Heterogeneous household finances and the effect of fiscal policy*

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Abstract

We analyse the connection between, household finances and the response of consumption government spending shocks. We study the time-evolving heterogenous distribution of net worth among U.S. households using the PSID. Then we discuss the effect that this heterogeneity has on the multiplier following an increase in public spending, with the help of a DSGE model featuring six different types of households according to their financial exposure and balance sheet composition. We show that heterogeneity in the structure of household finance is key to understanding the effects of fiscal shocks. In particular, we conclude that: (1) the response to consumption to the shock is negatively correlated with the household net worth; (2) the size of the fiscal multiplier critically depends on the weight of some types of consumers in total population; (3) the fiscal effect is positively correlated with wealth inequality; (4) the fiscal multiplier has increased after the financial crisis; and (5) the welfare impact of these shocks among households depends heavily on the composition of net worth.

Keywords: household finances, fiscal policy, heterogeneity.
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1. Introduction

Wealth inequality increased during the Great Moderation in the U.S., and other developed countries, and continued to do so during the Great Recession. In the U.S. the top 3 percent of the population owned 44.8 percent of the country's wealth in 1989, a share that rose to 51.8 percent in 2007 and 54.4 percent in 2013 (Federal Reserve Board Survey of Consumer Finances, 2014), twice as much as the amount of wealth in the hands of the poorest 90 percent. Prior to the financial crisis, the importance of this surge in inequality was somehow overshadowed by the fact that consumption differences across households were reduced, a process in which the financial sector played a key role channeling funds from lenders to borrowers at acceptable rates and credit conditions. The financial turmoil in 2008 brought about an important recomposition of the balance sheets of many households, with a devastating effect on the ability of some of them to obtain credit. Also the prices of financial and real assets plummeted and deflation increased the real value of debt. While these changes have had deep social and economic consequences, researchers as well as policy makers are becoming increasingly aware of their effect on the effectiveness of macroeconomic policies.

Since the onset of the crisis, discretionary fiscal policy has regained the attention it had lost during the years of sustained and stable growth. Given the limited fiscal space left for many heavily indebted governments, it is of paramount importance to identify the set of factors that condition the response of output and employment to fiscal stimuli, and to what extent this response differs from what was estimated on the basis of pre-crisis evidence (see e.g. the surveys by Ramey, 2011 and Spilimbergo et. al., 2009). Equipped with rich microeconomic data and general equilibrium models featuring household (and firm) heterogeneity, the recent literature revisits the study of the impact that such heterogeneity may have on the efficacy of discretionary fiscal stimuli.

This paper contributes to this literature by, first, characterizing different types of U.S. households according to their financial positions and, then, studying how the evolution of these categories may have influenced the aggregate economy's response to a government spending shock. We study the aggregate implications of this financial structure within the confines of DSGE model whose novel feature is to incorporate a variety of household types matching the categories uncovered in the empirical analysis. These household categories differ in the composition of their balance sheets and have been used individually, or in different combinations, in some macroeconomic models developed in the general equilibrium literature.[1] Specifically, we identify standard Ricardian optimising households, hand-to-mouth or rule-of-thumb consumers without access to credit, but who

[1] See Eggertsson and Krugman (2012), Gali, López-Salido and Vallés (2007), Iacoviello (2015), and Andrés, Boscá and Ferri (2015 and 2016).

may or may not hold real estate, borrowers with either high or low capacity to access credit backed by real estate collateral and, finally, consumers that do not posses collateralisable assets and borrow against their future labour income.

Identifying general equilibrium wealth and collateral effects on the marginal propensities to consume is difficult if individuals differ in labour income, employment status, productivity, education, etc. Our model limits the scope of heterogeneity among households just to their balance sheet position, assuming perfect insurance to unemployment as well as bargaining over wages and hours that is carried out by a single trade union in a search and matching environment. Thus, in response to a government spending shock, all households in the economy face the same variation in their labour income, but not in the other sources of spending (net worth and collateral).

The model is calibrated to match the most salient features of the U.S. economy. We inspect the mechanism considering alternative theoretical wealth distributions and access to credit among the population. We then give the simulated model a more solid empirical foundation by improving its calibration using the household distribution identified in the Panel Study of Income Dynamics (PSID).

We conclude that matching stylised facts regarding households finances is key to understand the reaction of economies to aggregate fiscal shocks like changes in government consumption. Our results show that changing the composition of the population according to their financial positions has important effects on the aggregate marginal propensity to consume and the output multiplier. In particular, the model implied multiplier may have risen by 40 per cent (from 1.56 to 2.19) in the U.S. as the share of credit constrained households has increased. This change is mostly explained by the increase in the sensitivity of consumption to fiscal shocks. In fact, consumption multipliers may have increased substantially since 1999 according to our model simulations. This increase in the sensitivity of consumption is related with a positive reaction of real wages and hours worked per employee, which discourage new job openings and may even cause unemployment to rise. At the individual level, the consumption response is negatively related with the net worth. Moreover, model simulations show that the size of the fiscal effect is positively correlated with wealth inequality. In particular, we find a high correlation between the Gini coefficient implied by the distribution of net wealth in the model and the output multiplier. This demand shock has also very different welfare impact, even of opposite signs, across households, benefiting the most the individuals that are more severely constrained in the financial market. Thus, the aggregate welfare cost of changes in government spending depends critically on the distribution of wealth and credit among the population. All in all, the share of households in the lowest part of the net wealth distribution has a disproportionate effect on the aggregate marginal propensity to consume, the value of the fiscal multiplier and the distributional consequences of fiscal shocks.

Section 2 presents a succinct review of the recent empirical literature on the macroeconomic implications of alternative household balance sheets. Section 3 contains a description of the data set and the criteria used to identify the different households' categories according to their financial position. Section 4 introduces the macroeconomic model that is used to draw the aggregate consequences of financial heterogeneity. In section 5 we study the evolution of the fiscal multiplier consistent with the observed pattern of household finances in the U.S. from 1999 to 2013 and explore the related issues of wealth inequality and welfare effects of fiscal shocks. Section 6 concludes.

2. Literature review

Kaplan, Violante and Weidner (2014) use survey data on household portfolios for the U.S., Canada, Australia, the U.K., Germany, France, Italy, and Spain to document the shares of the so called hand-to-mouth (HtM) households across countries, their demographic characteristics and the composition of the assets side of their balance sheets. They identify two types of HtM households: poor hand-to-mouth (with little or no liquid wealth and no illiquid wealth) and the wealthy hand-to-mouth (with little or no liquid wealth, but significant amounts of illiquid assets). Using data of the Survey of Consumer Finances for the U.S., they conclude that about 30 percent of the population falls within the HtM category, one-third (two thirds) of them being poor (wealthy) HtM. The authors find that both wealthy and poor HtM households have significantly stronger responses to transitory income shocks than non-HtM households. Besides, ignoring that the wealthy hand-to-mouth can use illiquid assets to buffer large negative shocks overstates the overall financial fragility of HtM households.

In a similar vein, Angrisani, Hurd and Rohwedder (2015) use panel data spanning the years 2001-2011 on a complete inventory of household spending and assets. They estimate the response of private spending to negative wealth shocks in the U.S. due to unexpected declines in house and stock market prices. Their main finding is that the marginal propensity to consume out of an unexpected housing wealth change is seven cents per dollar, and about four cents per dollar out of financial wealth. So, they find that consumption was reduced in the Great Recession because of losses in housing wealth and also, although less precisely estimated, because of financial wealth losses.

Other authors put the emphasis on the importance of the composition of the liabilities side of the balance sheet of households to understand the consumption responses of individuals to income shocks. For example, Cloyne and Surico (2014) use household expenditure data from 1978 to 2009 of the UK's Living Costs and Food Survey (commonly known as the Family Expenditure Survey) to show that households with mortgage debt exhibit large and persistent consumption responses to tax driven changes in their income. In contrast, homeowners without a mortgage do not appear to react, independently of the time horizon considered.

The references above look either at the assets or the liabilities side of balance sheets. But both sides of the T-account are important in shaping the effects of shocks on households' consumption and, thus, on aggregate output in the economy. Other papers have also looked at the net worth, defined as the value of households' asset holdings net of debt, trying to understand the evolution of consumption over the recent years. Jaramillo and Chailloux (2015) base their analysis on an unbalanced panel dataset for 14 advanced economies, from 1998 to 2012. They separate the effects on private final consumption expenditure of the components of disposable income (labor income, social benefits, personal income taxes and social security contributions) and of different categories of net wealth (financial assets, housing assets, and household debt), finding a significant long-term relation between consumption and the different components of income and wealth. While labor income remains the main driver of consumption, financial assets and housing assets are found to have a positive coefficient, while household debt has a negative one. Furthermore, these authors' results suggest that the contribution to consumption from an increase in financial or housing assets would be more than offset if financed fully through increases in household debt.

Carroll, Slacalek and Tokuoka (2014) document the importance of matching stylised facts at the household level to interpret the reaction of economies to shocks. Using data from 15 European countries, they find that wealth inequality and differences in the dynamics of household income affect the response of economies to fiscal stimuli in an economically relevant way. In their sample they track down substantial heterogeneity in net wealth to income ratios both across and within countries. Countries in which households tend to hold more net wealth respond less strongly to transitory income shocks, while countries with more unequal wealth distributions have a higher aggregate marginal propensity to consume and, thus, respond more strongly to shocks. Finally, Anderson, Inoue and Rossi (2015) present empirical evidence based on a narrative approach, finding that individuals whose consumption levels are most negatively affected by a positive government spending unexpected shock are the wealthiest and working-age individuals, whereas consumption of the poorest increases the most. Thus, the interesting conclusion is that positive government spending policy shocks tend to decrease consumption inequality.

Overall, the most important implication of this burgeoning (mostly) empirical literature is that the net wealth position of households is a major determinant of their spending decisions, and hence that the distribution of wealth in an economy interacts with (affects and is affected by) fiscal policy shocks in a non trivial manner. This is true not only for the case of tax changes, whose incidence on household wealth is more direct, but also following changes in public spending, through their macroeconomic effects on both the asset and the liabilities sides of the balance sheet.

3. Looking at the data

In this secton, we explore the heterogeneity in household net wealth using the Panel Study of Income Dynamics (PSID). We argue that the very useful classification of households proposed by Kaplan, Violante and Weidner (2014) can be refined to gain further insights on the transmission of fiscal shocks, both at the household and the aggregate level.

Following Kaplan, Violante and Weidner (2014), we first identify three types of households: Ricardian or not hand-to-mouth (*N-HtM*), poor wealth-to-mouth (*P-HtM*), and wealthy hand-to-mouth (*W-HtM*). Traditionally, *N-HtM* households are not cash constrained in their consumption/savings decisions, while *HtM* households consume up all their available resources every period. Kaplan, Violante and Weidner (2014) highlight the need of differentiating two types of *HtM* consumers. On the one hand, the *W-HtM* households who consume all their liquid resources but hold sizable quantities of illiquid wealth, such as housing. On the other hand, the *P-HtM* or traditional rule-of-thumb consumers who not only consume their current income but also do not hold any assets, liquid or illiquid.

Given the timing mismatch in between theoritical definitions of HtM behavior and data collection in surveys, Kaplan, Violante and Weidner (2014) suggest to classify as HtM households those holding average liquid wealth balances below half of their income. Let $\ln LW_t^i$ denote household's i holdings of liquid wealth in period t and inc_t^i be her income. We define income as salaries and other compensation plus private and government transfers. We identify liquid wealth with wealth in the PSID excluding the net equity value of real estate used as main home (a more detailed description of income and liquid wealth can be found in Appendix 2). We assume that illiquid wealth reduces to homeownership. Table 1 summarizes our identification strategy, which used the threshold approach described above as the main characteristic in order to separate *N-HtM* households from *HtM*. Consequently, we do not impose any restrictions regarding homeownership for *N-HtM*. We report the estimated weights using PSID data in Table 2 for all waves between 1999 and 2013. The relative weight of N-HtM households has been declining from 43% in 1999 to 36% in 2013. Therefore, theoretical models with only Ricardian households are mis-representing in between 57 and 65% of the population in the PSID.

Table 1: Household classification

Household	Wealth	Homeowner
N-HtM	$\ln LW_t^i \geq 0.5 * inc_t^i$	Unrestricted
W-HTM	$\ln LW_t^i < 0.5 * inc_t^i$	Yes
P-HTM	$\ln LW_t^i < 0.5 * inc_t^i$	No

Table 2: PSID Sample Weights (in %)

	1999	2001	2003	2005	2007	2009	2011	2013
N-HtM	42.98	42.34	41.89	41.30	41.38	37.08	36.61	35.94
W-HtM	25.42	26.33	27.28	26.52	24.89	25.84	25.21	24.20
P-HtM	31.60	31.33	30.83	32.18	33.73	37.08	38.18	39.86

But neither the *W-HtM* nor the *P-HtM* categories need to be homogeneous categories themselves. As stated before, *W-HtM* households are homeowners. Therefore, it seems natural to categorize them depending on whether they have a mortgage. We label those *W-HtM* households holding assets but with no liabilities as *HH* consumers. Among the *W-HtM* households with liabilities, we distinguish between those highly indebted, *BH*, and those with low leverage ratios, *BL*. Indebted *W-HtM* consumers are classified as being *BH* if their leverage ratio exceeds the median leverage ratio in the sample. *P-HtM* consumers can be classified in two categories depending on whether they have access to consumer credit. The traditional rule-of-thumb consumers are labeled as *HNH* and they do not hold any assets nor liabilities and they consume all their avaialble income. We propose a new category among *P-HtM* consumers: the Eggerston-Krugman, *EK*, households who do not hold any collateralizable assets but borrow against their future labor income. In the PSID, the *EK* households are those with negative liquid wealth since they have debts other than mortgages, which includes credit cards, student loans, medical or legal bills, and personal loans. Table 3 summarizes our identification strategy and Table 4 reports the estimated weights using PSID data. The decrease in the relative importance of Ricardian households in the population has been captured by an increase in the share of *EK* households. The latter are households with no assets but non-colateralized outstanding debt. The mean wealth for *EK* households continuously deteriorates from $-\$8,204$ in 1999 to $-\$21,114$ in 2013, while the mean wealth for Ricardians increases from $\$296,504$ in 2009 to $\$412,366$ in 2013, which captures the increasing inequality in the US. We should highlight here that even Ricardians suffer a toll on their mean wealth over the last recession: the mean wealth in 2009 was $\$514,652$ but in 2011, it was about $\$100,000$ lower (see Appendix 2 for a more detailed picture of the evolution of net wealth among different group of households).

Table 3: Household classification					
	Wealth	Homeowner	High Leverage	Low Leverage	Mortgage
R	$\ln LW_t^i \geq 0.5 * inc_t^i$	?	?	?	?
HH	$\ln LW_t^i < 0.5 * inc_t^i$	Yes	No	No	No
BL	$\ln LW_t^i < 0.5 * inc_t^i$	Yes	No	Yes	Yes
BH	$\ln LW_t^i < 0.5 * inc_t^i$	Yes	Yes	No	Yes
HNH	$0 < \ln LW_t^i < 0.5 * inc_t^i$	No	–	–	–
EK	$\ln LW_t^i \leq 0$	No	–	–	–

Table 4: PSID Sample Weights (in %)								
	1999	2001	2003	2005	2007	2009	2011	2013
R	42.98	42.33	41.89	41.30	41.37	37.09	36.61	35.94
HH	5.62	5.22	5.38	4.96	4.68	4.57	5.37	5.77
BL	6.82	6.88	7.67	7.61	6.99	7.42	7.29	6.48
BH	12.99	14.24	14.23	13.95	13.24	13.84	12.55	11.95
HNH	17.14	16.66	16.13	16.54	17.02	17.40	17.56	18.36
EK	14.45	14.67	14.70	15.64	16.71	19.67	20.62	21.50

4. Fiscal shocks with heterogenous households

4.1 The model

In this section we consider a household heterogeneity augmented Neo Keynesian model to explore the aggregate spending implications of the financial structure studied in the previous section. Here we sketch the most salient features of the model, and let the full set of equations that characterize the equilibrium to the Appendix 1.

We include different classes of households according to the structure of their balance sheets. The supply side of the model is standard, featuring price inertia and monopolistic competition. Search and matching frictions are not central to our discussions of the role played by household finances, but serves one main purpose. We assume that there is perfect risk sharing among the household members and that all workers are equally productive and delegate to a trade union the negotiation about wages and hours with firms. In equilibrium all households earn the same labor income, which allows us to isolate the effect of the other determinants of consumption in our model, namely wealth and collateral.[2] Although there is bargaining over hours, firms retain the "right to manage"

[2] Arrondel et al. (2014) use the Eurosystem Household Finance and Consumption Survey to study the balance sheets of households in a sample of 15 euroarea countries and report as a stylized fact that the structure of household wealth (hosuing, safe financial asstes and risky finacial assets) vary with the level of income but not so much with the unemplyment status, provided that this is of temporary neture. In this sense, nor much is lost by leaving aside the possible interactions among employment status and household finances. See McKay

to some extent as they are responsible for choosing optimally the amount of vacancies they post every period.[3]

Households

The economy is populated by N households who differ in a series of financial characteristics: housing tenancy, the degree of impatience, or the conditions of access to credit. Let N^i denote the i-type household mass, with i denoting an element of the set $I = \{R, HNH, HH, BL, BH, EK\}$. The meaning of the previous acronyms is as follows: R stands for Ricardian households; HNH are hand-to-mouth households with no access to financial markets and no real or financial assets; HH refers to hand-to-mouth households who can purchase and own houses but do not have access to credit and, hence, like HNH households, their total expenditures are equal to current income every period; BH (BL) represents households who borrow against a high (low) proportion of the expected value their real estate holdings; finally, EK type of households are those who cannot collateralize their housing holdings and have to borrow against the collateral provided by their expected future income. Define $\tau^i = \frac{N^i}{N} (\sum_{i \in I} \tau^i = 1)$ as the weight of the i-type household in the total population.

For convenience, we also define different subsets of households belonging to I. First, let $\widetilde{i}$ index the impatient households grouped in the subset $\widetilde{I} = \{HNH, HH, BL, BH, EK\}$. The subset $\widehat{I} = \{R, BL, BH, EK\}$ includes those households, indexed by $\widehat{i}$, who have access to financial markets. Finally $\bar{i}$ households in $\bar{I} = \{R, HH, BL, BH\}$ are homeowners.

Financially unconstrained Ricardian households (R) have traditionally been the main character in representative agent macroeconomic models. These are typically savers / lenders that own assets, but do not have liabilities. In our economy, Ricardian consumers coexist with financially constrained individuals, who are characterised by having a higher degree of impatience. The inclusion of hand-to-mouth consumers (HNH) was proposed by Galí, López-Salido and Vallés (2007) as a means of obtaining empirically consistent fiscal multipliers in DSGE models. Contrary to Ricardian consumers, HNH households have no assets, but they hold no liabilities either, so their net worth is zero. More recently, Kaplan, Violante and Weidner (2014) defined the wealthy hand-to-mouth households as those that consume all their disposable income every period but have sizable amounts of

and Reis (2016) for a detailed analysis of fiscal policy in an economy in which agents differ in their labor market status.

[3] The labor market displays an intensive (hours worked) and an extensive (filled vacancies) margin, whose different response to fiscal shocks helps to explain the output and employment multipliers in presence of financial heterogeneity (see Andrés, Boscá and Ferri, 2015).

wealth in illiquid assets, our HH households are part of this group. BL and BH households own both assets and liabilities and positive net wealth that depends on their capacity to borrow (Kiyotaki and Moore, 1997, and Iacoviello, 2005). BH households are able to pledge a higher proportion of collateral from their real estate holdings than BL households. Finally, other agents hold no collateralizable assets at all and have to borrow against their expected future labour income; we label these households EK since they resemble the ones that populate the Eggertsson and Krugman (2012) economy. Compared to Ricardian consumers, these households are located at the other extreme regarding the composition on their net worth, as they have only liabilities but no assets.[4]

The optimisation problem faced by a household of type i can be expressed as,

$$\max_{c_t^i, b_t^{\hat{i}}, x_t^{\bar{i}}, d_t^R, k_t^R, j_t^R} E_t \sum_{t=0}^{\infty} (\beta^i)^t \left[\ln\left(c_t^i\right) + \phi_x^{\bar{i}} \ln\left(x_t^{\bar{i}}\right) + n_{t\text{-}1}^i \phi_1 \frac{(1\text{-}l_{1t})^{1-\eta}}{1\text{-}\eta} + (1\text{-}n_{t\text{-}1}^i)\phi_2 \frac{(1\text{-}l_2)^{1\text{-}\eta}}{1\text{-}\eta} \right],$$

subject to:

$$c_t^i + j_t^R \left(1 + \frac{\phi}{2}\left(\frac{j_t^R}{k_{t-1}^R}\right)\right) + q_t\left(x_t^{\bar{i}} \text{-} x_{t-1}^{\bar{i}}\right) + d_t^R = (1 + r_{t-1}^n)\left(\frac{d_{t\text{-}1}^P}{1+\pi_t} \text{-} \frac{b_{t\text{-}1}^{\hat{i}}}{1+\pi_t}\right) \tag{1}$$
$$+ r_t k_{t-1}^R + w_t n_{t-1}^i l_{1t} + b_t^{\hat{i}} + f_t^R + trh_t,$$

$$k_t^R = j_t^R + (1-\delta)k_{t-1}^R, \tag{2}$$

$$\underset{i \in \{\tilde{I} \cap \hat{I}\}}{b_t^i} \le \varphi^i \left[m^i E_t \left(\frac{q_{t+1}(1+\pi_{t+1})\, x_t^i}{1+r_t^n} \right) \right] \tag{3}$$
$$+ (1-\varphi^i) \left[m^{EK} E_t \left(\frac{(1+\pi_{t+1})\, w_{t+1} n_t^i l_{1t+1}}{1+r_t^n} \right) \right],$$

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

Variables in this problem are normalised by the within-group working-age population (N_t^i). The index i in variables and parameters points to a specific financial structure of the household. Non-indexed variables and parameters are common to all households

[4] Households are sorted out exogenously. Some papers with fewer household types derive this separation endogenously. Kaplan and Violante (2014) do it with different types of hand-to-mouth consumers, and Cloyne, Ferreira and Surico (2016) include preferences for housing tenure so that borrowers and hand to mouth consumers ("renters" in their terminology) are sorted out endogenously.

in the model economy. The variables c_t^i, x_t^i,n_{t-1}^i and $(1 - n_{t-1}^i)$ represent, respectively, consumption, housing holdings, and the beginning of period employment and unemployment rates of different households. The time endowment is normalised to one and l_{1t} and l_2 stand for the hours worked per employee and hours devoted to job seeking by the unemployed, respectively. While there is a process of bargaining over l_{1t}, the amount of time devoted to job seeking (l_2) is assumed to be exogenous and the same among workers. The discount rate parameter, β^i, and the preferences on housing, ϕ_x^i, can differ depending on the household class the consumer belongs to. The Frisch elasticity of the labour supply, related with η, and the valuation of leisure by employed (ϕ_1) and unemployed (ϕ_2) workers are assumed to be the same for all the agents.

There is a fixed amount of real estate in the economy and the term $q_t \left(x_t^{\bar{i}} - x_{t-1}^{\bar{i}} \right)$ in (1), denotes housing investment for each household, where q_t is the real housing price. Households earn labour income $w_t n_{t-1}^i l_{1t}$, where w_t stands for hourly real wages. Later on we will see that under our assumptions $n_{t-1}^i = n_{t-1}$ for all $i \in I$, so that labour income is homogeneous across all household types. Also, there is an amount of lump sum transfers (taxes) from (to) the government (trh_t) that are received (payed) by Ricardian households.

Ricardian consumers are more patient than the rest of agents and, thus, are characterised by a high value of β^R; they are the only savers in the economy and lend $-b_t^R$ ($b_t^R < 0$) to the private sector and d_t^P to the public sector both in real terms. Debt contracts are set in nominal terms and are short term (one period); these households earn $(1 + r_{t-1}^n) \left(\frac{d_{t-1}^P}{1+\pi_t} - \frac{b_{t-1}^R}{1+\pi_t} \right)$ on their asset holdings, where r_{t-1}^n is the nominal interest rate on loans between $t-1$ and t. Patient consumers are also assumed to be the only ones who own physical capital (k_t^R) that earns $r_{t-1} k_{t-1}^R$, where r_t represents the gross return on physical capital. Capital accumulates according to (2), where j_t^R stands for productive investment and δ is the depreciation rate. Investment is subject to increasing marginal costs of adjustment which are controlled by the parameter ϕ. Moreover, given that firms make extraordinary profits, we assume that lenders receive these in the form of dividends f_t^R.

All the other consumers in the economy $(\widetilde{i})$ are more impatient and face the same discount factor, $\beta^{\widetilde{i}} < \beta^R$. Notice that (3) only holds for the subset of households $i \in \left\{ \widetilde{I} \cap \widehat{I} \right\}$. There is mortgage and labor income backed debt in the economy, and the possibility of access to each of them depends on the parameter φ^i. We assume that for BL, BH households $\varphi^i = 1$, which means that the total amount of debt (mortgage) they can get is a fraction of the liquidation value of their housing stock. However for the EK consumers we assume that $\varphi^i = 0$ so that they can take (non-mortgage) loans up to a proportion of the discounted expected tomorrow's labour income.[5] The first order conditions of this optimization problem are described in the appendix. Just notice that the impatient households' intertemporal substitution is limited as represented by the corresponding Euler equation in consumption,

$$\underset{i\in\left\{\widetilde{I}\cap\widehat{I}\right\}}{\lambda_{1t}^{i}} = \beta^{i}E_{t}\lambda_{1t+1}^{i}\left(\frac{1+r_{t}^{n}}{1+\pi_{t+1}}\right)+\mu_{t}^{i}\left(1+r_{t}^{n}\right), \tag{5}$$

where μ_t^i is the shadow price associated with the constraint (3). The Euler equation for Ricardian households $\left(\widehat{i}\notin\left\{\widetilde{I}\cap\widehat{I}\right\}\right)$ is similar to (5) with $\mu_t^i = 0$.

The remaining constraint faced by households concerns the law of motion of employment. Jobs are destroyed each period at the exogenous rate σ. Likewise, new employment opportunities come at the rate ρ_t^w that represents the probability that one unemployed worker will find a job, which is taken as exogenous by individual workers but is endogenously determined at aggregate level. Actually, ρ_t^w can be defined as the number of matched workers during period t over the volume of unemployed workers at the beginning of period t,

$$\rho_t^w(1-n_{t-1}) = \chi_1 v_t^{\chi_2}\left[(1-n_{t-1})\,l_2\right]^{1-\chi_2}, \tag{6}$$

where v_t stands for the number of active vacancies during period t, and χ_1 and χ_2 are the parameters in the matching function. For later use we define the marginal value of employment for a worker (λ_{ht}^i) as the marginal contribution of a newly created job to the utility of the household.

Firms' problem

Production is organised in three different levels: (1) a wholesale sector (indexed by j) where firms 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) an intermediate sector of firms (indexed by $\widetilde{j}$) that buy the homogenous good and transform it, without the use of any other input, into a firm-specific variety that they sell in a monopolistically competitive market; and (3) a competitive retail aggregator that buys differentiated varieties ($y_{\widetilde{j}t}$) from the intermediate sector at a price $P_{\widetilde{j}t}$ and sells a homogeneous final good (y_t) at price P_t.

(Subsubsubsection head:)The competitive retail sector

The competitive retail aggregator buys differentiated goods from firms in the in-

[5] Alternatively we could have allowed for different types of loans for all impatient households, with a proportion refereing to mortgaged debt and the rest being just backed by expected labor income. We find our modeling choice easier to handle without much loss of accuracy in the exercises below.

termediate 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

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

subject to,

$$y_t = \left[\int y_{\tilde{j}t}^{(1-1/\theta)} d_{\tilde{j}} \right]^{\frac{\theta}{\theta-1}}, \tag{7}$$

where $\theta > 1$ is a parameter that can be expressed in terms of the elasticity of substitution between intermediate goods ($\varkappa$), as $\theta = (1+\varkappa)/\varkappa$. The retailer's price is given by:

$$P_t = \left[\int_0^1 \left(P_{\tilde{j}t} \right)^{1-\theta} d\tilde{j} \right]^{\frac{1}{1-\theta}}. \tag{8}$$

(Subsubsubsection head:)The monopolistically competitive intermediate sector

The monopolistically competitive intermediate sector comprises $\tilde{j} = 1, ...\tilde{J}$ 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. In keeping with 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 $P_{\tilde{j}t} = (1+\pi_{t-1})^{\varsigma} P_{\tilde{j}t-1}$ (with ς representing the degree of indexation and π_{t-1} the inflation rate in $t-1$). The fraction of firms (of measure $1-\omega$) that set the optimal price (P_t^*) at t seek to maximise the present value of expected profits. The aggregate price level is given by,

$$P_t = \left[\omega \left(P_{t-1} \pi_{t-1}^{\varsigma} \right)^{1-\theta} + (1-\omega) \left(P_t^* \right)^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{9}$$

(Subsubsubsection head:)The competitive wholesale sector

The competitive wholesale sector consists of $j = 1, ...J$ firms, each selling a different quantity of a homogeneous good at the same price P_t^w to the monopolistically competitive intermediate sector. Firms in the perfectly competitive wholesale sector carry out the actual production using labour and capital. Capital demand and vacancy posting are decided by solving the cost minimisation problem faced by the representative competitive producer,

$$\min_{k_t, v_t} E_t \sum_{t=0}^{\infty} (\beta^R)^t \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R} \left(r_{t-1} k_{t-1} + w_t n_{t-1} l_{1t} + \kappa_v v_t \right), \tag{10}$$

subject to the production function

$$y_t = Ak_{t-1}^{1-\alpha}(n_{t-1}l_{1t})^{\alpha}, \tag{11}$$

and the law of motion for employment

$$n_t = (1-\sigma)n_{t-1} + \rho_t^f v_t, \tag{12}$$

where ρ_t^f is the probability that a vacancy will be filled in any given period t, ½

$$\rho_t^f v_t = \chi_1 v_t^{\chi_2}\left[(1-n_{t-1})\, l_2\right]^{1-\chi_2}. \tag{13}$$

The optimal vacancy posting is given by

$$\frac{\kappa_v}{\rho_t^f} = \beta^R E_t \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R}\frac{\partial V_{t+1}}{\partial n_t}. \tag{14}$$

and 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 opening the vacancy $\beta^R E_t \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R}\rho_t^f \lambda_{ft+1}$, where $\lambda_{ft} = \frac{\partial V_t}{\partial n_{t-1}}$ represents the next period firm's marginal value of an additional job.

Trade in the labour market: the labour contract

We assume, as in Boscá *et al*. (2011), that although households' types may differ in their reservation wages, they delegate wage and hours bargaining to a trade union. This trade union maximises the aggregate marginal value of employment for workers and distributes employment according to their shares in the working-age population. Thus, all households receive the same wage, work the same number of hours and have the same unemployment rates.

Following the standard practice, the Nash bargaining process maximises the weighted product of the parties' surpluses from employment. The optimal real wage and hours worked is given by:

$$\begin{aligned} w_t l_{1t} = {} & \lambda^w \left[mc_t \alpha \frac{y_t}{n_{t-1}} + \frac{\kappa_v v_t}{(1-n_{t-1})} \right] \\ & +(1-\lambda^w) \left[\left(\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} - \phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} \right) \sum_{i \in I} \frac{\tau^i}{\lambda_{1t}^i} \right] \\ & +(1-\lambda^w)(1-\sigma-\rho_t^w) \sum_{\tilde{i} \in \tilde{I}} \tau^i E_t \frac{\lambda_{ht+1}^{\tilde{i}}}{\lambda_{1t+1}^{\tilde{i}}} \left(\beta^R \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R} - \beta^{\tilde{i}} \frac{\lambda_{1t+1}^{\tilde{i}}}{\lambda_{1t}^{\tilde{i}}} \right), \end{aligned} \tag{15}$$

$$mc_t \alpha \frac{y_t}{n_{t-1} l_{1t}} = \phi_1 (1 - l_{1t})^{-\eta} \sum_{i \in I} \frac{\tau^i}{\lambda_{1t}^i}. \tag{16}$$

where $\lambda^w \in [0, 1]$ reflects workers' bargaining power.

Policy instruments and resources constraint

We assume the existence of a central bank that follows a Taylor's rule,

$$1 + r_t^n = \left(1 + r_{t-1}^n\right)^{r_R} \left((1 + \pi_t)^{1+r_\pi} \left(\frac{y_t}{\overline{y}}\right)^{r_y} (1 + \overline{r}^n) \right)^{1-r_R}, \tag{17}$$

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

Revenues and expenditures are made consistent by means of the government intertemporal budget constraint,

$$d_t^P = g_t + trh_t + \frac{(1 + r_{t-1}^n)}{1 + \pi_t} d_{t-1}^P. \tag{18}$$

In order to make the debt to GDP ratio stationary, the following fiscal policy reaction function is imposed,

$$trh_t = trh_{t-1} - \psi_1 \left[\frac{d_t^P}{gdp_t} - \overline{\left(\frac{d^P}{gdp} \right)} \right] - \psi_2 \left[\frac{d_t^P}{gdp_t} - \frac{d_{t-1}^P}{gdp_{t-1}} \right], \tag{19}$$

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

Finally, the aggregate resource constraint guarantees that the sum of demand components plus the cost of posting vacancies equals aggregate output,

$$y_t = A_t k_{t-1}^{1-\alpha} (n_{t-1} l_{1t})^\alpha = c_t + j_t \left(1 + \frac{\phi}{2} \left(\frac{j_t}{k_{t-1}} \right) \right) + g_t + \kappa_v v_t. \tag{20}$$

4.2 Calibration

The calibration strategy for our benchmark model consists in using standard values in the literature for some parameters and matching some relevant data moments for the US economy. In Table 5 we present the values of those parameters that allow us to identify the six different types of households that populate our benchmark economy. Thus, first we define the shares of the households' categories in the total population, assuming that Ricardian households represent 50 percent of the population ($\tau^R = 0.5$) and the other five type of individuals amount each to 10 percent of it (τ^{HNH}=τ^{HH}=τ^{BL}=τ^{BH}=τ^{EK}=0.1). The subjective intertemporal discount rate of patient households is $\beta^R = 0.99$, while all other five types are more impatient, presenting a discount factor of 0.95 (see Iacoviello, 2005). All individuals that own houses in our economy share the same preferences parameter on housing, $\phi_x^i = 0.12$. This value, as well as the the total stock of housing, X, depend on the value we assign to the ratio of assets of patient households ($\overline{b}^R$) to total output ($\overline{y}$) in the steady state, that we set following also Iacoviello (2005) such that the total stock of housing over yearly output is 140 percent. Finally, φ^i is set to one for BL and BH households, indicating that these individuals take credit using housing as collateral, and to zero for EK individuals, indicating that they borrow against their future labour income. Loan-to-value ratios are set to 0.735 (for BL households) and 0.985 (for BH and EK individuals), values that are slightly lower and higher than those in Iacoviello and Neri (2010).

Table 5. Parameterization of households

Type	τ^i	β	ϕ_x^i	φ^i	m^i
R	0.5	0.99	0.12	−−	−−
HNH	0.1	0.95	0	−−	−−
HH	0.1	0.95	0.12	−−	−−
BL	0.1	0.95	0.12	1	0.735
BH	0.1	0.95	0.12	1	0.985
EK	0.1	0.95	0	0	0.985

The remaining set of parameters is shown in Table 6. We take 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 $\overline{\rho}^f = 0.9$, the fraction of time spent working, $\overline{l_1} = 1/3$, and the fraction of time households spend searching $l_2 = 1/6$. The long-run employment ratio is computed to be $\overline{n} = 0.75$ as in Choi and Rios-Rull (2008). 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

$\left(\eta^{-1}\left(1/\overline{l}_1 - 1\right)\right)$ 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 $\overline{mc} = \frac{\theta-1}{\theta}$. The probability of not changing prices, ω, is set to 0.75, meaning that prices change every four quarters on average, whereas we take an intermediate value, $\varsigma = 0.4$, for inflation indexation. 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.

Table 6. Parameter values

Preferences:			
Labour elasticity, η	2		
Leisure preference (empl.), ϕ_1	1.59	Leisure preference (unempl.), ϕ_2	1.04
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	0.167
Frictions:			
Probability of not changing prices, ω	0.75	Investment adjustment costs, ϕ	5.5
Inflation indexation, ς	0.4		
Labour market:			
Matching elasticity, χ_2	0.5	Transition rate, σ	0.15
Workers' bargaining power, λ^w	0.5	Cost of vacancy posting, κ_v	0.04
Scale parameter matching, χ_1	1.56		
Policy:			
Fiscal reaction parameter, ψ_1	0.01	Fiscal reaction parameter, ψ_2	0.2
Interest rate smoothing, r_R	0.73	Interest rate reaction, r_π	0.27
Interest rate reaction, r_y	0		

We normalise both steady-state output ($\overline{y}$) and real housing prices ($\overline{q}$) to one. Steady-state government expenditure $\overline{g}/\overline{y}$, is set to 17 per cent of output, matching US data. We obtain the long-run value for vacancies from (12) $\overline{v} = \sigma\overline{n}/\overline{\rho}^f$. Then, we calibrate the ratio of recruiting expenditures to output $(\kappa_v\overline{v}/\overline{y})$ to represent 0.5 percentage points of output, as in Cheron and Langot (2004) or Choi and Rios-Rull (2008), and very close to the value of 0.44 implied by the calibration of Monacelli *et al.* (2010). From this ratio we obtain a value of $\kappa_v = 0.04$ and, using the steady-state firm's marginal value of an additional job, we can solve for the value of wages ($\overline{w}$). The steady-state value of matching flows in the economy equals the flow of jobs that are lost ($\sigma\overline{n}$) and we use the equality ($\sigma\overline{n} = \chi_1\overline{v}^{\chi_2}\left[(1-\overline{n})\, l_2\right]^{1-\chi_2}$) to solve for the scale parameter of the matching function $\chi_1 = 1.56$.

The long-run value of total factor productivity, $A = 1.50$, is calibrated from the production function to obtain the steady-state value of Tobin's q ratio, $\frac{\overline{\lambda}_2^I}{\overline{\lambda}_1^I}$. The return on capital ($\overline{r}$) comes from the first-order conditions and the steady-state value for capital stock ($\overline{k}$) from (**??**). Capital stock, together with the depreciation rate and the adjustment cost parameter, allows us to calculate the value of gross investment for the steady state and, using the aggregate constraint, the level of consumption $\overline{c}$. The steady-state value of the nominal interest rate $\overline{r}^n$, is related to the intertemporal discount rate of Ricardian households through the steady-state version of the first-order condition for consumption. The value for the lump-sum transfers in the steady state is such that from the government budget constraint the resulting debt-to-output ratio is 93 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 $\kappa_f = \tau^R f_t^R$.

Steady-state levels of the marginal utilities of consumption of the different types of consumers, $\overline{\lambda}_1^R$, $\overline{\lambda}_1^{HNH}$, $\overline{\lambda}_1^{HH}$, $\overline{\lambda}_1^{BL}$, $\overline{\lambda}_1^{BH}$, and $\overline{\lambda}_1^{EK}$ come from their respective first-order conditions. As regards leisure preference parameters in the household utility function, $\phi_1 = 1.59$ is calculated from the steady-state version of expression (16). A system of seven equations implying the steady state of expressions (**??**) for the six categories of individuals and (15) is solved for ϕ_2, $\overline{\lambda}_h^R$, $\overline{\lambda}_h^{HNH}$, $\overline{\lambda}_h^{HH}$, $\overline{\lambda}_h^{BL}$, $\overline{\lambda}_h^{BH}$, and $\overline{\lambda}_h^{EK}$. The resulting value for ϕ_2 is 1.04. 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.

4.3 Inspecting the mechanism: Simulation results

We now use the model to analyze the role played by household balance-sheet heterogeneity in shaping the short-run response of consumption to a transitory government spending shock. For expository purposes we do this using the wealth distribution that is implied by our calibration. In the next section we incorporate the main statistics from the observed distribution in the *PSID* discussed above.

Table 7 presents steady state levels of consumption, labour income and net wealth (and its distribution between assets and liabilities) across all six household categories in our economy. The model assumptions on the labour market warrant the same labour income across all household types (second column of Table 7), so that there is a very unequal steady state distribution of net wealth but a more egalitarian distribution of consumption.[6] Ricardian consumers are the only ones who hold assets other than real estate and have a ratio of net worth over labour income close to sixty. But net wealth is also very different among those household types that are subject to some kind of borrowing constraint.

Table 7. Steady state consumption, labour income and net wealth

	Cons	Lab income	Net wealth	Assets	Liabilities	Ratio
	(1)	(2)	(3)	(4)	(5)	(3)/(2)
R	0.740	0.578	33.375	33.375	0	57.7
HNH	0.578	0.578	0	0	0	0
HH	0.578	0.578	1.415	1.415	0	2.45
BL	0.554	0.578	0.872	3.292	2.420	1.51
BH	0.519	0.578	0.090	5.995	5.905	0.16
EK	0.572	0.578	-0.569	0	0.569	-0.98

Overall, the picture that arises from Table 7 with respect to the distribution of net worth and labour income, summarised in the last column of the table (representing the ratio of net wealth over labour income), is in line with empirical estimates by Carroll *et al*. (2014). These authors use data from the *European Household Finance and Consumption Survey* to show substantial heterogeneity in wealth-to-permanent income ratios, both across and within countries.

Ricardian consumers achieve the highest levels of per capita consumption, followed by hand-to-mouth consumers who do not have to make any interest rate payments in the steady state. Although *BH* households' asset holdings are the highest among the impatient consumers, their net wealth is low since they are also the most leveraged. Finally, among the households that participate in the credit market, per capita consumption levels are inversely related with the amount of liabilities they hold. Thus, *EK* consumers consume more than borrowers with a low capacity to get credit, and these more than the ones with easy access to loans. In the steady state indebted households have to distribute their incomes between consumption and debt interest payments. So, given equal labour incomes, heavily indebted households will reach lower consumption levels.

Figure 1 shows the absolute variation of consumption, labor income, and net worth for each type of household to a 1% increase in government spending for the benchmark parameterization. In terms of steady state levels in Table 7, these absolute responses of

[6] This is consitent with what we observe in the data, for instance for Euroepan households (see Eurosystem Household Finance and Consumption Network, 2013)

individual consumption implay substantial disparities that range from a 3.6% increase upon impact for the *EK* households to a decline (-0.4%) in the consumption of savers.

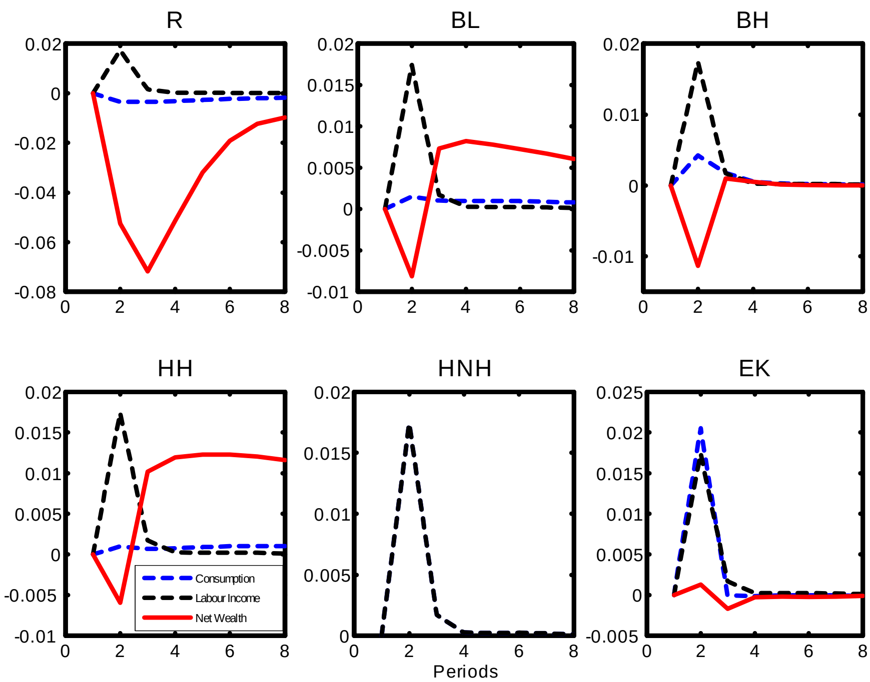


Figure 1: *Response of consumption, net wealth and labour income to a government spending shock (absolute variation)*

To understand the impact multiplier associated to a government spending shock we can make use of the implicit consumption function of each type of agent in our economy. To simplify matters we abstract from firm's profits and we can represent the current consumption of Ricardian households (lenders) as function of their ultimate income and net worth determinants as follows,

$$c_t^R = \digamma_{Rt}\left(\underbrace{(1\text{-}\delta+r_t)\,k_{t\text{-}1}^R+q_t x_{t\text{-}1}+(1+r_{t\text{-}1}^n)\left(\frac{d_{t\text{-}1}^P}{1+\pi_t}\text{-}\frac{b_{t\text{-}1}^R}{1+\pi_t}\right)}_{\text{Net worth: } NW_t^R}+\underbrace{w_t n_{t\text{-}1} l_{1t}}_{\text{Lab. Income}}\right).$$

Thus, the response of consumption to a change in g_t is given by

$$\frac{\partial c_t^R}{\partial g_t} = \underset{(+)}{\frac{\partial \digamma_{Rt}}{\partial NW_t^R}} \underset{(-)}{\frac{\partial NW_t^R}{\partial g_t}} + \underset{(+)}{\frac{\partial \digamma_{Rt}}{\partial (w_t n_{t-1} l_{1t})}} \underset{(+)}{\frac{\partial (w_t n_{t-1} l_{1t})}{\partial g_t}},$$

where the negative sign of $\frac{\partial NW_t^R}{\partial g_t}$, consistent with the sharp fall in NW_t^R that can be observed in equation (**??**), stems from the fact that the fiscal shock depresses both r_t and q_t and increases π_t. The Fisher effect is negative for lenders, since the real value of their financial assets is eroded as a consequence of the rise in current inflation π_t ($b_{t\text{-}1}^R$ is negative). Thus, although labour income increases after the shock, the fall in the value of the large amount of wealth held by Ricardians consumers dominates, causing a downward adjustment in their consumption spending.

Turning now to the other households categories, their total spending capacity depends on current labour income and net wealth plus the new credit flow, when available. There are also differences among them, depending on the precise nature of their exposure to the financial market. Consider first the implicit consumption function of those borrowers whose credit is backed by real estate (BH and BL in our terminology),

$$c_t^B = \digamma_{Bt}\left(\underbrace{q_t x_{t\text{-}1} \text{-} (1{+}r_{t\text{-}1}^n)\left(\frac{b_{t\text{-}1}^B}{1{+}\pi_t}\right)}_{\text{Net worth: } NW_t^B} + \underbrace{w_t n_{t\text{-}1} l_{1t}}_{\text{Lab. Income}} + \underbrace{b_t^B}_{\text{Credit}} \right).$$

In this case, the response of consumption to a change in g_t is given by

$$\frac{\partial c_t^B}{\partial g_t} = \underset{(+)}{\frac{\partial \digamma_{Bt}}{\partial NW_t^B}} \underset{(+/-)}{\frac{\partial NW_t^B}{\partial g_t}} + \underset{(+)}{\frac{\partial \digamma_{Bt}}{\partial (w_t n_{t-1} l_{1t})}} \underset{(+)}{\frac{\partial (w_t n_{t-1} l_{1t})}{\partial g_t}} + \underset{(+)}{\frac{\partial \digamma_{Bt}}{\partial b_t}} \underset{(+)}{\frac{b_t^B}{\partial g_t}},$$

with two main differences with respect to the case of lenders. First, the sign of $\frac{\partial NW_t^B}{\partial g_t}$ is now ambiguous, since the negative effect on the asset side is weaker, and the Fisher effect operates on the liabilities side, since $b_{t\text{-}1}$ is now positive. Notice that the amount of assets held by borrowers is lower since they hold no capital or government bonds and, as we shall see later on, less real estate than savers. As can be seen in the Figure 1, the asset price depreciation dominates, inducing a substantial, though smaller than in the case of Ricardians, drop in net worth on impact. Besides, the borrowing opportunities (3) increase with the shock despite the rise in the real interest rate, since the improved economic conditions bring about the expectation of a recovery in collateral ($\Delta E_t q_{t+1} x_t^i$). The multiplier is thus higher than that for Ricardian consumers, and consumption spending actually increases.

Notice also that the magnitude of this effect depends on the quality of collateral services, and hence is stronger for households with high (BH) than for those with low (BL) loan-to-value ratio. Although BL households are less leveraged than BH households ($b_{t-1}^{BL} < b_{t-1}^{BH}$), so that the Fisher effect is less intense, they also demand less housing ($x_{t-1}^{BL} < x_{t-1}^{BH}$), implying that the fall in q_t has a weaker effect on lowly indebted households. Considering just the response of labour income and net financial wealth, we would expect a more muted response of consumption for BH than for BL households. However, Figure 1 shows the opposite. The explanation for this result relies in the new credit flow term, b_t^B, that responds very differently for indebted consumers. The fiscal shock increases the expected value of the collateral ($E_t q_{t+1} x_t^b$), which according to (3) facilitates the access to credit. This effect is stronger for BH households since they have a higher loan-to-value ratio m^b.

The determinants of hand-to-mouth households' consumption can be represented as

$$c_t^{HH} = \digamma_{HHt}\left(\underbrace{q_t x_{t-1}}_{\text{Net worth: } NW_t^{HH}} + \underbrace{w_t n_{t-1} l_{1t}}_{\text{Lab. Income}}\right),$$

in the case of HH consumers, who can't borrow but still have housing wealth. However, for our HNH households with neither assets nor liabilities, the consumption fuction can be written as

$$c_t^{HNH} = \digamma_{HNHt}\left(\underbrace{w_t n_{t-1} l_{1t}}_{\text{Lab. Income}}\right) = w_t n_{t-1} l_{1t},$$

A typical hand-to-mouth consumer, as it has been considered in the literature, does not possess assets, so for HNH households $q_t x_{t-1}^{HNH} = 0$ and consumption replicates the evolution of current income, which stimulates a sizable impact response to the fiscal shock

$$\frac{\partial c_t^{HH}}{\partial g_t} = \underset{(+)}{\frac{\partial \digamma_{HHt}}{\partial NW_t^{HH}}} \underset{(-)}{\frac{\partial NW_t^{HH}}{\partial g_t}} + \underset{(+)}{\frac{\partial \digamma_{HHt}}{\partial (w_t n_{t-1} l_{1t})}} \underset{(+)}{\frac{\partial (w_t n_{t-1} l_{1t})}{\partial g_t}}.$$

HH households suffer the decline in the value of their assets with no compensation in the other side of their balance sheet. Besides, they do not have access to credit and, hence, their consumption response is the lowest one among the financially constrained households. The powerful response of HNH households' consumption, on the other hand, comes entirely through the effect of the fiscal shock on labor income,

$$\frac{\partial c_t^{HNH}}{\partial g_t} = \underset{(+)}{\frac{\partial \digamma_{HNHt}}{\partial (w_t n_{t-1} l_{1t})}} \underset{(+)}{\frac{\partial (w_t n_{t-1} l_{1t})}{\partial g_t}}.$$

Finally, the consumption function of EK households can be expressed as

$$c_t^{EK} = \digamma_{EKt} \left(\underbrace{-(1+r_{t-1}^n) \left(\frac{b_{t\text{-}1}^{EK}}{1+\pi_t} \right)}_{\text{Net worth: } NW_t^{EK}} + \underbrace{w_t n_{t-1} l_{1t}}_{\text{Lab. Income}} + \underbrace{b_t^{EK}}_{\text{Credit}} \right), \tag{21}$$

For these consumers the response of consumption to a government spending shock can be written as

$$\frac{\partial c_t^{EK}}{\partial g_t} = \underset{(+)}{\frac{\partial \digamma_{EKt}}{\partial NW_t^{EK}}} \underset{(+)}{\frac{\partial NW_t^{EK}}{\partial g_t}} + \underset{(+)}{\frac{\partial \digamma_{EKt}}{\partial (w_t n_{t-1} l_{1t})}} \underset{(+)}{\frac{\partial (w_t n_{t-1} l_{1t})}{\partial g_t}} + \underset{(+)}{\frac{\partial \digamma_{EKt}}{\partial b_t}} \underset{(+)}{\frac{b_t^{EK}}{\partial g_t}}.$$

EK consumers hold no assets, so the full Fisher effect on the liabilities side of the balance sheet makes $\frac{\partial NW_t^{EK}}{\partial g_t}$ positive and larger than in the case of other households. Besides, the effect of the shock on fresh credit is positive since the expected increase in future labor income eases the income based collateral constraint ($\varphi^{EK} = 0$ in (3)). As a consequence, these households are the ones with a stronger response of consumption on impact.

In Table 8 we show the empirical counterparts of these impact responses using the following decomposition

$$\frac{c_t^i\text{-}c^i}{c^i} = F_i'^{*} \left(\frac{NW^i}{c^i} \frac{NW_t^i - NW^i}{NW^i} + \frac{(wnl_1)}{c^i} \frac{(w_t n_{t\text{-}1} l_{1t}) - (wnl_1)}{(wnl_1)} + \frac{b^i}{c^i} \frac{b_t^i - b^i}{b^i} \right),$$

which shows the weight of the marginal propensity to consume out of each source of funds, net worth, labor income and fresh credit, along with the change in each component for different household types.

A first conclusion from Table 8 is the large heterogeneity across households in the consumption expenditure response induced by the shock. There is a clear negative relationship between the consumption response to the shock and the wealth of the household (last column). Households with less net wealth respond more strongly to an increase in government spending, a result which is consistent with some recent empirical evidence linking wealth and consumption (Carroll et al., 2014; Kaplan et al., 2014; Angrisani et

Table 8. Sources of the impact consumption response

	$\frac{c_t^i - c^i}{c^i}$	$\frac{NW^i}{c^i}\frac{NW_t^i - NW^i}{NW^i}$	$\frac{(wnl_1)}{c^i}\frac{(w_t n_{t\text{-}1} l_{1t}) - (wnl_1)}{(wnl_1)}$	$\frac{b^i}{c^i}\frac{b_t^i - b^i}{b^i}$	NW^i
R	-0.0044	-0.0721	0.0236	—	33.375
BL	0.0027	-0.0148	0.0315	0.0372	0.872
BH	0.0081	-0.0219	0.0336	0.1262	0.090
HH	0.0017	-0.0103	0.0302	0,0000	1.415
HNH	0.0302	0,0000	0.0302	0,0000	0
EK	0.0359	0.0023	0.0305	0,0032	-0.569

al, 2015). The central columns actually corroborate that balance sheets are pivotal in the distinct reaction of household consumption, an idea that has already been documented empirically by Parker et a. (2013), Agarwal and Qian (2014), Acconcia et al. (2015), Sahm et al. (2015) and Surico and Trezzi (2015).

In our model, the negative response of Ricardian households' consumption is mostly driven by the drop in net worth. Although the effect of fresh credit availability is minor in the case of EK households (as compared with BH and BL households below), the strong response of consumption is driven by the fact that these consumers are the only ones for whom the net worth effect is positive. Fresh credit is the main driver explaining the differences between BL and BH consumers' spending decisions. Also, a comparison between the two categories of hand-to-mouth households (HNH, and HH) makes clear the two channels pulling down the consumption multiplier of HH households: declining wealth and, more importantly, diversion of spending towards additional housing.

The different reaction of household consumption, following a government spending shock, suggests a clear connection among the financial exposure of the population, and the aggregate consumption, income and labour effects of the shock. In Table 9, we present in the first two columns output and consumption impact multipliers. The last two columns display the response of total hours worked and employment under alternatives scenarios regarding the distribution of households among the six types considered.

In the first row we assume an economy populated entirely by Ricardian consumers. The shock triggers the standard crowding out effect in consumption that, along with a similar effect on different forms of investment gives rise to a weak output multiplier, in fact lower than one. The effect on both total hours and employment is positive, but relatively less vigorous for the latter. This suggests that hours per employee are reacting importantly.

In the next rows we keep the share of Ricardian at 50% and distribute the remaining 50% equally among the different types of non Ricardian consumers in a sequential way. For example, in the second row the population is split on equal proportions between Ricardian and HH households, while in the last row each of the different classes of non Ricardian households represent 10% of the total population. The particular sequence we

Table 9. Fiscal effects	(1) $\frac{\Delta y_t}{\Delta g_t}$	(2) $\frac{\Delta c_t}{\Delta g_t}$	(3) $\frac{\Delta(n_{t-1}l_{1t})}{nl_1}$	(4) $\frac{\Delta(n_{t-1})}{n}$
R	0.850	-0.147	1.216	0.356
R+HH	0.873	-0.084	1.249	0.335
R+HH+BL	0.875	-0.083	1.252	0.338
R+HH+BL+BH	0.892	-0.060	1.276	0.352
R+HH+BL+BH+HNH	1.011	0.089	1.448	0.315
R+HH+BL+BH+HNH+EK	1.170	0.283	1.675	0.238

Note: (1) and (2): impact multipliers. (3) and (4): relative variations (%).

have chosen for this exercise implies a continuos increase in the size of the multiplier as we are adding new households categories to the economy. This exercise offers a rough indicator of what we miss in terms of the effect of fiscal policy by not providing enough detail on the households' side. Overall, the output multiplier to a government spending shock augments by more than 50 percent if we compare the homogenous Ricardian household economy with another one with a cautious distribution of a wide variety of non-Ricardian household categories.[7] Notice that almost all the change in the output multiplier, as we move from one distribution to the next, is explained by the change in the consumption multiplier, which suggests that the other components of aggregate demand are much less sensitive to variations in the household financial structure in the model economy. Also, not surprisingly total hours worked react positively with the output multiplier, although the effect on employment weakens as we introduce in the model more financially constrained groups of households.

5. The government spending multiplier and the distribution of wealth in the U.S.

5.1 Wealth inequality and the fiscal multiplier

In this section we feed our theoretical model with the evolution of observed shares as reported in previous Table 4. We then simulate for each year the macroeconomic effects of a transitory government expenditure shock of 1 percent of output. The corresponding time profile of the fiscal effects is displayed in Table 10. In the years prior to the Great Recession, the fiscal multiplier remains fairly stable. The fiscal multiplier increases significantly whenever the relative weight of Ricardian and EK households changes. The response of consumption by *EK* households is the largest in our baseline calibration, while the response of Ricardian households is negative. Therefore, it is not surprising that the

[7] Interestingly, these theoretical multipliers fall within the range found by Ramey (2011) in her JEL survey.

size of the consumption multiplier increases when the share of Ricardians drops or the share of *EK* households increases, and consequently this is reflected in a growing output multiplier. Overall, between 2005 and 2013 the output multiplier grows more than 30 per cent.

Table 10. The evolution of fiscal effects

		1999	2001	2003	2005	2007	2009	2011	2013
(1)	$\frac{\Delta y_t}{\Delta g_t}$	1.562	1.608	1.598	1.666	1.713	2.081	2.084	2.187
(2)	$\frac{\Delta c_t}{\Delta g_t}$	0.768	0.826	0.815	0.898	0.955	1.413	1.417	1.543
(3)	$\frac{\Delta(n_{t-1}l_{1t})}{nl_1}$	2.239	2.305	2.290	2.388	2.466	2.986	2.990	3.138
(4)	$\frac{\Delta(n_{t-1})}{n}$	0.052	0.032	0.039	0.003	-0.025	-0.219	-0.223	-0.284

Note: (1) and (2): impact multipliers. (3) and (4): relative variations (%).

The relative variations of total hours worked along the period reflects the time pattern of output in the economy. However, as the distribution of households in the economy changes towards a higher share of *EK* households and less Ricardians, the pressure on wages and hours per employee increases, provoking that firms post less vacancies with a lowering employment effect.

We can also derive from our model some implications regarding the relationship between wealth inequality and the fiscal multiplier. This relates to the work of Carroll *et al*. (2014) who postulate a positive association between wealth inequality and the aggregate marginal propensity to consume. We explore this issue in Figure 2 plotting the impact output multiplier against wealth inequality, as captured by the model-based Gini coefficient. To this end, we have plugged in the model the same observed distribution of households leading to the income multipliers in Table 10.

The results establish a clear association between the output multiplier and net wealth dispersion that increases as more constrained agents enter into scene. In terms of policy, positive fiscal shocks in a more unequal economy would display larger effects on output, as the positive slope of the regression line indicates. This relationship is the consequence of the heterogeneity in the responses of consumption across agents that we have explained in Table 8.

The Gini coefficients in Figure 2 have been calculated using the observed shares of the different households groups and the model implied steady state net wealth for each of them. In Figure 3 we show the correlation between these Gini coefficients and the ones obtained using the the observed distribution of the group averge wealth in the PSID. No matter that we use liquid net wealth (left panel) or total net wealth (right panel) we find that the positive correlation between the simulated and the observed wealth inequality indexes is very high (0.93 and 0.71 respectively), although stronger when liquid wealth is used. Thus, our model is capable of reproducing an important part of the observed mean variation in wealth inequality.

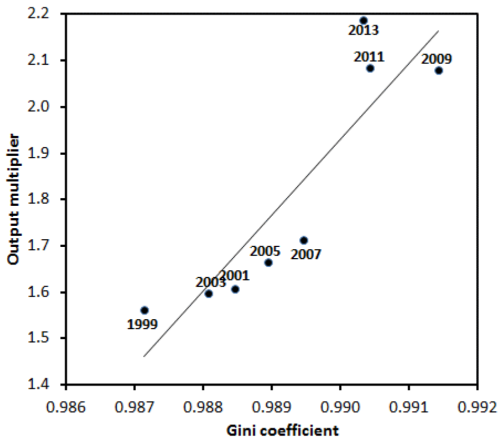


Figure 2: *Output multiplier and inequality (theoretical results)*

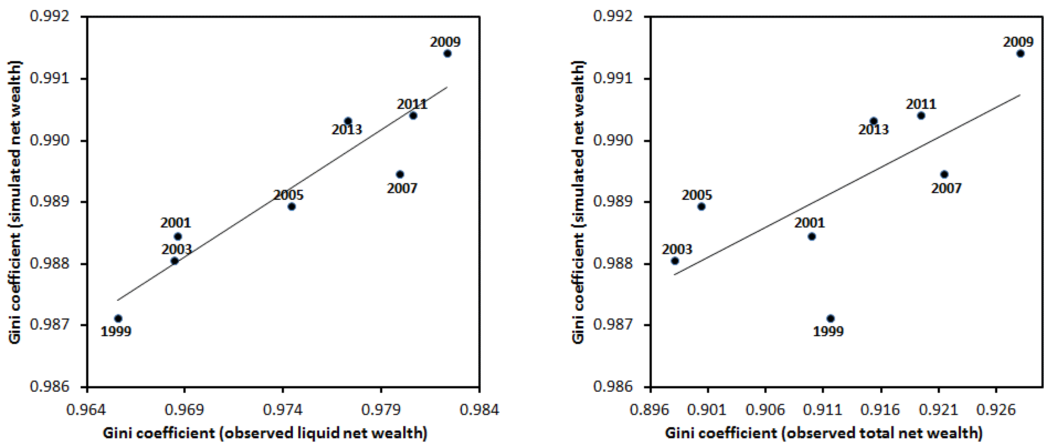


Figure 3: *Theoretical and observed Gini coefficients.*

5.2 Welfare effects

The heterogeneity in our model allows us to compare the effect of a government spending change on the consumption response across households categories. But households' utility also depends on their real estate holdings. To assess the distributional consequences of the policy in a more global way we compute its effect on household's welfare. We define welfare $\overline{V}^i$ as the discounted 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 remaining constant throughout

$$\overline{V}^i = \sum_{t=0}^{\infty} (\beta^i)^t \left[\begin{array}{c} \ln\left(\overline{c}_t^i\right) + \phi_x^i \ln\left(\overline{x}_t^i\right) + \overline{n}_{t-1}\phi_1 \frac{(1-\overline{l}_{1t})^{1-\eta}}{1-\eta} \\ +(1-\overline{n}_{t-1})\phi_2 \frac{(1-\overline{l}_2)^{1-\eta}}{1-\eta} \end{array} \right],$$

where i is the index referring to household's type. Now, we define $V^{i,s}$ as the welfare of 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 their initial steady state

$$V^{i,s} = \sum_{t=0}^{\infty} (\beta^i)^t \left[\begin{array}{c} \ln\left(c_t^{i,s}\right) + \phi_x^i \ln\left(x_t^{i,s}\right) + n_{t-1}^s\phi_1 \frac{(1-l_{1t}^s)^{1-\eta}}{1-\eta} \\ +(1-n_{t-1}^s)\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} \end{array} \right], \tag{22}$$

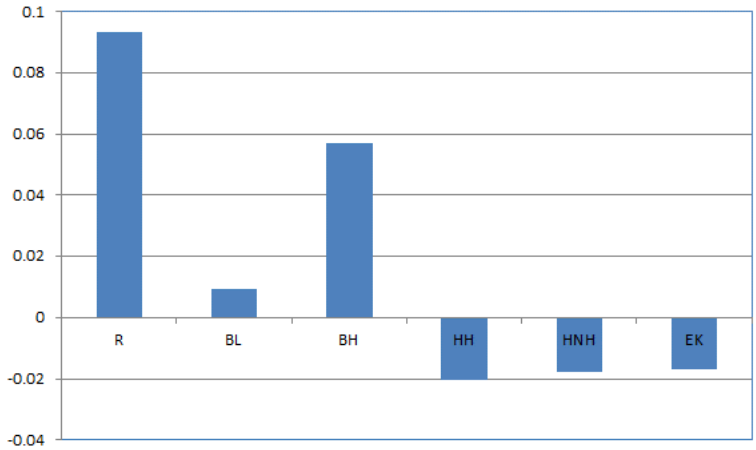
where $c_t^{i,s}$, $x_t^{i,s}$, n_{t-1}^s and l_{1t}^s denote consumption, housing, employment rate and hours per worker, respectively, under a fiscal shock. We calculate the welfare cost Δ^i associated with a fiscal measure as the fraction of steady state consumption that a household would be willing to give up in order to be as well off after the fiscal shock. That is,

$$V^{i,s} = \sum_{t=0}^{\infty} (\beta^i)^t \left[\begin{array}{c} \ln\left[\overline{c}_t^i\left(1-\Delta^i\right)\right] + \phi_x^i \ln\left(\overline{x}_t^i\right) + \overline{n}_{t-1}\phi_1 \frac{(1-\overline{l}_{1t})^{1-\eta}}{1-\eta} \\ +(1-\overline{n}_{t-1})\phi_2 \frac{(1-\overline{l}_2)^{1-\eta}}{1-\eta} \end{array} \right]. \tag{23}$$

Thus, from (22) and (23):

$$\Delta^i = 1 - \exp\{\left(V^{i,s} - \overline{V}^i\right)\left(1-\beta^i\right)\} \tag{24}$$

where a negative value for Δ implies a welfare gain.



Welfare effects by household category

Welfare effects across time by household category

Figure 4: *Welfare effects.*

The upper panel in Figure 4 shows that the effect in terms of welfare derived from the increase in government spending in our model (i.e. using the household shares in the benchmark calibration) is actually very heterogeneous among households. There is a drop in aggregate welfare that affects basically Ricardians and borrowers with house tenure (much more to *BH* households than to *BL* households). Both types of hand-to-mouth individuals (*HH* and *HNH* households) and Eggertsson-Krugman type households, on the contrary, improve slightly as a consequence of the measure.

Putting the observed population shares we get from PSID into the model, we can observe in the lower panel of Figure 4 that fiscal expansions would have benefited all types of consumers from 1999 to 2013, with the exception of the wealthiest (R and BH) household's groups. The benefit in terms of consumption units from fiscal expansions increases considerably after 2007, mainly for the poorest categories (HH, HNH and EK households).

The main message arising from our welfare result is that fiscal policy may generate a non negligible welfare distributional response, even under the assumption that government spending does not directly affect preferences. The way in which each household welfare is affected depends very much on her position in the financial market, in other words on her balance sheets. By the same token, and related with the current austerity debate, our results point towards important welfare effects of fiscal consolidations that could harm the most the less favoured part of the population.

6. Concluding remarks

We have introduced an otherwise standard New Keynesian DSGE augmented to allow for some degree of heterogeneity in the population. More specifically we focus on the presence of individuals with different connections with the financial market, that generate heterogeneity in their balance sheet composition. To facilitate the theoretical analysis of the effect of wealth on consumption, we abstract from differences in labor income. The categories of households that we consider match some of the most popular ones in the literature along with some others that have attracted much attention recently: Ricardians, rule-of-thumbers, mortgagors with high or low capacity of borrowing, hand-to-mouthers with illiquid wealth (real estate) but no liabilities, and Eggertsson-Krugman consumers, who can borrow but have not real estate to collateralize their debt that has to be guaranteed with expected future income.

We have studied several issues related to the economy's response to fiscal shocks under different assumptions concerning the structure of individual balance sheets in the economy. Then we have taken a closer look at the some of the most salient features of this structure for the US economy, using the Panel Study of Income Dynamics (PSID). We conclude that while the distribution of households is fairly stable for most of the types, the share of Ricardians significantly declines during the Great Recession and its aftermath while the share of Eggertsson-Krugman consumers increases. Given that the consumption response to a fiscal shock by Eggertsson-Krugman consumers is the largest, our estimates suggest that the fiscal multiplier grows more than 30% between 2005 and 2013.

We show that matching stylised facts regarding households finances is key to understand the reaction of economies to fiscal shocks. There are a number of relevant conclusions that can be drawn from our analysis. First, the marginal propensity to consume is negatively related with the net worth. Second, the size of the fiscal effect is positively correlated with *ex ante* wealth inequality. Third, changing the composition of the population importantly affects the aggregate marginal propensity to consume and the output multiplier. Fourth, fiscal shocks have non negligible distributional effects that are reflected not only in size but also in the sign of welfare changes for different segments of the population.

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Appendix 1: The complete model

A.1 Households' problems equations

First order conditions:

$$\lambda_{1t}^{i} = \frac{1}{c_t^i} \qquad i = \{R, HNH, HH, BL, BH, EK\} \tag{1.1}$$

$$\frac{\lambda_{2t}^{R}}{\lambda_{1t}^{R}} = \beta^R E_t \frac{\lambda_{1t+1}^{R}}{\lambda_{1t}^{R}} \left\{ r_{t+1} + \delta + \frac{\phi}{2} \frac{j_{t+1}^{R2}}{k_t^{R2}} + \frac{\lambda_{2t+1}^{R}}{\lambda_{1t+1}^{R}} (1-\delta) \right\} \tag{1.2}$$

$$\lambda_{2t}^{R} = \lambda_{1t}^{R} \left[1 + \phi \left(\frac{j_t^R}{k_{t-1}^R} \right) \right] \tag{1.3}$$

$$\lambda_{1t}^{R} = \beta^R E_t \lambda_{1t+1}^{R} \left\{ \frac{1 + r_t^n}{1 + \pi_{t+1}} \right\} \tag{1.4}$$

$$\lambda_{1t}^{i} = \beta^i E_t \lambda_{1t+1}^{i} \left(\frac{1 + r_t^n}{1 + \pi_{t+1}} \right) + \mu_t^i (1 + r_t^n) \qquad i = \{BL, BH, EK\} \tag{1.5}$$

$$\lambda_{1t}^{R} q_t = \frac{\phi_x^R}{x_t^R} + \beta^R E_t q_{t+1} \lambda_{1t+1}^{R} \tag{1.6}$$

$$\lambda_{1t}^{i} q_t = \frac{\phi_x^i}{x_t^i} + \mu_t^i m^i E_t q_{t+1} (1 + \pi_{t+1}) + \beta^i E_t q_{t+1} \lambda_{1t+1}^{i} \qquad i = \{BL, BH\} \tag{1.7}$$

$$\lambda_{1t}^{HH} q_t = \frac{\phi_x^{HH}}{x_t^{HH}} + \beta^{HH} E_t q_{t+1} \lambda_{1t+1}^{HH} \tag{1.8}$$

$$\begin{aligned} \lambda_{ht}^{i} &= \lambda_{1t}^{i} w_t l_{1t} + \left(\phi_1 \frac{(1 - l_{1t})^{1-\eta}}{1-\eta} - \phi_2 \frac{(1 - l_2)^{1-\eta}}{1-\eta} \right) \\ &\quad + (1 - \sigma - \rho_t^w) \beta^i E_t \lambda_{ht+1}^{i} \qquad i = \{R, HNH, HH, BL, BH, EK\} \end{aligned} \tag{1.9}$$

Constraints:

$$c_t^i + q_t\left(x_t^i - x_{t-1}^i\right) = -(1+r_{t-1}^n)\left(\frac{b_{t-1}^i}{1+\pi_t}\right) + w_t n_{t-1}^i l_1 + b_t^i + trh_t \qquad i=\{BL,BH,EK\} \tag{1.10}$$

$$c_t^{HNH} = w_t n_{t-1}^{HNH} l_1 + trh_t \tag{1.11}$$

$$c_t^{HH} + q_t\left(x_t^{HH} - x_{t-1}^{HH}\right) = w_t n_{t-1}^{HH} l_1 + trh_t \tag{1.12}$$

$$b_t^i \leq m^i E_t\left(\frac{q_{t+1}\left(1+\pi_{t+1}\right)x_t^i}{1+r_t^n}\right) \qquad i=\{BL,BH\} \tag{1.13}$$

$$b_t^{EK} \leq \left[m^{EK} E_t\left(\frac{\left(1+\pi_{t+1}\right)w_{t+1} n_t^{EK} l_{1t+1}}{1+r_t^n}\right)\right] \tag{1.14}$$

$$k_t^R = j_t^R + (1-\delta)k_{t-1}^R \tag{1.15}$$

$$\begin{aligned} n_t^i &= (1-\sigma)n_{t-1}^i + \rho_t^w(1-n_{t-1}^i) \qquad (1.16)\\ &= (1-\sigma)n_{t-1}^i + \chi_1 v_t^{\chi_2}\left[\left(1-n_{t-1}\right)l_2\right]^{1-\chi_2} \qquad i=\{R,HNH,HH,BL,BH,EK\} \end{aligned}$$

A.2 Aggregation

$$c_t = \tau^R c_t^R + \tau^{HNH} c_t^{HNH} + \tau^{HH} c_t^{HH} + \tau^{BL} c_t^{BL} + \tau^{BH} c_t^{BH} + \tau^{EK} c_t^{EK} \tag{1.17}$$

$$n_t = \tau^R n_t^R + \tau^{HNH} n_t^{HNH} + \tau^{HH} n_t^{HH} + \tau^{BL} n_t^{BL} + \tau^{BH} n_t^{BH} + \tau^{EK} n_t^{EK} \tag{1.18}$$

$$\tau^{BL} b_t^{BL} + \tau^{BH} b_t^{BH} + \tau^{EK} b_t^{EK} + \tau^R b_t^R = 0 \tag{1.19}$$

$$\tau^{HH}x_t^{HH}+\tau^{BL}x_t^{BL}+\tau^{BH}x_t^{BH}+\tau^{R}x_t^{R}=X \tag{1.20}$$

$$k_t=\tau^R k_t^R \tag{1.21}$$

$$j_t=\tau^R j_t^R \tag{1.22}$$

$$d_t=-\tau^R d_t^R \tag{1.23}$$

A.3 Firms

$$\pi_t=\gamma^f E_t\pi_{t+1}+\varrho\widehat{mc}_t+\gamma^b\pi_{t-1} \tag{1.24}$$

$$mc_t=\overline{mc}(1+\widehat{mc}_t) \tag{1.25}$$

$$r_t=(1-\alpha)mc_t\frac{y_t}{k_{t-1}} \tag{1.26}$$

$$y_t=Ak_{t-1}^{1-\alpha}(n_{t-1}l_{1t})^{\alpha} \tag{1.27}$$

$$\lambda_{ft}=\alpha mc_t\frac{y_t}{n_{t-1}}-w_t l_{1t}+(1-\sigma)\beta^R E_t\frac{\lambda_{1t+1}^R}{\lambda_{1t}^R}\lambda_{ft+1} \tag{1.28}$$

$$\begin{aligned}\kappa_v v_t &= \rho_t^f v_t\beta^R E_t\frac{\lambda_{1t+1}^R}{\lambda_{1t}^R}\lambda_{ft+1}\\ &= \chi_1 v_t^{\chi_2}\left[(1-n_{t-1})\,l_2\right]^{1-\chi_2}\beta^R E_t\frac{\lambda_{1t+1}^R}{\lambda_{1t}^R}\lambda_{ft+1}\end{aligned} \tag{1.29}$$

$$\rho_t^f = \frac{\chi_1 v_t^{\chi_2} \left[(1 - n_{t-1})\, l_2 \right]^{1-\chi_2}}{v_t} \tag{1.30}$$

A.4 Bargaining in the labour market

$$\begin{aligned}
w_t l_{1t} = \lambda^w \left(\alpha mc_t \frac{y_t}{n_{t-1}} + \frac{\kappa_v v_t}{(1 - n_{t-1})} \right) \\
+(1-\lambda^w) \left[\left(\frac{\tau^R}{\lambda_{1t}^R} + \frac{\tau^{HNH}}{\lambda_{1t}^{HNH}} + \frac{\tau^{HH}}{\lambda_{1t}^{HH}} + \frac{\tau^{BL}}{\lambda_{1t}^{BL}} + \frac{\tau^{BH}}{\lambda_{1t}^{BH}} + \frac{\tau^{EK}}{\lambda_{1t}^{EK}} \right) \left(\phi_2 \frac{(1-l_2)^{1-\eta}}{1-\eta} - \phi_1 \frac{(1-l_{1t})^{1-\eta}}{1-\eta} \right) \right] \\
+(1-\lambda^w)(1-\sigma-\rho_t^w)\tau^{HNH} E_t \frac{\lambda_{ht+1}^{HNH}}{\lambda_{1t+1}^{HNH}} \left(\beta^R \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R} - \beta^{HNH} \frac{\lambda_{1t+1}^{HNH}}{\lambda_{1t}^{HNH}} \right) \\
+(1-\lambda^w)(1-\sigma-\rho_t^w)\tau^{HH} E_t \frac{\lambda_{ht+1}^{HH}}{\lambda_{1t+1}^{HH}} \left(\beta^R \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R} - \beta^{HH} \frac{\lambda_{1t+1}^{HH}}{\lambda_{1t}^{HH}} \right) \\
+(1-\lambda^w)(1-\sigma-\rho_t^w)\tau^{BL} E_t \frac{\lambda_{ht+1}^{BL}}{\lambda_{1t+1}^{BL}} \left(\beta^R \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R} - \beta^{BL} \frac{\lambda_{1t+1}^{BL}}{\lambda_{1t}^{BL}} \right) \\
+(1-\lambda^w)(1-\sigma-\rho_t^w)\tau^{BH} E_t \frac{\lambda_{ht+1}^{BH}}{\lambda_{1t+1}^{BH}} \left(\beta^R \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R} - \beta^{BH} \frac{\lambda_{1t+1}^{BH}}{\lambda_{1t}^{BH}} \right) \\
+(1-\lambda^w)(1-\sigma-\rho_t^w)\tau^{EK} E_t \frac{\lambda_{ht+1}^{EK}}{\lambda_{1t+1}^{EK}} \left(\beta^R \frac{\lambda_{1t+1}^R}{\lambda_{1t}^R} - \beta^{EK} \frac{\lambda_{1t+1}^{EK}}{\lambda_{1t}^{EK}} \right)
\end{aligned} \tag{1.31}$$

$$\alpha mc_t \frac{y_t}{n_{t-1} l_{1,t}} = \left[\frac{\tau^R}{\lambda_{1t}^R} + \frac{\tau^{HNH}}{\lambda_{1t}^{HNH}} + \frac{\tau^{HH}}{\lambda_{1t}^{HH}} + \frac{\tau^{BL}}{\lambda_{1t}^{BL}} + \frac{\tau^{BH}}{\lambda_{1t}^{BH}} + \frac{\tau^{EK}}{\lambda_{1t}^{EK}} \right] \phi_1 (1 - l_{1t})^{-\eta} \tag{1.31}$$

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

A.5 Policy instruments and resources constraint

$$y_t = c_t + j_t \left(1 + \frac{\phi}{2} \left(\frac{j_t}{k_{t-1}} \right) \right) + g_t + \kappa_v v_t \tag{1.32}$$

$$1 + r_t^n = \left(1 + r_{t-1}^n\right)^{r_R} \left((1 + \pi_t)^{1+r_\pi} \left(\frac{y_t}{\overline{y}} \right)^{r_y} (1 + \overline{r}^n) \right)^{1-r_R} \tag{1.33}$$

$$d_t = g_t + trh_t + \frac{(1 + r_{t-1}^n)}{1 + \pi_t} d_{t-1} \tag{1.34}$$

$$trh_t = trh_{t-1} - \psi_1 \left[\frac{b_t}{y_t} - \overline{\left(\frac{b}{y} \right)} \right] - \psi_2 \left[\frac{b_t}{y_t} - \frac{b_{t-1}}{y_{t-1}} \right] \tag{1.35}$$

Appendix 2: Income and wealth in the PSID

INCOME

Income of a household contains the following categories:

- Salary
- Dividends
- Rent payments received
- Worker comp
- Trust fund income
- Financial support from relatives
- Financial support from non-relatives
- Child Support Recieved
- Alimony Recieved
- Supplemental security income, temp assistance for needy families (state program), other welfare
- Pensions/annuity
- Lump Sum Payments (Inheritances, itemized deductions)
- Financial Support given to others

WEALTH

Variable *Wealth1* in the PSID includes

- Net value of farm or business assets
- Value of checking accounts, saving accounts, money market funds, certificates of deposit, savings bonds, Treasury Bills, and other IRAS.
- Value of debts other than mortgages (credit cards, student loans, medical or legal bills, personal loans).
- Value of private annuities or IRAs
- Net value of real estate other than main home.
- Value of shares of stock in publicly held corps, mutual funds or investment trusts.
- Net value of vehicle or other assets ’on wheels’.
- Value of other investment in trusts or estates, bond funds, life insurance policies, special collections.

Table A.2.1: PSID Mean Net Liquid Wealth

	1999	2001	2003	2005	2007	2009	2011	2013
R	296,504	316,694	314,569	378,240	450,933	514,652	414,960	412,366
HH	5,943	6,100	4,837	3,922	4,990	1,493	2,165	361
BL	13,165	11,384	12,159	12,376	12,114	11,850	4,817	12,040
BH	8,834	8,335	6,091	5,565	889	901	-2	-1,011
HNH	6,364	6,316	6,678	6,699	7,057	7,320	7,702	8,190
EK	-8,204	-9,037	-11,097	-11,791	-14,117	-17,192	-18,232	-21,114

Table A.2.2: PSID Mean Net Equity

	1999	2001	2003	2005	2007	2009	2011	2013
R	76,138	91,084	104,033	137,898	155,027	135,820	123,491	123,466
HH	55,369	57,978	66,971	80,624	89,727	91,702	92,123	95,953
BL	60,127	78,253	90,757	130,820	142,827	115,423	103,368	105,587
BH	18,304	23,035	24,595	31,878	37,177	16,321	4,943	13,600
HNH	445	0	73	0	0	0	0	0
EK	440	0	0	29	0	0	0	0