies down.

There are important differences in welfare effects depending on fiscal shocks, rules and household debt level. A positive shock to government spending is always associated with a welfare loss, irrespective of whether household debt is high or low, the fiscal rule used to stabilise debt, and the type of household. Actually, it is the only shock for which this negative effect on welfare is so general. Rules on taxes that directly affect labour decisions (τ^w and τ^{sc}) are especially harmful in terms of welfare¹⁴. The opposite is true when the rule comes in the form of variations in government spending, in which case a welfare gain is produced irrespective of the fiscal shock; this is simply the straightforward consequence of the welfare enhancing effect of reducing tax rates augmented by the welfare-diminishing effect of rises in g .

As with fiscal multipliers, the social welfare costs of fiscal changes are always more intense in a situation of high private leverage¹⁵. This is not only due to the fact that the impact on borrowers' welfare of any policy change is always much more intense than that on the lenders'¹⁶ (and there is a higher proportion of borrowers in the *HI* regime), but also because the very response of borrowers' welfare is more intense when the loan-to-value ratio is high. Borrowers and lenders share the same leisure, but borrowers' consumption

¹⁴ The only exception is the positive and very small effect on lenders' welfare when the fiscal shock is on capital taxes under high indebtedness

¹⁵ The exception here comes from the welfare cost associated to a shock on τ^k with a fiscal rule on consumption taxes.

¹⁶ Again there is only one exception, corresponding to a shock in τ^k with a fiscal rule on lump-sum transfers, when the effect for both type of households is virtually the same.

TABLE 5 — WELFARE COSTS OF TRANSITORY SHOCKS
($\Delta \times 100$)

Shocks	Agents	High Indebtedness						Low Indebtedness					
		Fiscal rules			Fiscal rules			Fiscal rules			Fiscal rules		
		tr/h	δ	τ^c	τ^w	τ^{sc}	τ^k	tr/h	δ	τ^c	τ^w	τ^{sc}	τ^k
δ	Lenders	0.047		0.063	0.059	0.059	0.075	0.050		0.057	0.122	0.121	0.075
	Borrowers	0.119		0.141	1.039	1.014	0.170	0.051		0.190	0.950	0.920	0.131
	Social	0.083		0.102	0.550	0.538	0.123	0.050		0.083	0.288	0.281	0.086
τ^c	Lenders	-0.010	-0.042		0.001	0.001	0.017	-0.007	-0.052		0.061	0.061	0.017
	Borrowers	-0.133	-0.357		0.749	0.726	-0.084	-0.199	-0.308		0.664	0.636	-0.122
	Social	-0.072	-0.199		0.376	0.364	-0.033	-0.045	-0.103		0.182	0.176	-0.011
τ^w	Lenders	-0.006	-0.030	0.006		0.002	0.015	-0.022	-0.057	-0.017		0.027	-0.002
	Borrowers	-0.380	-0.546	-0.371		0.236	-0.342	-0.324	-0.402	-0.232		0.261	-0.261
	Social	-0.193	-0.288	-0.182		0.119	-0.163	-0.082	-0.126	-0.060		0.074	-0.054
τ^{sc}	Lenders	-0.005	-0.026	0.005	0.001		0.013	-0.019	-0.048	-0.014	0.023		-0.002
	Borrowers	-0.320	-0.460	-0.312	0.213		-0.287	-0.272	-0.338	-0.195	0.240		-0.219
	Social	-0.162	-0.243	-0.154	0.107		-0.137	-0.067	-0.106	-0.050	0.066		-0.045
τ^k	Lenders	-0.019	-0.053	-0.002	-0.006	-0.006		-0.012	-0.059	-0.004	0.057	0.056	
	Borrowers	-0.018	-0.232	0.007	0.819	0.797		-0.034	-0.140	0.103	0.804	0.776	
	Social	-0.018	-0.142	0.003	0.407	0.776		-0.016	-0.075	0.017	0.207	0.201	

All fiscal shocks implying a one percent increase in $\frac{PD_t}{y_t}$ on impact.

and housing holdings tend to increase when borrowers find the access to mortgages easier. Differences in the welfare effects between lenders and borrowers can be substantial. For example, in a *HI* regime, the maximum difference in welfare gains (amounting to 0.5% of steady state consumption) corresponds to a fiscal expansion fuelled by a reduction in τ^w later compensated with government purchases cuts. On the other side, the reverse fiscal strategy of increasing g and using a rule in τ^w also generates the largest difference in welfare losses: borrowers will lose approximately the equivalent of 1% more of steady state consumption than lenders.

For our calibrated economy, the most harmful policy corresponds to a rise in government spending combined with an adjustment in income taxes τ^w over time to respond to variations of debt to GDP ratio. According to our numerical simulations, in a scenario of high private indebtedness, the agents would be willing to give up 0.55% of their steady state consumption stream to avoid the fiscal shock. On the other side, a negative shock on income taxes combined with a fiscal rule in which government spending is adjusted over time provokes the most positive impact on welfare, equivalent to an increase of 0.288% in steady state consumption. Overall, the difference between choosing the best and the worst strategy to stimulate the economy in terms of welfare cost yields 0.828 percentage points of the initial steady state consumption in a high indebtedness regime and 0.414 percentage points in a low indebtedness regime.

4.2 Fiscal reforms: Permanent changes in government size and tax structure

So far we have assumed that fiscal shocks in the economy were transitory, however, some fiscal changes in the context of the present economic crisis can be considered permanent since households do not expect them to be reversed in the near future. In the remainder of this section, we study how the previous results change when the fiscal shock is permanent. Notice that a permanent change in a specific fiscal instrument compensated for with a change in another instrument to stabilise debt is akin to a fiscal reform, such as the one that has been undertaken in many advanced countries to mitigate the rampant debt crisis aggravated by the financial crisis. In particular, a permanent shock on g (and its corresponding increase in revenues to finance it) can now be interpreted as a change in social preferences for a bigger (lower) size of the public sector in the economy. On the other hand, a permanent decrease in any tax rate counteracted by any other tax rate can be thought of as a long-run change in the economy's tax structure¹⁷. We are again interested both in the short and long-run macroeconomic impact of these reforms, as well as their effect on households' welfare.

¹⁷ Using a model for the Euro Area with a fiscal rule on lump-sum taxes Coenen, McAdam and Straub (2008) analyse the effects of reducing the tax wedge to the levels prevailing in the US.

TABLE 6 – IMPACT OUTPUT MULTIPLIERS
PERMANENT SHOCK

Fiscal rule	Output									
	g		τ^c		τ^w		τ^{sc}		τ^k	
	LI	HI	LI	HI	LI	HI	LI	HI	LI	HI
trh	0.88	0.23	0.85	0.21	1.27	3.50	1.08	2.97	2.80	3.65
g			0.80	1.12	1.23	4.11	1.04	3.48	2.72	4.38
τ^c	0.82	1.13			1.23	4.10	1.04	3.45	2.71	4.37
τ^w	-0.07	-3.91	-0.07	-3.76			0.51	0.70	2.05	0.29
τ^{sc}	0.07	-3.65	0.07	-3.52	0.69	0.95			2.14	0.45
τ^k	-2.12	-3.46	-2.03	-3.34	-1.01	0.78	-0.85	0.68		

LI: Low private indebtedness regime; HI: High private indebtedness regime
Shocks in columns, fiscal rules in rows

Impact multipliers of permanent fiscal shocks

In this section, we analyse the impact multipliers of permanent shocks to public spending and different tax rates. As before, we let the government stabilise the debt to output ratio using a potential set of fiscal rules. Table 6 shows the impact multipliers after a permanent fiscal shock. We first corroborate that multipliers are still very dependent on the level of private leverage and the specific tax mix. In particular, a higher level of indebtedness is accompanied by a higher absolute value of the impact multiplier. This implies that the impact multiplier of a permanent fiscal reform is positive and much stronger when the level of indebtedness is high, but for the very same reason, becomes extremely contractionary when the level of debt is high and the reform involves an increase of capital and labour taxes as secondary instruments.

However, the size of these impact multipliers (and hence the differences in the output effects between a good and a bad fiscal strategy) is much more pronounced in this case than when the changes in the fiscal instruments are transitory. This is the case of any such combination involving taxes on labour and taxes on consumption (or government spending). The positive (negative) impact on output of reducing (increasing) labour taxes and increasing (decreasing) consumption taxes, for instance, is three times larger when the shock is permanent. Coenen et al. (2012) find that the output effects decline when the government spending shock is permanent. This is also the result that we obtain in the columns regarding g and τ^c . However, Table 6 indicates that the impact multiplier can also increase with the persistence of the shock when the primary instrument chosen to stimulate the economy entails taxes on labour and capital. This is because a permanent decrease in these taxes implies a permanent reduction in the distortion that they cause. In all the cases, the conditions of the mortgage market are key determinants of the multiplier's size.

Long-run multipliers of permanent fiscal shocks

Table 7 shows the present value long-run multipliers corresponding to permanent shocks for which the financial regime seems to be of no consequence at all. Thus, the differences among the two indebtedness scenarios vanish altogether in the long-run following a permanent fiscal shock. The macroeconomic effect of these fiscal reforms is, as expected, different across fiscal strategies with the multipliers above the main diagonal in Table 7 being positive or zero, whereas those below it are negative or zero. Not surprisingly, fiscal strategies consisting of raising (reducing) the capital tax rate have the strongest negative (positive) long-run impact on output. Reducing the size of the government sector by cutting down g , accompanied by a decrease of distortionary taxes also generates positive long-run output effects, which is nevertheless negligible when the consumption tax rate is used as a secondary instrument.

TABLE 7 – LONG-RUN OUTPUT MULTIPLIER
PERMANENT SHOCK

Fiscal rule	Output									
	g		τ^c		τ^w		τ^{sc}		τ^k	
	LI	HI	LI	HI	LI	HI	LI	HI	LI	HI
<i>trh</i>	0.94	0.94	0.91	0.91	1.30	1.30	1.11	1.11	2.50	2.47
g			-0.01	-0.00	0.53	0.53	0.45	0.45	1.58	1.54
τ^c	-0.01	-0.01			0.53	0.53	0.45	0.45	1.58	1.54
τ^w	-0.79	-0.84	-0.75	-0.79			-0.02	-0.02	0.96	0.86
τ^{sc}	-0.76	-0.82	-0.72	-0.78	-0.01	-0.02			0.98	0.87
τ^k	-1.96	-1.91	-1.86	-1.81	-1.04	-0.97	-0.87	-0.81		

LI: Low private indebtedness regime; HI: High private indebtedness regime
Shocks in columns, fiscal rules in rows

Table 8 summarises the more interesting results from a policy point of view, seeking to answer three questions: (1) what are the maximum differences in terms of output multipliers among alternative strategies? (2) does the level of household debt affects these differences? and (3) how do these differences depend on the time span considered?

The table shows the strategy that maximises and minimises the value of the output multiplier taking into account the nature of the shock (transitory or permanent) and the time span over which the multiplier is computed (impact or long-run). With the exception of impact multipliers and transitory shocks in a low indebtedness regime, the differences in the multiplier between the most and the least efficient fiscal policy strategies are generally significantly higher than one. As an example, in a high leverage environment, a debt neutral fiscal reform that lowers taxes on capital reducing the size of the government increases output in the short run by 4,38 percentage points, whereas a permanent increase in government size financed by higher labour taxes has a negative impact on output,

TABLE 8 – FISCAL STRATEGY AND OUTPUT MULTIPLIER

		Transitory		Permanent		
		Impact	Long-run	Impact	Long-run	
LI	$\frac{\text{shock}}{\text{rule}}$	Max	$\frac{g}{\tau^c} (0.88)$	$\frac{\tau^w}{g/\tau^c} (1.18)$	$\frac{\tau^k}{g} (2.72)$	$\frac{\tau^k}{g/\tau^c} (1.58)$
		Min	$\frac{\tau^k}{\tau^w} (0.13)$	$\frac{g}{\tau^w} (-3.84)$	$\frac{g}{\tau^k} (-2.12)$	$\frac{g}{\tau^k} (-1.96)$
		Dif	0.75	5.02	4.84	3.54
HI	$\frac{\text{shock}}{\text{rule}}$	Max	$\frac{g}{\tau^c} (1.38)$	$\frac{\tau^w}{\tau^c} (1.22)$	$\frac{\tau^k}{g} (4.38)$	$\frac{\tau^k}{g/\tau^c} (1.54)$
		Min	$\frac{\tau^k}{\tau^w} (-0.04)$	$\frac{g}{\tau^w} (-2.82)$	$\frac{g}{\tau^w} (-3.91)$	$\frac{g}{\tau^k} (-1.91)$
		Dif	1.42	4.04	8.29	3.45

For each variable, the table displays the fiscal strategy (fiscal shock and fiscal rule) that maximises and minimises the impact effect (in parenthesis)

Lump sum transfers rule excluded

–3,91%. In addition, with the exception of long-run multipliers associated with permanent changes, the level of household debt affects the value of the multipliers in a significant manner. As regards the time horizon, the maximum differences among multipliers are always larger in the long-run when the shock is transitory, whereas the opposite is true for permanent shocks.

Welfare effects under perfect foresight: permanent shocks

Table 9 presents the welfare cost in terms of consumption using the expressions (34) and (36) when the change in the policy instrument is permanent. Not surprisingly, given the permanent nature of the policy, the size of the welfare effect of the different strategies is now higher than it was in the case of transitory fiscal shocks (Table 5). Although, as we have just seen, the debt regime seems to have no impact on the long-run macroeconomic impact of permanent fiscal changes, welfare depends on other variables (consumption, housing and leisure) whose response is largely affected by the financial regime.

As regards the fiscal measure, an increase in the size of the government is always associated with a welfare loss, irrespective of whether it is easier or more difficult for households to borrow. Likewise, changes in the tax structure resulting in higher labour or capital taxes are especially harmful in terms of welfare, and more so if the additional revenue is used to finance additional government spending.

Focusing now on the level of household indebtedness, welfare effects are generally greater for borrowers than for lenders¹⁸, and the effect after a tax change may not go in the same direction for these two groups of consumers; for instance, combining movements in

¹⁸ The main exceptions are policies that entail a lower capital tax.

the capital tax rate with changes in the opposite direction in labour taxes (τ^w) can provoke important distributional effects in terms of welfare.(i.e. in the case of a change in τ^w stabilized by a rule in τ^k). Except for the case of changes in capital taxes, the welfare costs are generally more intense in a situation of high private leverage. However, a permanent increase in capital taxes in a low indebtedness environment always implies larger social welfare losses than in a high indebtedness scenario, where they can even become welfare enhancing. On the other hand, a permanent reduction in capital taxes is always more welfare enhancing when the capacity to borrow is low. In this case, the steady state capital stock in the economy is high (lenders give less credit and invest more in capital), so the capital tax rate has to be reduced by less to increase the primary deficit by 1%. Thus, the posterior increase in taxes to fulfil debt requirements needs to be lower, generating more muted welfare losses on borrowers. The important differences in welfare among borrowers and lenders reveal that in models with homogeneous agents, the social welfare effects can be seriously downward biased.

Parallel to the case of a transitory shock, the most harmful policy corresponds to an increase in government size compensated with a permanent adjustment in income taxes τ^w . According to our numerical simulations, in a high private indebtedness scenario, the agents would need a compensation of 3.17% of their steady state consumption stream to accept this fiscal structural change. On the other side, a permanent reduction in income taxes combined with a reduction in the weight of government expenditure provokes the most positive impact on welfare, equivalent to an increase in 2.14% of the steady state consumption.

Overall, the welfare difference between choosing the best and the worst long-run debt neutral strategy, to stimulate the economy by increasing the ratio of primary deficit to output by 1 percent, yields 5.31 percentage points of the initial steady-state consumption in a high indebtedness regime and 4.15 percentage points in a low indebtedness regime.

TABLE 9 — WELFARE COSTS OF PERMANENT SHOCKS
($\Delta \times 100$)

Shocks	Agents	High Indebtedness						Low Indebtedness					
		Fiscal rules			Fiscal rules			Fiscal rules			Fiscal rules		
		hrh	δ	τ^c	τ^w	τ^{sc}	τ^k	hrh	δ	τ^c	τ^w	τ^{sc}	τ^k
δ	Lenders	0.971	-1.427	1.487	1.425	1.427	2.404	1.009	-1.433	1.485	1.820	1.807	2.402
	Borrowers	0.885	-1.495	1.316	4.878	4.601	1.946	0.259	-1.470	1.332	3.245	2.975	1.667
	Social	0.928	-1.461	1.402	3.167	3.027	2.175	0.859	-1.440	1.454	2.107	2.042	2.255
τ^c	Lenders	-0.484	-1.094	0.092	-0.068	-0.067	0.874	-0.447	-1.433	0.315	0.315	0.304	0.872
	Borrowers	-0.570	-1.495	2.602	3.241	2.991	0.453	-1.184	-1.470	1.697	1.448	1.448	0.179
	Social	-0.526	-1.461	1.600	1.600	1.474	0.664	-0.593	-1.440	0.593	0.534	0.534	0.734
τ^w	Lenders	-0.303	-1.094	0.092	0.009	0.009	0.805	-0.589	-1.423	-0.213	-0.213	0.006	0.514
	Borrowers	-2.602	-3.213	-2.183	-0.316	-1.833	-1.833	-2.323	-2.541	-1.469	-1.469	-0.323	-1.217
	Social	-1.446	-2.148	-1.039	-0.153	-0.506	-0.506	-0.934	-1.646	-0.463	-0.463	-0.059	0.170
τ^{sc}	Lenders	-0.261	-0.928	0.077	0.006	0.672	0.672	-0.502	-1.205	-0.181	0.011	0.011	0.424
	Borrowers	-2.216	-2.738	-1.866	-0.154	-1.568	-1.568	-1.968	-2.152	-1.247	-0.144	-0.144	-1.039
	Social	-1.234	-1.829	-0.890	-0.074	-0.442	-0.442	-0.793	-1.394	-0.393	-0.020	-0.020	0.134
τ^k	Lenders	-1.133	-2.047	-0.645	-0.721	-0.791	-0.791	-1.097	-2.041	-0.647	-0.381	-0.386	-0.386
	Borrowers	-0.784	-1.508	-0.330	2.146	1.992	1.992	-1.083	-1.295	-0.139	1.162	1.007	1.007
	Social	-0.958	-1.777	-0.487	0.723	0.646	0.646	-1.095	-1.892	-0.545	-0.070	-0.106	-0.106

All fiscal shocks implying that $\frac{pD_t}{y_t}$ is shocked in the same amount on impact.

5. Concluding remarks

In this paper we have looked in detail at a well-known dimension of fiscal policy that has, nonetheless, received scant attention so far in the theoretical literature: the influence of the financial environment, more specifically the conditions of access to mortgaged debt by households, on the effectiveness and welfare impact of fiscal stimuli and reforms. To that end, we model the interaction among the volume of private debt and other features that characterise fiscal policy, such as the instrument used to apply discretionary fiscal stimuli, the degree of persistence of the fiscal shock, and the instrument used to stabilise the level of debt to ensure that the debt to GDP ratio is stationary. We study both the macroeconomic effects, at different time horizons, of these policies, as measured by the present value fiscal multipliers, as well as the welfare costs of these alternative fiscal strategies.

The wide array of multipliers that we obtain are very informative as to the complexity of the strategies that policy makers face, and do not permit a straightforward classification. However, from our simulation experiments, there seem to be some consistent patterns regarding the macroeconomic effects of different fiscal policy strategies.

For the case of a transitory fiscal shock, when the fiscal rule uses the less distortionary fiscal instruments, the impact multipliers become substantially amplified in an environment of easy access to credit by impatient consumers, regardless of which of the five primary instruments studied is used to shock the economy. Impatient households change their consumption and housing demand as a consequence of these shocks by more than patient consumers (who are prepared to smooth their consumption through intertemporal substitution) do, and this response is stronger the higher the pledgeability of their collateralisable assets. However, when the government reacts to debt deviations by rising distortionary taxes on income, labour or capital, the effects of household debt on the size of the impact output multipliers vanish or reverse, no matter the primary fiscal instrument used. These differences in the multipliers between a scenario of high and low access to credit tend to shrink in the long-run or even reverse in the case of fiscal rules on distortionary taxes.

We also find that the persistence of the fiscal shock significantly changes the size of the multipliers. For the extreme case of persistence corresponding to a permanent fiscal shock (a structural change in the fiscal architecture of the economy), we again find critical differences in the value of the impact output multiplier, depending on the capacity of households to borrow. We find that these multipliers are always higher in absolute value when the volume of household debt is large. All this notwithstanding, the long-run present value output multipliers are independent of the amount of household debt in the economy, and this is true for any primary fiscal instrument or fiscal rule used by the government.

Overall, the picture arising regarding output multipliers and their relation with the volume of household debt is one of household debt intensifying the effects on output of different fiscal stimulus policies, although three factors tend to weaken (not always eliminate) this relationship: the implementation of fiscal rules on distortionary taxes on labour, a longer time span considered to calculate the output multiplier and the persistence of the fiscal shock.

Going beyond the macroeconomic multiplier analysis, these fiscal shocks exert an unequal welfare effect on impatient and patient households that, depending on the fiscal strategy, can even be of a different sign. Welfare gains or losses provoked by the different fiscal shocks are generally higher for borrowers than for lenders. This is due to the fact that the strong response of consumption spending by these agents is also accompanied by significant changes in leisure and housing demand. This suggests that the social costs of choosing an inadequate fiscal package might be quite high and not properly picked up by models of homogeneous consumers. It also points to the non-negligible distributional impacts of alternative fiscal policies, especially in highly indebted economies.

While we have offered an exhaustive set of results related to fiscal multipliers under different economic and policy environments, there are some important aspects that have remained untouched in our analysis and are kept on the research agenda. One of these dimensions refers to the interaction between monetary and fiscal policy in the presence of borrowing constraints. In this respect, it would be worth further investigating whether our results still hold in a context in which monetary policy does not react to the fiscal shock (i.e. in the zero lower bound). Also, although we explore a large set of combinations between primary and secondary fiscal instruments, we have not considered the case of implementing measures to reduce the debt to output ratio (a proper fiscal consolidation). Finally, exploring the complementarity between private debt and public debt is a promising research path that we believe deserves further attention in the future.

Appendix 1: Solving the model

1. Patient households

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

$$W(\Omega_t^l) = \max_{c_t^l, k_t^l, j_t^l, b_t^l, x_t^l} \left\{ \begin{array}{l} \ln c_t^l + \phi_x \ln x_t^l + n_{t-1}^l \phi_1 \frac{(1-l_t)^{1-\eta}}{1-\eta} \\ + (1-n_{t-1}^l) \phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} + \beta^l E_t W(\Omega_{t+1}^l) \end{array} \right\} \quad (1.1)$$

where maximisation is subject to constraints (2), (3) and (4). The solution to the optimisation program above generates the following first-order conditions for consumption, capital stock, investment, loans and the holdings of housing:

$$\lambda_{1t}^l = \frac{1}{(1 + \tau_t^c) c_t^l} \quad (1.2)$$

$$\frac{\lambda_{2t}^l}{\lambda_{1t}^l} = \beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \left\{ r_{t+1}(1 - \tau_t^k) + \tau_t^k \delta + \frac{\phi}{2} \frac{j_{t+1}^l}{k_t^l} + \frac{\lambda_{2t+1}^l}{\lambda_{1t+1}^l} (1 - \delta) \right\} \quad (1.3)$$

$$\lambda_{2t}^l = \lambda_{1t}^l \left(1 + \phi \frac{j_t^l}{k_{t-1}^l} \right) \quad (1.4)$$

$$\lambda_{1t}^l = \beta^l E_t \lambda_{1t+1}^l \left\{ \frac{1 + r_t^n}{1 + \pi_{t+1}} \right\} \quad (1.5)$$

$$\lambda_{1t}^l q_t = \frac{\phi_x}{x_t^l} + \beta^l E_t q_{t+1} \lambda_{1t+1}^l \quad (1.6)$$

According to condition (1.2), the current marginal utility of consumption is the inverse of actual consumption. Expression (1.3) ensures that the intertemporal reallocation of capital cannot improve the household's utility. Equation (1.4) 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. Euler condition (1.5) means that variations across periods in the marginal utility of consumption are coherent with the discount rate and existing real interest rates. Finally, expression (1.6) represents the dynamics of the demand for housing.

We can also define the marginal value of employment for a worker λ_{ht}^l , as:

$$\lambda_{ht}^l \equiv \frac{\partial W_t^l}{\partial n_{t-1}^l} = \lambda_{1t}^l w_t (1 - \tau_t^w) (l_{1t} - \bar{r}l_2) + \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} \right) + (1 - \sigma - \rho_t^w) \beta^l E_t \frac{\partial W_{t+1}^l}{\partial n_t} \quad (1.7)$$

where λ_{ht}^l measures the marginal contribution of a newly created job to the utility of the household. The first term captures the value of the cash-flow generated by the new job in t , i.e. the labour income measured according to its utility value in terms of consumption (λ_{1t}^l). The second term on the right-hand side of (1.7) 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 in the future, conditional to the probability that the new job will not be lost.

2. Impatient households

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

$$W(\Omega_t^b) = \max_{c_t^b, b_t^b, x_t^b} \left\{ \begin{array}{l} \ln c_t^b + \phi_x \ln x_t^b + n_{t-1}^b \phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} \\ + (1 - n_{t-1}^b) \phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} + \beta^b E_t W(\Omega_{t+1}^b) \end{array} \right\} \quad (1.8)$$

where maximisation is subject to constraints (7), (8) and (9). The solution to the optimisation program is characterised by the following first-order conditions:

$$\lambda_{1t}^b = \frac{1}{(1 + \tau_t^c) c_t^b} \quad (1.9)$$

$$\lambda_{1t}^b = \beta^b E_t \lambda_{1t+1}^b \left(\frac{1 + r_t^n}{1 + \pi_{t+1}} \right) + \mu_t^b (1 + r_t^n) \quad (1.10)$$

$$\lambda_{1t}^b q_t = \frac{\phi_x}{x_t^b} + \mu_t^b m^b E_t q_{t+1} (1 + \pi_{t+1}) + \beta^b E_t q_{t+1} \lambda_{1t+1}^b \quad (1.11)$$

where μ_t^b is the Lagrange multiplier of the borrowing constraint, and the marginal value

of employment for an impatient household worker (λ_{ht}^b) can be obtained as,

$$\lambda_{ht}^b \equiv \frac{\partial W_t^b}{\partial n_{t-1}^b} = \lambda_{1t}^b w_t (1 - \tau_t^w) (l_{1t} - \bar{r}l_2) + \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1-\eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1-\eta} \right) + (1 - \sigma - \rho_t^w) \beta^b E_t \frac{\partial W_{t+1}^b}{\partial n_t} \quad (1.12)$$

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

3. Aggregation

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

$$c_t = (1 - \tau^b) c_t^l + \tau^b c_t^b \quad (1.13)$$

$$n_t = (1 - \tau^b) n_t^l + \tau^b n_t^b \quad (1.14)$$

$$\tau^b b_t^b + (1 - \tau^b) b_t^l = 0 \quad (1.15)$$

$$\tau^b x_t^b + (1 - \tau^b) x_t^l = X \quad (1.16)$$

where X is the fixed stock of real estate in the economy. For the variables that exclusively concern patient households, aggregation is merely performed as:

$$k_t = (1 - \tau^b) k_t^l \quad (1.17)$$

$$j_t = (1 - \tau^b) j_t^l \quad (1.18)$$

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

$$\lambda_{ht} = (1 - \tau^b) \frac{\lambda_{ht}^l}{\lambda_{1t}^l} + \tau^b \frac{\lambda_{ht}^b}{\lambda_{1t}^b} \quad (1.19)$$

Lump sum transfers are aggregated in the usual way as

$$trh_t = \tau^b trh_t^b + (1 - \tau^b) trh_t^l$$

where we also assume that transfers are distributed according to the population size in each group such that $trh_t^b = trh_t^l = trh_t$. Finally, the aggregate public debt is given by,

$$b_t = - (1 - \tau^b) b_t^p$$

4. The competitive retail sector

The first-order condition from the profit maximisation problem of retailers gives us the following expression for the demand of each variety:

$$y_{jt}^{\tilde{}} = \left(\frac{P_{jt}^{\tilde{}}}{P_t} \right)^{-\theta} y_t \quad (1.20)$$

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

$$P_t = \int_0^1 P_{jt}^{\tilde{}}{}^{1-\theta} d\tilde{j}^{\frac{1}{1-\theta}} \quad (1.21)$$

5. The monopolistically competitive intermediate sector

The solution for the maximisation problem of the representative variety producer is

$$P_{jt}^* = \left(\frac{\theta}{\theta - 1} \right) \frac{E_t \sum_{s=0}^{\infty} (\beta\omega)^s \Lambda_{t,t+s} \mu_{t+s}^{-1} (P_{t+s})^{\theta+1} y_{t+s} \left(\prod_{s'=1}^s (1 + \pi_{t+s'-1})^\zeta \right)^{-\theta}}{E_t \sum_{s=0}^{\infty} (\beta\omega)^s \Lambda_{t,t+s} (P_{t+s})^\theta y_{t+s} \left(\prod_{s'=1}^s (1 + \pi_{t+s'-1})^\zeta \right)^{1-\theta}} \quad (1.22)$$

Taking into account (1.21) and that θ is assumed time invariant, the corresponding aggregate price level is given by,

$$P_t = \omega P_{t-1} \pi_{t-1}^\zeta{}^{1-\theta} + (1 - \omega) (P_t^*)^{1-\theta}{}^{\frac{1}{1-\theta}} \quad (1.23)$$

From (1.21) and (1.23) we can obtain an expression for aggregate inflation of the form,

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

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

6. The competitive wholesale sector

We can express the maximum expected value of a firm in the perfectly competitive wholesale sector in state Ω_t^f as a function $V(\Omega_t^f)$ that satisfies the following Bellman equation:

$$V(\Omega_t^f) = \max_{k_t, v_t} y_t - r_{t-1}k_{t-1} - (1 + \tau_t^{sc}) w_t n_{t-1} l_{1t} - \kappa_v v_t + \beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} V(\Omega_{t+1}^f) \quad (1.24)$$

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

$$r_t = (1 - \alpha) m c_{t+1} \frac{y_{t+1}}{k_t} \quad (1.25)$$

$$\frac{\kappa_v}{\rho_t^f} = \beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \frac{\partial V_{t+1}}{\partial n_t} \quad (1.26)$$

where the demand for private capital is determined by (1.25). 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 (1.26) 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 job in t for a firm (λ_{ft}) is,

$$\lambda_{ft} \equiv \frac{\partial V_t}{\partial n_{t-1}} = \alpha m c_t \frac{y_t}{n_{t-1}} - (1 + \tau_t^{sc}) w_t l_{1t} + (1 - \sigma) \beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \frac{\partial V_{t+1}}{\partial n_t} \quad (1.27)$$

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 (1.27) one period ahead, we can rewrite condition (1.26) as:

$$\frac{\kappa_v}{\rho_t^f} = \beta^l E_t \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} \left[\alpha m c_{t+1} \frac{y_{t+1}}{n_t} - (1 + \tau_t^{sc}) w_{t+1} l_{1t+1} + (1 - \sigma) \frac{\kappa_v}{\rho_{t+1}^f} \right] \quad (1.28)$$

7. Trade in the labour market: the labour contract

The solution of the Nash maximisation problem gives the optimal real wage and hours worked (Boscá, Doménech and Ferri, 2011):

$$\begin{aligned}
(1 - \tau_t^w) w_t l_{1t} &= \lambda^w \left(\frac{(1 - \tau_t^w)}{(1 + \tau_t^{sc})} \alpha mc_t \frac{y_t}{n_{t-1}} + \frac{(1 - \tau_t^w)}{(1 + \tau_t^{sc})} \frac{\kappa_v v_t}{(1 - n_{t-1})} \right) \\
+(1 - \lambda^w) \frac{(1 - \tau^b)}{\lambda_{1t}^l} + \frac{\tau^b}{\lambda_{1t}^b} &\left(\phi_2 \frac{(1 - l_2)^{1-\eta}}{1 - \eta} - \phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1 - \eta} \right) + (1 - \tau_t^w) \bar{r} l_2 w_t \\
+(1 - \lambda^w) (1 - \sigma - \rho_t^w) \tau^b E_t &\frac{\lambda_{ht+1}^b}{\lambda_{1t+1}^b} \beta^l \frac{\lambda_{1t+1}^l}{\lambda_{1t}^l} - \beta^b \frac{\lambda_{1t+1}^b}{\lambda_{1t}^b} \\
\frac{(1 - \tau_t^w)}{(1 + \tau_t^{sc})} \alpha mc_t \frac{y_t}{n_{t-1} l_{1,t}} &= \frac{1 - \tau^b}{\lambda_{1t}^l} + \frac{\tau^b}{\lambda_{1t}^b} \phi_1 (1 - l_{1t})^{-\eta} \tag{1.30}
\end{aligned}$$

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 labour, depending on worker bargaining power λ^w . Putting aside the last term on the right hand side, the wage is a weighted average of the highest feasible wage (i.e., the marginal productivity of labour 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, plus unemployment benefits). This reservation wage is, in turn, a weighted average of the lowest acceptable wage of both types of worker. 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 (1.29) is part of the reservation wage that depends only on the existence of impatient workers (only if $\tau^b > 0$ 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 will continue with some probability $(1 - \sigma)$ in the future, yielding a labour 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.

Appendix 2: Calibration

1. Parameters from previous studies

Thus, we take from Iacoviello (2005) the subjective intertemporal discount rate of patient households, $\beta^l = 0.99$ and the subjective discount rate of impatient households, $\beta^b = 0.95$. We take very standard values for the Cobb-Douglas parameter $\alpha = 0.7$ and the depreciation rate of physical capital $\delta = 0.025$. The elasticity of matching to vacant posts $\chi_2 = 0.5$ comes from Monacelli *et al* (2010), whereas the exogenous transition rate from employment to unemployment, $\sigma = 0.15$, is taken from Andolfatto (1996) and Cheron and Langot (2004). These authors also provide some average steady-state values, such as the probability of a vacant position becoming a productive job, which is assumed to be $\bar{\rho}^f = 0.9$, the fraction of time spent working, $\bar{l}_1 = 1/3$, and the fraction of time households spend searching $l_2 = 1/6$. The long-run employment ratio is computed to be $\bar{n} = 0.75$ as in Choi and Rios-Rull (2008). Furthermore, 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 labour elasticity of substitution, we consider $\eta = 2$ implying that average individual labour supply elasticity $\eta^{-1} \frac{1}{\bar{l}_1} - 1$ is equal to 1, the same as in Andolfatto (1996). The adjustment costs parameter for productive investment $\phi = 5.5$, is taken from QUEST II, which considers the same function as ours for capital installation costs. Parameters affecting the New Phillips Curve are also standard in the literature. We set a value of $\theta = 6$ for the elasticity of final goods implying a steady state markup of $\frac{\theta}{\theta-1} = 1.2$. Hence, the steady state value for the marginal cost is obtained as $\bar{m}\bar{c} = \frac{\theta-1}{\theta}$. 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, $\zeta = 0.4$, for inflation indexation. Average tax rates for consumption, τ^c , labour, τ^w , capital, τ^k , and social security contributions, τ^{sc} , are taken from Boscá, García and Taguas (2005) whereas replacement rate, rr , is from Shimer (2005). Regarding Taylor's rule, the parameters $r_R = 0.73$ and $r_\pi = 0.27$ are taken from Iacoviello (2005). We choose a value of 0, for the parameter measuring the interest rate reaction to output r_y .

2. Calibrated parameters from steady-state relationships

We normalise both steady-state output (\bar{y}) and real housing prices (\bar{q}) to one. Steady-state government expenditure \bar{g}/\bar{y} , is set to 17 per cent of output (*US Bureau of Economic Analysis* data for 2009). We obtain the long-run value for vacancies from (19) $\bar{v} = \sigma\bar{n}/\bar{\rho}^f$. Then, we calibrate the ratio of recruiting expenditures to output ($\kappa_v\bar{v}/\bar{y}$) 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, Perotti and Trigari (2010). From this ratio we obtain a value of $\kappa_v = 0.04$ and using the steady-state version of the equation (1.28), we can solve for the value of wages (\bar{w}). The steady-state value of matching flows in the economy equals the flow of jobs that are lost ($\sigma\bar{n}$) and we use the equality ($\sigma\bar{n} = \chi_1 \bar{v}^{\chi_2} [(1 - \bar{n}) l_2]^{1-\chi_2}$) to solve for the scale parameter of the matching function $\chi_1 = 1.56$.

The the long-run value of total factor productivity, $A = 1.58$, is calibrated from the production function (21), using (3) and (1.4) to obtain the steady-state value of Tobin's q ratio, $\frac{\bar{\lambda}_2^l}{\bar{\lambda}_1}$, the return on capital (\bar{r}) from (1.3) and the steady-state value for the capital stock (\bar{k}) from (1.25). 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, using (21), the level of consumption \bar{c} . The steady-state value of the nominal interest rate \bar{r}^n , is related to the intertemporal discount rate of lenders through the steady-state version of equation (1.5). The steady state value for the lump-sum transfers (subsidies or taxes) is such that from (24) the resulting debt to output ratio is 94 per cent on annual terms. In order to compute κ_f , we use the following equality between the source of income and aggregate spending

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

where $\kappa_f = 1 - \tau^b d^l$.

Letting γ_l be the ratio of assets of patient households in the steady-state to total output ($\bar{b}^l = \gamma_l \bar{y}$) and conditional to the value of γ_l , we can obtain the steady-state values of several variables. Equation (1.15) yields \bar{b}^b . Next, we can compute the steady-state level of consumption of borrowers \bar{c}^b , from the budget restriction (7) and the consumption level of lenders \bar{c}^l , from the aggregation equation (1.13). Our next step consists in calibrating steady-state levels of the marginal utilities of consumption of both types of consumers, $\bar{\lambda}_1^l$ and $\bar{\lambda}_1^b$, from their respective first-order conditions in equations (1.2) and (1.9). We can then obtain the borrowers' steady-state housing holdings \bar{x}^b from (8), and the long-run equilibrium value of the collateral constraint shadow price $\bar{\mu}^b$ from (1.10). This makes it possible to compute the parameter that accounts for the housing weight in utility ϕ_x , from the last first-order condition of borrowers' optimisation programme (equation (1.11)). The value of the parameter ϕ_x enables us to compute the steady-state holdings of housing for lenders \bar{x}^l , from the first order condition (1.6), and the fixed stock of real estate in the economy X , from the aggregation rule (1.16). Note that the values we obtain for ϕ_x and X depend 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 170 per cent¹⁹. The resulting value for ϕ_x is 0.11.

As regards leisure preference parameters in the household utility function, $\phi_1 = 1.15$ is calculated from the steady-state version of expression (1.30). A system of three equations implying the steady state of expressions (1.7) (1.12) and (1.29) is solved for ϕ_2 , $\bar{\lambda}_h^b$ and $\bar{\lambda}_h^l$. The resulting value for ϕ_2 is 0.89. Therefore the calibrated values for ϕ_1 and ϕ_2 imply that the value attributed to leisure by an employed worker is well above that attributed by an unemployed worker.

¹⁹ Iacoviello considers a value of 140 per cent for this ratio. We have corrected it to take into account the housing bubble of the years prior to 2007.

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