DURABLE GOODS, BORROWING CONSTRAINTS AND CONSUMPTION INSURANCE

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Abstract

In this paper we study the transmission of income shocks into nondurable consumption in the presence of durable goods. We use a standard a life-cycle model with two goods to characterize the interaction of durability of goods, durability of shocks, and borrowing constraints as determinants of shock transmission. We show that borrowing constraints lead to a substitution between durable and non-durable goods upon arrival of an unexpected income change. This substitution biases the conventional measures of insurance based on the response of non-durable consumption to income changes. The sign of this bias depends critically on the persistence of the shock. We show that households have less insurance against transitory shocks and more insurance against permanent shocks than commonly measured. We calibrate the model economy to the US in order to measure the size of this bias.

Keywords: Consumption insurance, durable goods, incomplete markets, borrowing constraints, persistence of income shocks.

JEL Codes: E21, D91, D12.

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1 Introduction

The standard life-cycle model of consumption under complete markets predicts that households will choose to completely smooth out income fluctuations. As a result, at least since Hall and Mishkin (1982), the response of expenditure on non-durable consumption goods to unexpected income changes has been used to measure the amount of insurance available to private households. For instance, the recent work by Blundell, Pistaferri, and Preston (2008) finds that consumption expenditure hardly reacts to transitory shocks, whereas around 2/3 of permanent income shocks translate into consumption. These facts have been interpreted as households being able to insure almost completely against transitory shocks but not against permanent shocks.

But the use of consumption responses to income shocks as a measure of insurance ignores substitution with durable goods. Yet, there is a growing evidence that expenditure on durable goods reacts much more to unexpected income changes than expenditure in non-durable goods.[1] Therefore, in order to use consumption data to learn about household insurance, we need first to understand the substitution between durable and non-durable goods upon arrival of unexpected income changes.

In this paper we make a first step in this direction and study the response to income shocks of both durable and non-durable consumption goods. In particular, we assume homothetic preferences over the two types of consumption goods, we abstract from adjustment costs in the stock of durable goods, and we focus on the interplay of borrowing constraints and the persistence of shocks. Given these assumptions, we think of durable goods as cars, furniture, home appliances, and the like, but we exclude housing from our main exercise.[2] As it is well known, with homothetic preferences, no adjustment costs in durable goods, and no binding borrowing constraints, a standard consumption model predicts that the optimal composition of the basket between durable and non-durable goods is constant and does not change with income shocks. Hence, the response of non-durable expenditure to income shocks would be a sufficient statistic for the level of insurance. However, as first shown by Chah, Ramey, and Starr (1995), when borrowing constraints bind the ratio of durable to non-durable goods is not constant: households hitting the borrowing constraint shift their consumption basket away from durable goods, as their

[1] See for instance Browning and Crossley (2009), Johnson, McClelland, and Parker (2011), or Aaronson, Agarwal, and French (2011).

[2] Excluding housing from the definition of durable goods is relatively common when studying consumption responses to labor income shocks, see for instance Aaronson, Agarwal, and French (2011). However, it is not the only option. Luengo-Prado (2006), for instance, study a micro model with housing and adjustment costs to analyze the aggregate consumption response to income shocks.

durability is valued less when households would like to bring consumption from the future to the present and cannot do so. Since income changes of different persistence have a different impact on the desired borrowing of households, the presence of borrowing constraints will generate consumption responses that mix lack of insurance with substitution between goods of different durability, the exact mix depending on the persistence of the shock. Therefore, the response of non-durable consumption to income shocks will present a biased measure of insurance.

Our first contribution is to define a new measure of consumption insurance based on the response to income shocks of the whole consumption basket. This allows us to characterize theoretically the bias in the standard measure of insurance based on the response of non-durable consumption only. The size of the bias depends positively on the durability of the goods, negatively on the fraction of the durable goods that can be collateralized, and negatively on the persistence of the income shocks. The sign of the bias depends on the persistence of the income shocks. A positive income innovation that is not too persistent alleviates the borrowing constraint and therefore spurs a rebalancing from non-durable goods towards durable goods. Therefore, the observed weak response of non-durable consumption to transitory income shocks should not be completely interpreted as insurance because part of it is due to the substitution towards durable goods. This leads us to conclude that households have less insurance against transitory shocks than commonly thought. In contrast, when the income innovation is very persistent the sign of the bias can be reversed. This will not happen if a household has an optimal consumption profile that increases over the life-cycle, as then a very persistent positive shock to labor earnings also alleviates the borrowing constraint. However, if a household has a desired consumption profile that falls over time, a permanent income shock makes borrowing constraints more severe and hence the sign of the bias is reversed. The reason is that the household wants to spend today not only the whole increase in current income, but also part of the expected increase in income coming in the next periods. This will indeed be the case in our calibration, and in any calibration that requires the discount rate to be lower than the interest rate. Its main implication is that the response of non-durable consumption due to lack of insurance is magnified by the substitution away from durable goods. Therefore, true insurance against permanent shocks is larger than what is typically measured in the data by the response of non-durable expenditure only. This makes us conclude that the excess smoothness of consumption may even be more puzzling than previously thought.[3]

[3]For an early formulation of the excess smoothness puzzle see Campbell and Deaton (1989)

Our second contribution is to quantify the consumption responses to income changes predicted by a standard life-cycle model of durable and non-durable goods. By doing so, we can measure the size of the bias in previous measures of consumption insurance.

In our main calibration we do find a strong substitution between durable and non-durable goods upon arrival of income shocks, more so for young households (with a head up to 40 years of age) who are more likely to be hitting their borrowing constraints. In particular, the average increase in non-durable consumption as a response to transitory shocks is 20 percent of the income change, and this is 7 percentage points smaller than the response of the stock of durable goods. In contrast, the response of non-durable goods to permanent income shocks is 78 percent, which is 12 percentage points higher than the response of the stock of durable goods. For young households, the transmissions are larger, and the differential in transmission between goods are 12 and 24 percentage points respectively. Hence, transitory shocks generate a sizable rebalancing towards durable goods and permanent shocks generate an even larger rebalancing away from durable goods. These large substitutions translate into non negligible measures of bias in conventional measures of insurance. In particular, for the whole population, insurance against transitory shocks is 1.5 percentage points smaller than when measured from the response of non-durable goods only; for young household it is 2.6 percentage points smaller. In contrast, insurance against permanent shocks is 2.7 percentage points higher for the overall population and 5.2 percentage points higher for young households.

One key aspect of our quantitative analysis is the importance of the borrowing constraints. We have taken a very conservative view in assuming that all household assets are liquid and can be used without any cost to smooth income shocks. However, as argued by Kaplan and Violante (2012), many middle-aged wealthy households may behave as borrowing constrained if the income shocks they suffer are not large enough and their portfolio contains many illiquid assets such as pensions funds or real estate. In our robustness section we explore this possibility, and show that considering illiquid assets may increase substantially the amount of substitution between durable and non-durable goods upon arrival of an income change. This would increase the size of the biases in the typical measures of consumption insurance.

As a final note, it would be interesting to test empirically whether unexpected income changes drive responses in the ratio of non-durable goods and the *stock* of durable goods that are different for constrained and unconstrained households. Testing the rebalancing effect in the data, however, is notoriously difficult. As mentioned above, several authors find that *expenditure* on durables increase (fall) more than expenditure on non-durables upon the arrival of positive (negative) shocks. For instance, Browning and Crossley

(2009) show that among a sample of Canadian unemployed workers, those with lower unemployment benefits reduce expenditure on durable goods more, and do so more for those goods with higher durability. Johnson, McClelland, and Parker (2011) look at the consumer responses to the reception of the checks of the Economic Stimulus Payments of 2008 in the US. They also find the response to be larger for durable goods than for non-durable goods. Aaronson, Agarwal, and French (2011) find that households affected by a minimum wage hike increase expenditure on durables much more than in non-durables, while increasing collateralized debt at the same time. However, this evidence is not easy to interpret. As pointed out by Bils and Klenow (1998), to achieve a given increase in the stock of durables one needs to increase expenditure more when the durability of the good is higher (the depreciation rate lower). Hence, evidence of durable expenditure reacting more to transitory income shocks than non-durable expenditure does not need to reflect a rebalancing of durable and non-durable goods.

The remaining of the paper is organized as follows. We describe the basic model in Section 2 and we calibrate it in Section 3. Then, in Section 4 we discuss how to measure the bias in the conventional measure of insurance to shocks and present our main quantitative findings. In Section 5 we discuss several alternative calibrations. Finally, Section 6 concludes.

2 The Model

We use a standard life-cycle model of consumption with idiosyncratic shocks to labor earnings and borrowing constraints.[4] We add durable goods as in Fernández-Villaverde and Krueger (2011). Durable goods enter the (homothetic) utility function, they serve as partial collateral for borrowing, and they can be adjusted at no cost.

2.1 Timing

Households live for an uncertain life span of at most T periods. The probability of surviving between age t and $t+1$ is given by $\pi_{t,t+1}$, with $\pi_{T,T+1} = 0$. We define $\pi_t = \prod_{j=1}^{t-1} \pi_{j,j+1}$ as the unconditional probability of a newborn surviving up to age t. Their lives are divided in two main periods: working life and retirement. Households are born as working adults, so working life lasts from age $t = 1$ to age $T = T_R$, at which retirement is mandatory. Hence, T_R is the unique retirement age in this economy. From $t = T_R + 1$ to $t = T$, they live as retirees.

[4] The model is quite close to the framework in Kaplan and Violante (2010), and follows a long tradition of similar work as Storesletten, Telmer, and Yaron (2004) or Gourinchas and Parker (2002).

2.2 Preferences and decisions

Households have time-separable preferences defined over streams of consumption of non-durable goods C_t and service flows of durable goods D_t, which are assumed to be proportional to its stock. Time preferences are captured by the discount factor β, so that at any age t households discount the utility of age $t+j$ at a rate $\beta^j \frac{\pi_{t+j}}{\pi_t}$. Under these assumptions, the lifetime objective function of a household is given by

$$E_0 \sum_{t=1}^{T} \beta^{t-1} \pi_t U\left(C_t, D_t\right) \tag{1}$$

We assume CRRA preferences over a CES aggregator of non-durable consumption and services from durable goods:

$$U\left(C_t, D_t\right) = \frac{\left[\gamma C_t^{\epsilon} + (1-\gamma) D_t^{\epsilon}\right]^{\frac{1-\sigma}{\epsilon}}}{1-\sigma}$$

where $\sigma > 0$ measures the degree of risk aversion, $\epsilon < 1$ measures the elasticity of substitution between goods and $0 < \gamma < 1$ captures the weight of each type of consumption in households' preferences.

Households seek to maximize their lifetime utility by choosing each period t how much to spend in non-durable consumption, C_t, how many durable goods to buy (or sell), I_t, and how many financial assets to save (or borrow) for the next period, A_{t+1}, subject to a set of constraints described below.

2.3 Durable goods

The stock of durable goods evolve according to the following law of motion:

$$D_t = (1-\delta) D_{t-1} + I_t \tag{2}$$

where $(1-\delta)$ is the fraction of the end-of-period stock at $t-1$ that remains providing utility at t. Notice that the utility function in (1) depends on the end-of-period stock of durables, D_t, after period t purchases and sales, I_t. Durable goods have a relative price of P, with non-durable goods acting as the numeraire.

2.4 Labor income and pension income

Income while working, Y_t, is given by a stochastic process to be defined below. After age T_R, households receive an age-invariant payment Y_{T_R} from social security. This payment is household-specific and it is made a function of its entire labor income history. At any age, we summarize past earnings history or social security wealth in the variable $H_t = \frac{1}{t}\sum_{j=1}^{t} Y_j$, or recursively:

$$H_t = \frac{(t-1)H_{t-1} + Y_t}{t} \tag{3}$$

Thus, pension payments can be written as a function of H_{T_R}. Making pension payments a function of the history of past income is important. As it will be shown in later sections, the amount of rebalancing between durable and non-durable goods depends on the persistence of the income shocks. And the persistence of the income shocks depends on how much of them is translated into pension income, as well as on the exact nature of the stochastic process.

We assume that the stochastic process governing the log of labor earnings, y_t, can be represented as the sum of a random walk, z_t, a purely transitory shock, ε_t, and a deterministic, age-specific mean, μ_t:

$$\begin{aligned} y_t &= \mu_t + z_t + \varepsilon_t \\ z_t &= z_{t-1} + \eta_t \\ \varepsilon_t &\sim \mathcal{N}(0, \sigma_\varepsilon) \\ \eta_t &\sim \mathcal{N}(0, \sigma_\eta) \\ z_0 &\sim \mathcal{N}(0, \sigma_{z_0}) \end{aligned} \tag{4}$$

where η_t is a permanent shock to labor income.

2.5 Financial assets and borrowing constraints

Households save and borrow through a perfectly competitive annuity market. We denote A_t the amount saved or borrowed in annuities, which yields a constant net return r, and r_t is the age-specific interest rate corrected by survival probabilities, that is, $r_t = (1+r)/\pi_{t,t+1} - 1$. We model borrowing constraints by restricting a measure of end-of-period households' net worth to be above a threshold $\underline{A}_t$. Moreover, the measure of net worth only incorporates the value of the end-of-period stock of durables up to a fraction $0 \leq \theta \leq 1$, implying a limited role of durables as collateral. Hence, financial assets are bounded below by,

$$(1 + r_{t+1})A_{t+1} + \theta\,(1-\delta)\,PD_t \geq \underline{A}_t \tag{5}$$

We consider a general specification for $\underline{A}_t$ reflecting financial market imperfections and heterogeneous borrowing capacity at the same time, by linking $\underline{A}_t$ to the natural borrowing limit. At age t, the lower bound to the present discounted value of labor income is given by

$$\underline{Y}_t + \sum_{j=t+1}^{T} \left(\prod_{k=t+1}^{j} \frac{1}{1+r_k} \right) \underline{Y}_j \tag{6}$$

where $\underline{Y}_j$ denotes the lowest possible income for age j given the information available at age t. Therefore, expression (6) is the maximum amount at age t that can be repaid with probability one, the natural borrowing limit for an agent in the model economy. We can use (6) to define the borrowing limit as

$$\underline{A}_t = -\alpha \left[\underline{Y}_{t+1} + \sum_{j=t+2}^{T} \left(\prod_{k=t+2}^{j} \frac{1}{1+r_k} \right) \underline{Y}_j \right] \tag{7}$$

where $0 \leq \alpha \leq 1$ is the parameter determining the overall tightness of the borrowing constraint. Thus, expression (5) means that the agent's relevant net worth at the beginning of age $t+1$, which is decided at age t, must be equal to or greater than a fraction α of the present value of all the resources it can generate from age $t+1$ to T with certainty.[5]

An extreme case is $\alpha = 0$ and $\theta = 0$, which precludes borrowing altogether. Another interesting case to consider is $\alpha = 0$ and $\theta > 0$, a case in which collateralized debt is the only form of borrowing allowed. The particular case of $\alpha = 0$ and $\theta = 1$ can be rationalized as emerging from a limited commitment setup, in which the penalty for defaulting is the seizure of the whole stock of durables, as in Fernández-Villaverde and Krueger (2011).

An important remark is that the income process specified above allows for realizations of income arbitrarily close to zero at any point in time, albeit with an extremely low probability. Hence, no unsecured debt can be supported by future labor earnings. However, the Social Security system features a minimum, positive level of benefits for any household. In practice, a value of $\alpha > 0$ only enables households to borrow against their future pensions, an arguably odd assumption on borrowing limits. We get back to this point when discussing the calibration of the model in Section 3.

[5]The agent can die before T. However, the discount factor is the corrected interest rate, which incorporates the survival probabilities. Hence, a financial intermediary lending to the continuum of households would always recover the amount lent plus the riskless rate r.

2.6 Period budget constraint

With all the elements defined we can construct the budget constraint during working life as:

$$C_t + PI_t + A_{t+1} \leq (1 + r_t)A_t + Y_t(z_t, \varepsilon_t) \tag{8}$$

and during retirement:

$$C_t + PI_t + A_{t+1} \leq (1 + r_t)A_t + Y^R(H_{T_R}) \tag{9}$$

2.7 Choices

Summing up, households choose the sequences $\{C_t\}_{t=1}^T$, $\{I_t\}_{t=1}^T$, and $\{A_t\}_{t=2}^T$ to maximize (1), subject to a sequence of T_R constraints of the form in (8) and $T - T_R$ constraints of the form in (9), the laws of motion defined by (2) and (3), the borrowing constraints (5), the stochastic process for labor income defined in (4), and some initial conditions A_1, D_0, and z_0.[6]

2.8 State variable transformation

It may be useful to rewrite the period budget constraint in terms of total resources available to the household at a given time, including the amount that it will be able to borrow. Let's define cash on hand at the beginning of period t as:

$$\tilde{X}_t = (1 + r_t)A_t + (1 - \delta)\, PD_{t-1} + Y_t - \frac{\underline{A}_t}{(1 + r_{t+1})} \tag{10}$$

and

$$\tilde{A}_{t+1} = A_{t+1} - \frac{\underline{A}_t}{(1 + r_{t+1})} \tag{11}$$

We can then write the period budget constraint as

$$C_t + PD_t + \tilde{A}_{t+1} \leq \tilde{X}_t \tag{12}$$

Then, we can rewrite (5) as

$$\tilde{A}_{t+1} + \frac{\theta\, (1 - \delta)\, PD_t}{(1 + r_{t+1})} \geq 0 \tag{13}$$

where a negative $\tilde{A}_{t+1}$ can be interpreted as collateralized debt.

[6]From its definition, it is understood that $H_0 = 0$.

2.9 Lagrangian formulation

The problem can be summarized in the following Lagrangian:

$$
\begin{aligned}
L &= E_0 \sum_{t=1}^{T} \beta^t \pi_t U\left(C_t, D_t\right) \\
&+ E_0 \sum_{t=1}^{T} \beta^t \pi_t \mu_t \left[\tilde{X}_t - PD_t - C_t - \tilde{A}_{t+1}\right] \\
&+ E_0 \sum_{t=1}^{T} \beta^t \pi_t \lambda_t \left[\tilde{A}_{t+1} + \frac{\theta\left(1-\delta\right) PD_t}{1+r_{t+1}}\right]
\end{aligned} \tag{14}
$$

where the multiplier λ_t reflects the value of marginally relaxing the borrowing constraint, while μ_t is the standard multiplier associated to the period budget constraint. The first order conditions for an optimum are given by

$$
\begin{aligned}
U_C\left(C_t, D_t\right) &= \mu_t && (15) \\
\beta \pi_{t,t+1}(1+r_{t+1}) E_t\left[\mu_{t+1}\right] &= \mu_t - \lambda_t && (16) \\
\frac{1}{P} U_D\left(C_t, D_t\right) + \beta \pi_{t,t+1}\left(1-\delta\right) E_t\left[\mu_{t+1}\right] &= \mu_t - \lambda_t \frac{\theta\left(1-\delta\right)}{1+r_{t+1}} && (17)
\end{aligned}
$$

Equation (15) equalizes the shadow value of resources within the period to the marginal utility of consumption. Equation (16) is the standard Euler equation that describes the law of motion of the shadow value of wealth. It states that the value of investing one unit of non durable consumption in the financial asset (left hand side) must equal its cost (right hand side). This cost is the shadow value of resources today minus the value of relaxing the borrowing constraint, which is given by the multiplier λ_t. Hence, when the borrowing constraint binds ($\lambda_t > 0$) the expected growth of marginal utilities is lower and the expected consumption growth is higher. Equation (17) drives the choice of durable goods. The left hand side states the value of buying today one unit of the durable good, which is the utility flow of the durable good today plus the value tomorrow of the undepreciated stock. The right hand side is the cost, which is given by the shadow value of the resources used to buy the unit of durable good minus the value of relaxing the borrowing constraint. The value of the durable good in relaxing the borrowing constraint is given by the multiplier λ_t times the fraction of the durable good that can be collateralized, and hence that is useful for this purpose.

2.9.1 Optimal basket of durable and non-durable goods

Combining the optimality conditions contained in equations (15)-(17) we obtain:

$$\frac{U_D\left(C_t, D_t\right)}{U_C\left(C_t, D_t\right)} = \left(\frac{r_{t+1} + \delta + \frac{\lambda_t}{\mu_t}\left(1-\delta\right)\left(1-\theta\right)}{1 + r_{t+1}}\right) P \tag{18}$$

Whenever the borrowing constraint does not bind at t, we have that $\lambda_t = 0$ and this expression reduces to the standard condition

$$\frac{U_D\left(C_t, D_t\right)}{U_C\left(C_t, D_t\right)} = \left(\frac{r_{t+1} + \delta}{1 + r_{t+1}}\right) P \tag{19}$$

This states that the marginal rate of substitution between durable and non-durables is equal to their relative price times the user cost of durables. Hence, the ratio between marginal utilities is independent of individual level variables and will be equalized across households of a given age t. Note that, while an income shock can translate into the growth rate of consumption, it can not have a differentiated impact on each type of goods. The intuition is that, without any restriction to adjust the C_t/D_t ratio, and given the isoelastic nature of the utility function, only the level of consumption bundle reacts to shocks, but not its composition. Thus, including durable goods in this simple manner has no consequences for the study of consumption responses to income shocks. In fact, under the assumed utility function the consumption ratio is given by

$$\left(\frac{C_t}{D_t}\right)^{1-\epsilon} = \frac{\gamma}{1-\gamma}\left(\frac{r_{t+1} + \delta}{1 + r_{t+1}}\right) P \tag{20}$$

and this equation can be used in the Euler equation to derive an expression for non-durable consumption growth as in previous studies that omit durable goods, such as Blundell, Pistaferri, and Preston (2008).

In the case of binding borrowing constraints, this result no longer holds. With $\lambda_t > 0$ the user cost of durables is larger than with $\lambda_t = 0$ and so are the marginal rate of substitution and the ratio C_t/D_t. The new term captures the opportunity cost of the durable good in the future —when consumption has less value than in the present— minus the value of the durable good as collateral. When the borrowing constraint is binding, the value of the $(1-\delta)$ units of the stock of durable good that are left tomorrow falls because the household would like to bring consumption from the future to the present. Hence, it is less worthy to buy a durable good today and the ratio C_t/D_t goes up. However, this effect is partly offset by the collateral services of the durable good, which depend on the fraction $(1-\delta)\,\theta$ that can be collateralized. The more severe the value of the borrowing constraint (higher λ_t/μ_t) and the smaller the value of the durable good as collateral (lower θ), the higher the ratio C_t/D_t. In the limit, if the residual value of the durable good expenditure can be collateralized completely, $\theta = 1$, then the optimal ratio C_t/D_t is as in the case without binding borrowing constraints. In the case that the durable good could be used for non-collateralized loans ($\theta > 1$), then we would have that with binding borrowing constraints the share of durable goods would be larger than in the case without borrowing constraints.

Now, how does the basket of consumption goods change with income shocks? This will depend on how the income shocks affect the severity of the borrowing constraint and hence the ratio of multipliers $\frac{\lambda_t}{\mu_t}$. As we argue in the next subsection, a purely transitory positive shock unequivocally alleviates the borrowing constraint, hence λ_t/μ_t falls and there is a rebalancing towards durable goods and away from non-durable goods. A permanent shock may, but not necesarilly will, have a similar effect. Whether it does or not will depend on the desired path for consumption. In particular, whenever households desire a falling consumption profile over time, a positive permanent shock will have the opposite effect, increasing λ_t/μ_t and leading to a rebalancing towards non-durable goods.

2.10 A model without uncertainty

To understand the role of the persistence of income shcoks let's simplify our model in a few respects. First, household live forever and survival probabilities are equal to one in all periods; second, there is no retirement and labor earnings Y_t are deterministic and given by the recursion $Y_{t+1} = \rho Y_t$ with $1 > \rho > 0$; and third, there are no borrowing constraints. Under these simplifications the optimal basket of durable and non durable goods is given by equation (20). Substituting it into the Euler equation we can obtain an expression for non-durable consumption growth,

$$C_{t+1} = [\beta\,(1+r)]^{1/\sigma}\,C_t$$

Using (20) again we obtain an analogous expression for the stock of durable goods,

$$D_{t+1} = [\beta\,(1+r)]^{1/\sigma}\,D_t$$

And substituting this expression in the law of motion for durables we obtain that expenditure on durable goods must grow at the same rate as the stock:

$$I_{t+1} = [\beta (1+r)]^{1/\sigma} I_t$$

Without liquidity constraints, the relevant resource constraint at any point in time is given by the intertemporal budget constraint

$$\sum_{j=0}^{\infty} (1+r)^{-j} (C_{t+j} + I_{t+j}) = \sum_{j=0}^{\infty} (1+r)^{-j} Y_{t+j} + (1+r) A_t$$

Assuming $1+r > \rho$ and $1+r > [\beta (1+r)]^{1/\sigma}$ we can use the expressions for consumption growth above to write total expenditure in t as a function of income and assets in t,

$$C_t + I_t = \frac{1 - \frac{[\beta(1+r)]^{1/\sigma}}{1+r}}{1 - \frac{\rho}{1+r}} Y_t + \left(1 - \frac{[\beta (1+r)]^{1/\sigma}}{1+r}\right)(1+r) A_t$$

Given the expression for expenditure, we can also write A_{t+1} as a function of Y_t and A_t:

$$A_{t+1} = \frac{[\beta(1+r)]^{1/\sigma} - \rho}{1+r-\rho} Y_t + [\beta(1+r)]^{1/\sigma} A_t \tag{21}$$

This expression allows us to understand the effect on savings of an income increase. If $\rho < [\beta (1+r)]^{1/\sigma}$, the marginal propensity to spend out of an increase in Y_t will be less than one and hence savings in t will increase with Y_t. That is to say, whenever the income growth is less than the desired consumption growth, part of an increase in income today is saved and spread over future periods. As we increase income growth ρ (or decrease the desired consumption growth $[\beta (1+r)]^{1/\sigma}$) the marginal propensity to consume becomes larger and hence savings increase less. Whenever $\rho > [\beta (1+r)]^{1/\sigma}$ an income increase today generates a larger increase in expenditure than in income, and hence a reduction in savings or an increase in borrowing. The reason for this is that the income increase today implies an income growth larger than the desired consumption growth and hence the households want to borrow part of the increase in future income and spend it today.

Now consider the case in which borrowing (saving) is constrained to be below (above) a threshold. Specifically, let the constraint be of the form $A_{t+1} \geq \underline{A}$, and let A^*_{t+1} denote the unconstrained level of assets as defined in (21). In this setup, a household will be unconstrained as long as $A^*_{t+1} - \underline{A} > 0$. The difference $A^*_{t+1} - \underline{A}$ will increase with Y_t when $\rho < [\beta (1+r)]^{1/\sigma}$, that is to say, for any given state (A_t, D_{t-1}) , a sufficiently high Y_t

will render the household unconstrained. On the other hand, whenever $\rho > [\beta(1+r)]^{1/\sigma}$, the difference $A^*_{t+1} - \underline{A}$ will decrease with Y_t. In this case, a household of given state (A_t, D_{t-1}) will be *constrained* (unconstrained) for a sufficiently *large* (low) level of Y_t.

Let's now map these results into the full model with life cycle and uncertainty. A purely transitory income shock ($\rho = 0$) increases desired savings, and hence it alleviates the borrowing constraints in case they were binding. By alleviating the borrowing constraints the desired ratio C_t/D_t falls. As we consider more persistent income shocks, the household wants to spend a larger fraction of today's income increase because the higher persistence implies that income will also grow in the coming periods. Hence, desired savings increase less and there is a smaller reduction in the severity of the borrowing constraint. As a result, the rebalancing between C_t and D_t is also smaller. Finally, whenever the income shocks have a large persistence, future income increases almost as much as current income. If the desired consumption growth is less than the persistence of the shock, the household will like to borrow against future income and increase expenditure today more than the income increase. When borrowing constraints are binding this makes them more severe and hence the ratio C_t/D_t goes up.

3 Calibration

Our quantitative exercise is the following. We want to choose values for the key parameters β, γ, δ, and θ such that the model is consistent with the key facts of overall wealth accumulation, expenditure share on durable goods, aggregate ratio of expenditure to stocks of durable goods, and collateralized borrowing in durable goods. The remaining parameters are measured directly from the data or fixed to standard values. Then, we will ask the model its predictions for the life-cycle profiles of the transmission coefficients of income shocks to expenditures and we will assess quantitatively how much of the transmission is due to rebalancing between durable and non-durable goods and how much is due to lack of insurance.

3.1 Data

We use three main data sources at the household level: the Panel Study of Income Dynamics (PSID), the Consumer Expenditure Survey (CEX), and the Survey of Consumer Finance (SCF). Our PSID sample corresponds to the one contained in the Blundell, Pistaferri, and Preston (2008) CEX-PSID imputed dataset. As for the CEX, we work with two datasets: the quarterly panel used in Heathcote, Perri, and Violante (2010), and the series of annual cross-sections described in Harris and Sabelhaus (2000). Unless stated otherwise, the reference period is 1980-1992, the time interval covered by Blundell, Pistaferri, and Preston (2008).

We classify the different expenditure categories in the CEX as either durable or non-durable. Durable goods include cloth, jewelry, furniture, household appliances, vehicles and spare parts, books, and sport and recreational equipment, but exclude housing. Non-durables include food and other household supplies, household utilities, services, public transport fees, fuel and tolls and education expenditures.[7] We exclude health expenditures from the analysis.[8] We also use aggregate data on durables from the 2011 revision of *Fixed Reproducible Tangible Wealth* by the Bureau of Economic Analysis. Our definition of durables in the aggregate data closely follows the one in the micro data, and it's basically obtained from subtracting therapeutic equipment from the total stock of consumer durables.

3.2 Timing and demographics

A period is a year. We assume households are born to working life at age 25 and retire at age 60. Certain death takes place at age 95. This implies $T_R = 35$ and $T = 70$. The survival probabilities are a decreasing function of age, following the *National Center for Health Statistics life tables* for 1989-1991. We use the age-specific mortality rates for the whole population.

3.3 Preferences

Our utility function has three parameters to be set: ϵ, which captures the elasticity of substitution between goods; σ, which measures the coefficient of relative risk aversion; and γ, which measures the weight of nondurable goods. In addition, we have the intertemporal discount factor β. We set σ to 2, as widely used in the literature. We also fix $\epsilon = 0$, implying a Cobb-Douglas aggregator for durables and nondurables. We do this on empirical grounds, following the evolution of expenditure shares over time in the US. The relative price of durable goods to non-durable goods has fallen steadily at least for the last 40 years, whereas the share of durables to nondurables has remained stable over time, a feature consistent with a unit elasticity of substitution between goods. The attempts to

[7] Cloth is considered a semi-durable, and has often been included among nondurables in previous studies. Treating it as nondurable has no effect in our quantitative exercise.

[8] In principle, education could also be excluded from non-durable consumption, as it can constitute a form of investment rather than consumption. We kept it in our measure of consumption to use a consistent definition across datasets, since we observed it separately in the annual CEX sample, but not in the quarterly panel taken from Heathcote, Perri, and Violante (2010).

estimate the elasticity of substitution between durables and nondurables using micro data also support the specification that the time series evolution of aggregate data suggests. Most studies cannot reject the hypothesis of $\epsilon = 0$.[9] The remaining parameters, γ and β, are calibrated in equilibrium as detailed below.

3.4 Income process

We calibrate the earnings process to replicate the main features of earnings dispersion in the PSID data.[10] The deterministic component is set to mimic the average age profile of after-tax earnings. Following Kaplan and Violante (2010), we choose the variance of the permanent shock to match the increase in earnings dispersion over the life cycle. We have 2 parameters left to match the level of the variance, $\sigma^2_{z_0}$ and σ^2_{ε}. We fixed the proportion between the variance of transitory shocks and permanent shocks to 5, the one implied by the calibration in Kaplan and Violante (2010). The initial variance of the permanent component of income is then set so as to replicate the variance of dispersion of earnings at 25.

3.5 Technology parameters

The return to savings r is set to 3%. The pension benefits are a concave function of average working life earnings, explicitly capturing the progressivity of the U.S. social security system. This function is characterized by a minimum, positive level of benefits, a maximum level of benefits, and a piecewise-linear function of average earnings in between. The specific bend points and replacement rates are taken from Storesletten, Telmer, and Yaron (1999).[11] The depreciation rate, δ, and the fraction of durable goods that can be used as collateral, θ, are calibrated in equilibrium, as explained below.

In our baseline calibration we set $\alpha = 0$, which precludes unsecured debt. As previously discussed, the availability of unsecured debt in the context of this model depends mostly (through the natural borrowing limit) on the income process specified. The log-normality assumption implies the possibility of arbitrarily small labor income endowments, and hence it restricts the natural borrowing limit to be equal to the present discounted value of pension benefits (which has a positive lower bound given by the existence of a minimum

[9]See Fernández-Villaverde and Krueger (2011) for a summary of empirical estimates of this parameter.

[10]We work with the variance of *residual* earnings, which are obtained from a regression of log earnings on a number of controls, including time and age dummies.

[11]Storesletten, Telmer, and Yaron (1999) report the actual figures in 1993 dollars and the relative values with respect to GNP per capita. Our model generates relative values in line with the latter, using total household income to measure GNP, since we don't model production.

benefit). We find this channel for unsecured debt as an artifact of the model, rather than as a meaningful economic mechanism, and hence choose to switch it off.[12] In the robustness section we check for the effects of $\alpha > 0$.

3.6 Parameters calibrated in equilibrium

We choose γ, β, δ, and θ to match a set of cross-sectional statistics measured from US data. Table 1 summarizes the targets and sources used, as well as the calibration outcomes. In particular, we target the average durables to non-durables expenditure ratio in the Consumer Expenditure Survey (CEX); the average wealth to income ratio in the Survey of Consumer Finance (SCF); the ratio between aggregate expenditure on durables and the aggregate stock of consumer durables reported in *Fixed Reproducible Tangible Wealth* as computed by Campbell and Hercowitz (2003); and the average fraction of durable goods purchases which are self-financed in the CEX. Wealth is defined as total net worth and income as total (labor and financial) income both in the data and in the model.

Although these parameters are chosen jointly to match the targets in Table 1, we can link each of them to a statistic that is particularly informative about its value. The discount factor β is a key driver of wealth accumulation over the life cycle. The taste parameter γ governs the average relative consumption of durables and nondurables. The depreciation rate δ determines the expenditure necessary to maintain a constant stock of durable goods over time. Hence, with a stationary population, the ratio of aggregate expenditures to the aggregate stock of durables is driven by this parameter.

A key parameter in our analysis is θ, which captures the extent to which durable goods can be used as collateral for borrowing. As discussed above, the rebalancing in the consumption basket of constrained households is decreasing in θ, disappearing when $\theta = 1$. We exploit the information available in the CEX on new loans acquired to purchase vehicles. In particular, for each household with positive expenditure on durable goods, we divide the amount borrowed to purchase vehicles by total expenditure on durable goods. We take the average value of this ratio across households as a measure of the extent to which durable goods are self-financed. This calculation delivers a value of 0.10. The value of θ is determined in equilibrium to match this number, since in the model the amount of debt generated by a purchase of durables is $\theta\frac{(1-\delta)}{1+r}I$.

We also calibrate a version of the model without durable goods. In this case, θ, δ,

[12]With $\alpha > 0$ the young would have less access to unsecured credit than the old because the present discounted value of their pensions is smaller. Moreover, households with a long history of positive shocks can accumulate Social Security claims substantially above the minimum level, even if they receive extremely low income realizations in the remainder of their working lives.

Table 1: Calibration targets and results

Parameter	Value	Target	Model	Data
(a) Common				
σ	2			
r	3%			
σ_{ε}^2	0.05			
σ_{η}^2	0.01			
$\sigma_{z_0}^2$	0.15			
(b) With durables				
β	0.9294	average W/Y (SCF)	2.5001	2.5000
γ	0.7852	average I/C (CEX)	0.2444	0.2444
δ	0.1292	aggregate I/D (BEA)	0.1406	0.1400
θ	0.1183	average $\theta\frac{(1-\delta)}{1+r}$ (CEX)	0.1000	0.1000
(c) Without durables				
β	0.9426	average W/Y (SCF)	2.4999	2.5000

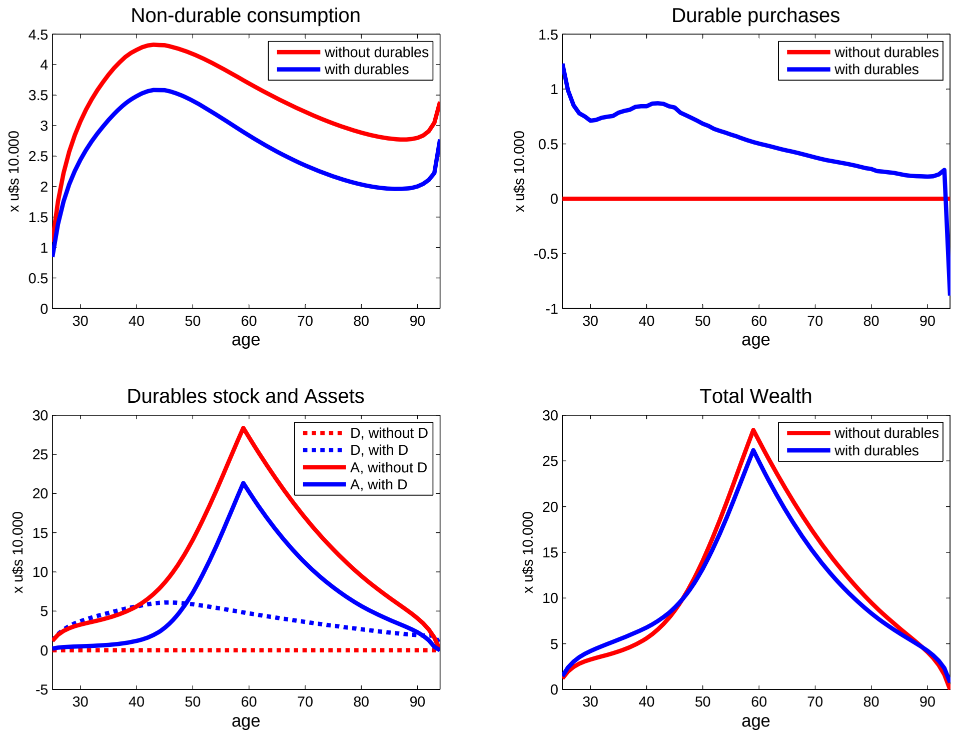
and γ are absent. However, β need to be recalibrated in order to keep wealth profiles in accordance with data.

3.7 Simulated life cycle profiles

Figure 1 shows the average life cycle profile for the main variables in our model, expressed in tens of thousands of dollars. Red lines depict the profiles emerging from the model without durable goods, while the blue lines represent our baseline model with durables. In the top left panel, we can see the characteristic hump shape of consumption expenditure, as documented in Fernández-Villaverde and Krueger (2006). The top right panel shows a much smaller hump in expenditure on durable goods. It also illustrates the incentive to accumulate durable goods early in life, with high levels of expenditure at young ages. The bottom panels show the evolution of wealth and its composition over the life cycle. Total household wealth is shown in the bottom right panel, where it can be seen that households start to accumulate wealth slightly later in life if durables are omitted. However, as the bottom left panel shows, the biggest difference between the two models is in the composition of wealth. Households build up a stock of durables at early stages of the life cycle (dotted blue line), while they accumulate financial assets in the model without durables (solid red line). In contrast, the average level of financial assets held by households is considerably lower in the model with durables (solid blue line), and it is in fact very close to zero during a large portion of the working life.

The life-cycle profiles generated by the model are roughly in line with previous findings

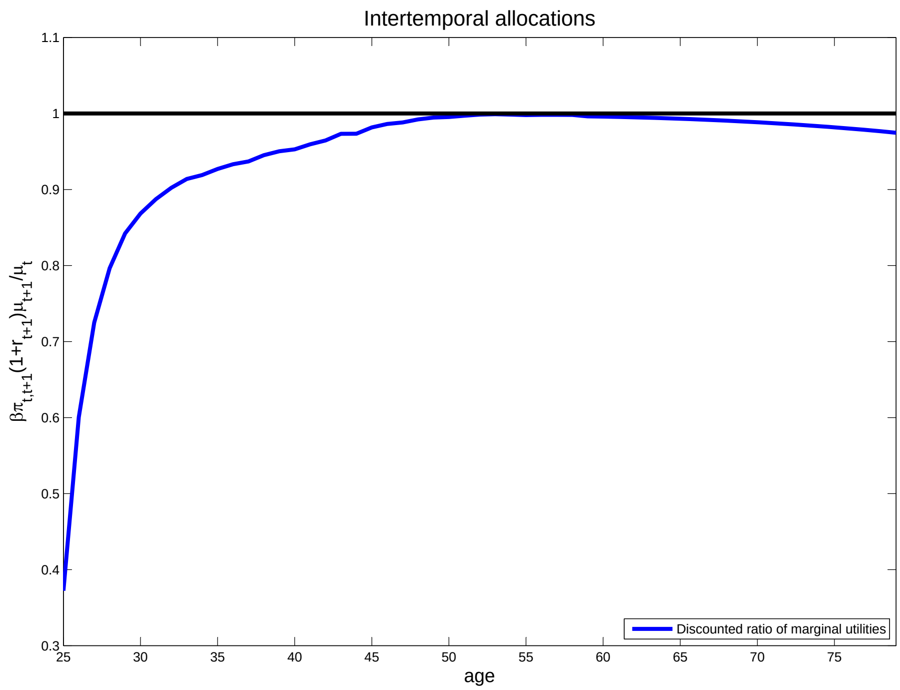
Figure 1: Average Life Cycle Profiles



in the literature. In particular, nondurable consumption peaks around 45 years of age, as documented by Gourinchas and Parker (2002) and Fernández-Villaverde and Krueger (2006).[13] Also in line with Gourinchas and Parker (2002), consumption anticipates the peak in income (not shown), which happens at around 55. However, the size of the hump in non-durable consumption exceeds the empirical counterparts. Nondurable consumption more than doubles between age 25 and the peak, compared to the estimated increase of 25% in Fernández-Villaverde and Krueger (2006) or 50% in Gourinchas and Parker (2002). A similar pattern is observed for expenditure on durable goods, apart from an initial spike in durables expenditure, as our households are born without any durables. This feature is also present in Fernández-Villaverde and Krueger (2011), who build a very similar model. After the initial period, expenditure on durables is hump-shaped, resembling the empirical findings of Fernández-Villaverde and Krueger (2006) in terms of timing of the hump, the peak being approximately 60% higher than the minimum, in contrast with the estimated

[13]Fernández-Villaverde and Krueger (2006) find, however, that the timing of the hump in consumption is sensitive to the equivalence scale chosen to compare households of different sizes.

Figure 2: Intertemporal allocations



33%. Total expenditure inherits the excessive hump of its components: the increase in total expenditure is above 100% in the model, compared to the 30% in estimated by Gourinchas and Parker (2002) and Fernández-Villaverde and Krueger (2006). Wealth accumulation follows the characteristic pattern in this family of models, with most of the asset accumulation taking place near retirement. In particular, the evolution of wealth in the model without durable goods is comparable to the zero borrowing limit case in Kaplan and Violante (2010), while the wealth composition in the economy with durables shares the main features of the zero borrowing limit case in Fernández-Villaverde and Krueger (2011).[14]

Figure 2 illustrates the incidence of borrowing constraints over the life cycle. This is important to our analysis, since the effect that we are trying to measure arises when borrowing constraints are binding. Specifically, Figure 2 depicts the cross-sectional average by age of the ex-post discounted ratio of marginal utilities, $\beta\pi_{t,t+1}(1+r_{t+1})\frac{\mu_{t+1}}{\mu_t}$. This is

[14] In that exercise, Fernández-Villaverde and Krueger (2011) preclude borrowing altogether, while we allow for collateralized lending. However, our calibrated down payment $1-\theta$ is almost 0.9, which restricts lending substantially. Their main exercise aims to encompass housing as well as smaller durables, hence allowing for full collateralization of durables. Another important difference in terms of wealth accumulation is the absence of a pension system in their model.

just an ex-post version of the Euler equation, and should be equal to 1 in the absence of binding borrowing constraints. We can see that largest deviations from the optimal intertemporal allocation of consumption are concentrated among young households. By the age of 45, the borrowing constraint is not binding for most households, and, on average, no significant deviation from the desired allocations are observed. At later stages of retirement life borrowing constraints become binding again for some households, as their degree of impatience makes them optimally deplete their stocks of assets before T.[15]

4 The transmission of shocks and the measure of insurance

Let c_{it} be log non durable consumption for household i at age t and d_{it} be log durable consumption for household i at age t. Following Blundell, Pistaferri, and Preston (2008), we define the transmission coefficients for the shock x_{it} as

$$\begin{aligned}\phi_x^c &= \frac{cov\left(\Delta c_{it}, x_{it}\right)}{var\left(x_{it}\right)} \\ \phi_x^d &= \frac{cov\left(\Delta d_{it}, x_{it}\right)}{var\left(x_{it}\right)}\end{aligned}$$

These coefficients measure the proportional change in each consumption good that comes as a response to shocks. ϕ_x^c has been used as a measure of (lack of) insurance because it measures the change in marginal utility of consumption —expressed back in consumption units— in a model without durables.[16] In particular, if the utility function was given by $u\left(C\right) = \frac{C^{1-\sigma}-1}{1-\sigma}$, then

$$\phi_x^c = \frac{cov\left(\Delta c_{it}, x_{it}\right)}{var\left(x_{it}\right)} = \frac{cov\left(\Delta \log\left(\frac{\partial u(C_{it})}{\partial C_{it}}\right)^{-\frac{1}{\sigma}}, x_{it}\right)}{var\left(x_{it}\right)}$$

The change in the marginal utility is a good measure of lack of insurance in a one-good model because under complete markets households choose to equalize marginal utilities across states of the world. However, in a two-good model the marginal utility of one good may remain almost unchanged while the marginal utility of the other good changes substantially. This will happen whenever there is rebalancing from one good to the other,

[15] The quick deaccumulation of assets during retirement is known to be strongly counterfactual, see for instance Nakajima and Telyukova (2011). Since we focus on the transmission of income shocks during working life, we abstract from motives to save during retirement, such as health uncertainty or intentional bequests.

[16] See for instance Blundell, Pistaferri, and Preston (2008) and Kaplan and Violante (2010).

and the use of changes in the marginal utility will give us different measures of insurance depending on which good we look at.

To come up with a measure of lack of insurance that can be used in the two-good model as well as in the one-good model we consider the transmission of income shocks into the consumption basket $V = C^{\gamma} D^{1-\gamma}$,

$$\phi_x^v = \frac{cov\left(\Delta v_{it}, x_{it}\right)}{var\left(x_{it}\right)} = \phi_x^c + (1-\gamma)\left(\phi_x^d - \phi_x^c\right)$$

where v_{it} is the logarithm of V_{it}. Equation (20) above shows that in absence of binding borrowing constraints $c_{it} - d_{it}$ is independent from shocks. Hence, $\phi_x^c - \phi_x^d = 0$ for both shocks and $\phi_x^v = \phi_x^c$. In that case, the transmission coefficient of non-durable consumption is a correct measure of lack of insurance. Instead, when the borrowing constraints bind, equation (18) shows that $\phi_x^d - \phi_x^c > 0$ if the shock x_{it} alleviates the borrowing constraint and $\phi_x^d - \phi_x^c < 0$ if the shock makes the borrowing constraint more severe. In this situation, ϕ_x^c gives a biased measure of insurance and the difference $\phi_x^c - \phi_x^v$ tells us how much of the transmission of income shocks into nondurable consumption is due to rebalancing.

4.1 Results

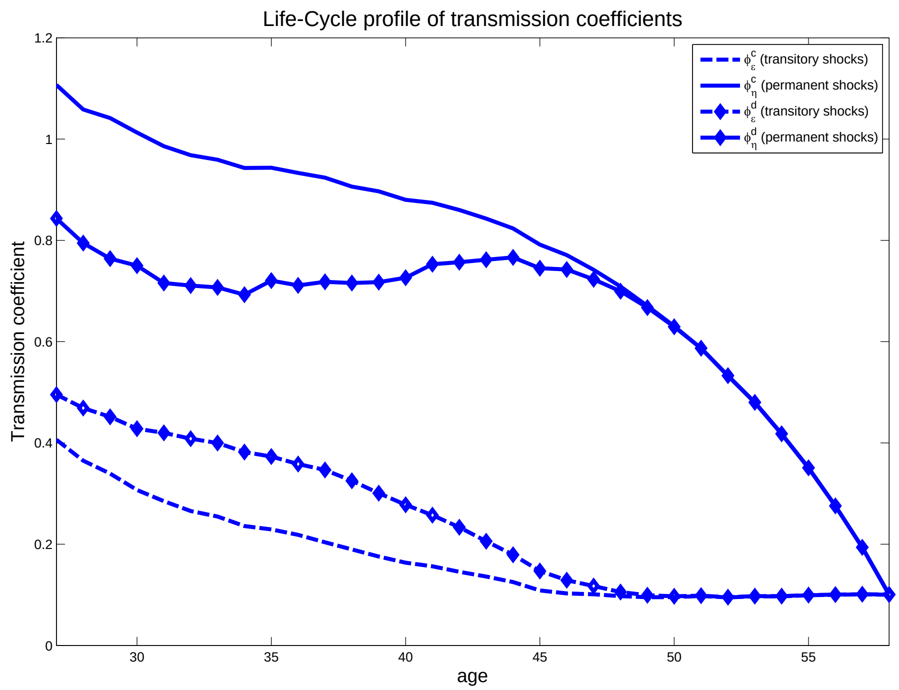
Now, we use our calibrated model to compute the transmission coefficient by age with simulated data. In Figure 3 we plot the transmission coefficients for both non-durable (plain lines) and durable goods (lines with diamonds). The solid lines correspond to the permanent sock and the dashed lines to the transitory shock. The difference between the transmission to durables and nondurables gives the extent of rebalancing for each type of shock.

Several features arise from the transmission coefficient ϕ_x^c of the non-durable good in Figure 3. In line with the previous literature, permanent shocks have a much larger impact on consumption than transitory shocks. As it is usual in this kind of models, there is a clear life-cycle pattern in the transmission of shocks. For both types of income shocks, the transmission to non-durable expenditure decreases with age. This pattern is qualitatively consistent with the findings of Cerletti (2011), who shows falling transmissions of shocks to consumption for Spanish households. To the best of our knowledge, no similar profile has been documented empirically for the US.[17] The shape of the age profile for transmission is the result of two forces: the age profile of binding borrowing constraints and the proximity

[17] Blundell, Pistaferri, and Preston (2008) estimate transmission coefficients for two different cohorts. They obtain mildly higher transmission for the younger cohort, especially with respect to permanent shocks, but the difference across cohorts is not statistically significant.

to the retirement age. The fraction of households hitting the borrowing limit is higher at young ages, when the accumulated wealth is low. Older households are better self-insured against transitory shocks, explaining the reduction in ϕ_{ε}^{c} as age increases. On the other hand, permanent shocks are only permanent in the sense of lasting for the whole working life. Hence, as the retirement age approaches, permanent and transitory shocks are more alike. Therefore, the gap between the transmission coefficients of both types of shocks disappears as households grow old.

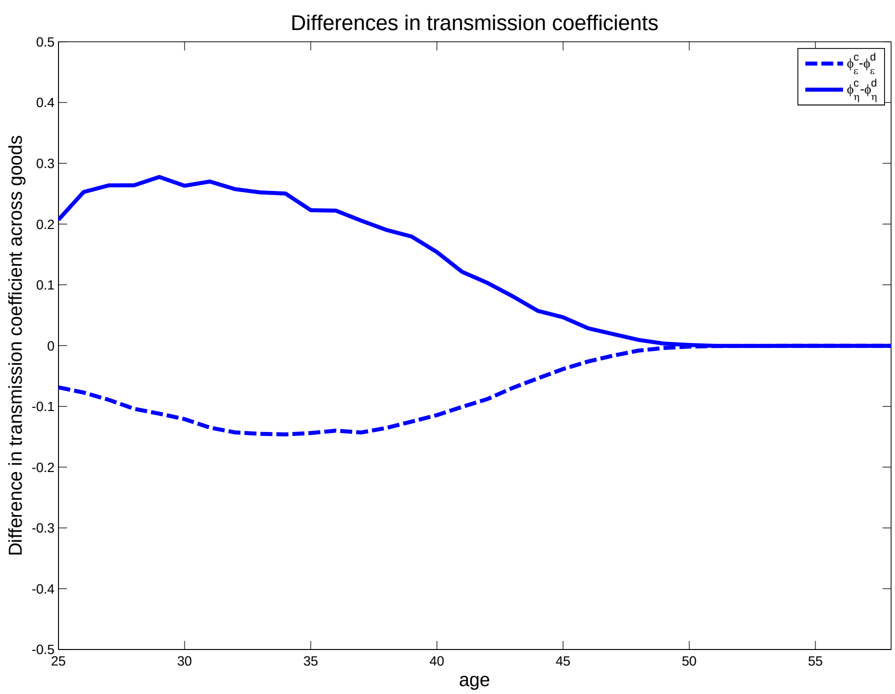
Figure 3: Transmission coefficients of income to consumption



Comparing the transmission coefficients of nondurable consumption with the ones of the durable good, we find important differences for young (constrained) households. In particular, we can see that the fraction of a transitory shock that passes on to non-durable consumption is lower than its equivalent for durables. On the other hand, a permanent shock has a higher impact over non-durable consumption than it has over durable goods. These differences reflect the consumption rebalancing described in section 2.9.1, and they tell us that the transmission of income shocks to nondurable consumption cannot be interpreted as a measure of insurance in young households. In particular, the amount of insurance against transitory shocks is lower than what the transmission coefficients suggest, while the amount of insurance against permanent shocks is higher than what the transmission coefficients suggest.

Another way of seeing this same results is in Figure 4, where we plot the amount of rebalancing computed as the difference in transmission coefficients between nondurables and durables. We can see that consumption rebalancing is important for young households, disappearing after the age of 45, when liquidity constraints cease to bind, as seen in Figure 2. A transitory shock to a constrained household induces a rebalancing towards durable goods ($\phi_\varepsilon^c < \phi_\varepsilon^d$), hence the response of non-durables is lower than that of the consumption basket. A permanent shock to a constrained household has the opposite effect, rebalancing consumption towards nondurable goods ($\phi_\eta^c > \phi_\eta^d$), and hence transmitting more to non-durable goods than to the composite basket. In terms of equation (20), this implies that λ_t/μ_t, our measure of the tightness of the borrowing constraint, comoves positively with the permanent shock. In other words, positive permanent shocks aggravate the severity of borrowing constraints, while negative permanent shocks ease it. These differences disappear over the life cycle, as borrowing constraints become less binding on average, and the responses to shocks of both goods converge.

Figure 4: Difference in transmission coefficients



Finally, we can look at the average of the transmission coefficients. Table 2 summarizes the results on transmission of income shocks into the different consumption goods. Panel

(a) reports the coefficients for all households, panel (b) shows the same information for the youngest households only, and panel (c) for the oldest (working-age) households. Again, we can see that consumption is much more sensitive to income shocks for young households, which are more likely to be constrained, than for old ones. In fact, nondurable consumption of the young reacts practically one to one with permanent shocks, while only 62% of permanent shocks are transmitted into non-durable consumption for the old. Overall, the average transmission of permanent shocks for all households is 78%. For transitory shocks, we find that 31% are transmitted into non-durable consumption for the young and 11% for the old, with an average transmission over the whole population above 19%. In comparison to the empirical findings by Blundell, Pistaferri, and Preston (2008), our model generates larger transmission of shocks to nondurable consumption, roughly 10 percentage points higher than their baseline estimates for both types of shock. This could imply that our model economy lacks some smoothing mechanism available to the households in their sample, a point the literature has made in the context of single-good models.[18] Perhaps remarkably, our transmission coefficients are closer to those obtained by Blundell, Pistaferri, and Preston (2008) once they augment their baseline sample with a subsample of low income households.[19] If these additional households face tighter borrowing constraints than their representative sample, this would point to our specification of the borrowing limit being excessively tight at least for some households.

The transmission of income shocks into durable goods is substantially different from the transmission into non-durables, and these differences go in opposite direction depending on the persistence of the shocks. For the overall population, the response of durables to transitory shocks is 6.9 percentage points larger than the response of non-durables, showing some rebalancing of the consumption basket towards durables. Instead, the response of durables to permanent shocks is 12.4 points smaller than the one of non-durables, showing a larger rebalancing away from durables. The consumption rebalancing induced by shocks changes over the life cycle along with the importance of the borrowing constraints. In particular, for young households, the transmission of transitory shocks into durable goods is 12.2 percentage points higher than into non-durables, and the transmission of permanent shocks into durable goods is 24.3 percentage points lower than into non-durables.

[18] See Kaplan and Violante (2010) for a discussion on the limitations of self-insurance as the only mechanism to smooth consumption, and Kaplan (2012) for a discussions of potential insurance channels for the young.

[19] They exclude the SEO sub-sample of PSID for most of their analysis, which comprises households who had low-income in 1968 and their subsequent split-offs. When included, they obtain a transmission coefficient of 12.1% for transitory shocks and 76.5% for permanent shocks.

Table 2: Transmission coefficients of income to consumption (%)

	ϕ_x^c	ϕ_x^d	$\phi_x^c - \phi_x^d$	ϕ_x^v	$\phi_x^c - \phi_x^v$
(a) All households					
Transitory shocks	19.6	26.5	-6.9	21.1	-1.5
Permanent shock	78.2	65.8	12.4	75.5	2.7
(b) Young households (below 40)					
Transitory shocks	31.2	43.4	-12.2	33.8	-2.6
Permanent shock	101.4	77.1	24.3	96.2	5.2
(c) Old households (over 40)					
Transitory shocks	11.5	14.7	-3.2	12.2	-0.7
Permanent shock	62.2	58.1	4.1	61.3	0.9

Note: The first column reports the transmission of income shocks into non-durable goods, the second one the transmission into durable goods, the third one reports the rebalancing between durable and non-durable goods as a response of the income shocks, the fourth column reports the transmission of shocks into the consumption basket and hence it reflects our measure of lack of insurance, the fifth column reports the bias in the standard measure of consumption insurance.

These differences in transmission imply relatively small although non negligible biases of the insurance measures based on non-durable consumption. The fourth column in Table 2 reports our measure of lack of insurance, ϕ_x^v, and the fifth column the implied bias, $\phi_x^c - \phi_x^v$. The bias of the transmission of permanent shocks for the young is 5.2 percentage points. That is to say, the transmission of permanent shocks into non-durable consumption is 101.4 percent, but the transmission of the shock into the consumption basket is 96.2 percent. For transitory shocks, the transmission is 31.2 percentage points and without rebalancing this would only be 33.8, with the bias being -2.6 percentage points. Note that the bias, which we define as the difference between ϕ_x^c and ϕ_x^v, is given by

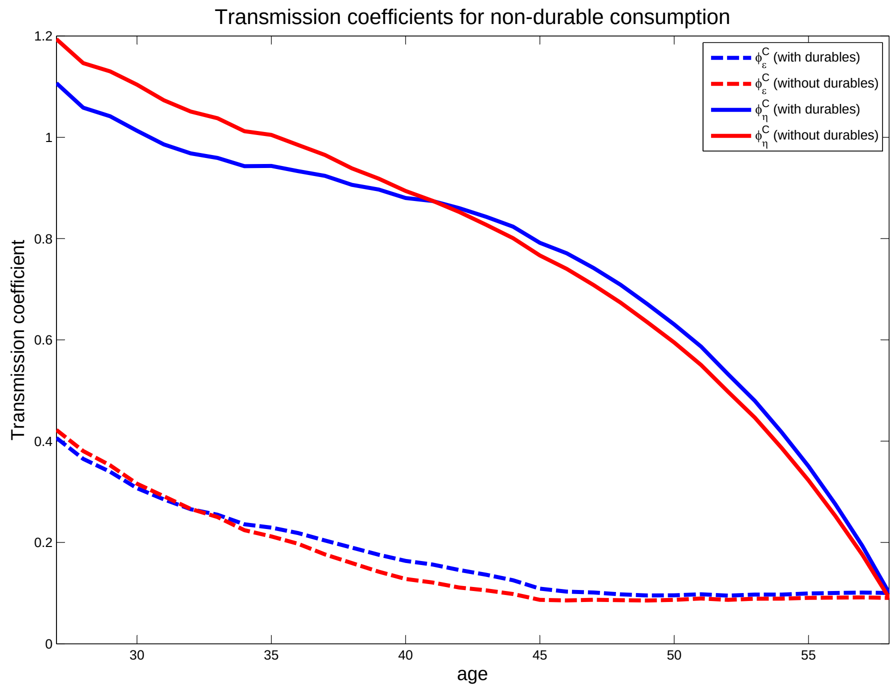
$$\phi_x^c - \phi_x^v = (1-\gamma)\left(\phi_x^c - \phi_x^d\right)$$

so, with the calibrated value of $\gamma = 0.79$ the bias is roughly 0.2 times the difference between the transmission coefficients.

4.2 Differences between models

A final important observation is that the transmission of shocks into non-durable consumption predicted by a model without durable goods may be quite different from the ones predicted by our model for those households who are not borrowing constrained. The reason for this is that the two models do not differ only in the substitution between goods,

Figure 5: Transmission coefficients (non-durables)



but also in some other important aspects. First, the model with durables has a higher ability to borrow (as long as $\theta \neq 0$). Second, while the two economies are calibrated to the same total wealth, the timing of wealth accumulation is different: in the model with durable goods households accumulate more wealth in the first part of the life-cycle, whereas in the model without durable goods households have more wealth in the second part of the life cycle (see Figure 1). Third, the composition of wealth is also different: in the model with durable goods, most of the assets held before the age of 50 are durable goods. Finally, in order to achieve the same amount of total wealth in both economies, households are somewhat more impatient in the model with durables (see Table 1).

Hence, in this Section we want to compare the transmission coefficients predicted by our model to those of the model without durable goods. In Figure 5 we plot the transmission coefficients for nondurable consumption for both models. Blue lines depict the transmission coefficients in the model with durable goods, while red lines indicate the transmission coefficients in the model without durables. The solid lines correspond to the transmission of permanent shocks, and the dashed lines to the transitory shock. We see that the main differences are in permanent shocks and in younger households. In particular, the transmission of permanent shocks to nondurable consumption is lower in the model with durables up to age 40, being slightly higher thereafter. In contrast, the transmission of transitory shocks is slightly higher in the model with durables at young ages, with all the differences disappearing in the second half of the working life. The differences of transmissions by age groups below 40 go in the opposite direction than rebalancing alone would suggest. Since households are more patient in the model without durables, they keep higher liquid assets to insure themselves against transitory income fluctuations. On the other hand, the transmission of permanent shocks reflect the trade-off that constrained households face: at the constraint, there is a unique mapping from the level of non-durable consumption (C_t) to the composition of consumption (C_t/D_t). Hence, they optimally reduce the overall response of non-durable consumption to avoid departing too far from the unconstrained consumption bundle.

5 Extensions and robustness checks

Although our model assumptions and calibration targets are empirically motivated, as described above, some of them are by no means incontrovertible. In this section, we analyze the sensitivity of our findings to alternative modeling choices and calibration strategies. Table 3 summarizes the calibration results of the different exercises we conducted. We explain each of them in detail below.

Table 3: Alternative parameterizations: calibration results.

Specification	Baseline	Illiquid wealth	Housing	Unsecured debt
Parameters				
β	0.9294	0.9175	0.9264	0.9501
γ	0.7852	0.7852	0.7745	0.7755
θ	0.1183	0.1183	0.8000	0.1183
δ	0.1292	0.1292	0.0452	0.1292
τ	-	0.0709	-	-
α	0	0	0	1.0390
Statistics				
average W/Y	2.5001	2.5000	2.5001	2.5000
fraction with $W < 0$	0.0000	0.0000	0.0000	0.0000
average I/C	0.2444	0.2444	0.2444	0.2444
aggregate I/D	0.1406	0.1407	0.0557	0.1410
average W^{liq}/W^{noliq}	1.2300	0.2280	2.2290	0.8726

5.1 Liquidity of assets

So far, we have considered a single financial asset, A_t, to reflect the total net worth of households, once consumer durables are excluded. This definition hides the heterogeneous nature of the different components of households' balance sheets, especially in terms of liquidity. Moreover, a fraction as large as 80% of average household wealth is held in illiquid assets. Therefore, the self-insurance role of wealth may be overstated in our baseline exercise. Modeling portfolio decisions in the presence of illiquid assets is beyond the scope of this paper. However, we acknowledge that our characterization of A_t can be interpreted as an extreme assumption about portfolio composition, where all wealth is held in the liquid asset.

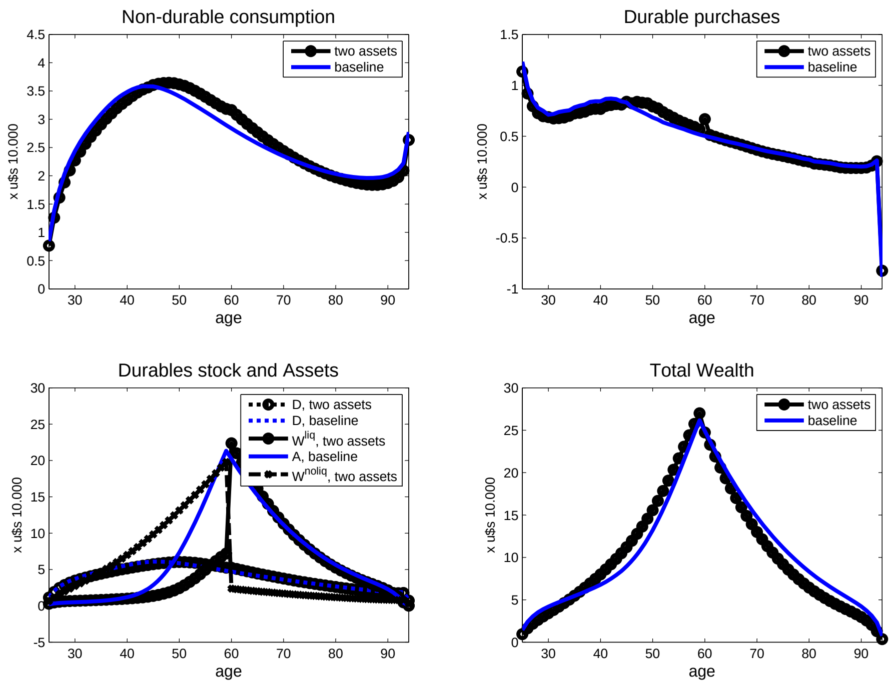
Hence, for completeness, we run a simple alternative extreme case, in which some fraction of total wealth is fully illiquid and can not be accessed before retirement. The interpretation is that households save in illiquid assets for life-cycle considerations, while they keep liquid assets for precautionary motives. Specifically, we maintain liquid savings as an endogenous variable, but we restrict savings in illiquid assets, which we label "retirement accounts", to be a constant fraction τ of income. Upon retirement, households receive the (capitalized) value of retirement accounts as a lump-sum transfer.[20] Therefore, the baseline model assumes that the retirement accounts can be withdrawn in full at any time and no cost, while the alternative forbids any anticipated withdrawal. To be consistent with the definition used in the data, we compute net liquid (illiquid) wealth as total liquid (illiquid) assets minus total liabilities associated to the purchase of liquid (illiquid) assets. In terms of our model, we can define liquid wealth W_t^{liq}, and illiquid wealth W_t^{noliq}, as:

$$\begin{aligned} W_t^{liq} &= A_{t+1} + \theta \frac{1-\delta}{1+r_{t+1}} D_t \\ W_t^{noliq} &= (1-\theta \frac{1-\delta}{1+r_{t+1}}) D_t + \underbrace{\sum_{j=1}^{t} \tau Y_j \prod_{k=j}^{t} (1+r_{k+1})}_{\text{retirement accounts}} \end{aligned}$$

In Table 3 we apply the same definition to single-asset economies, where retirement accounts are not present. Hence, in those cases the ratio W^{liq}/W^{noliq} is just a measure of

[20]Since life is deterministic after retirement, recovering illiquid assets as either a one-time payment or an annuity does not matter. By abstracting from any potential misalignment between the timing of illiquid assets payments and the desired consumption profile, the one-time assumption ensures that after-retirement life is the same in both the baseline and the alternative model.

Figure 6: Average Life Cycle Profiles



the contribution of the net stock of consumer durables to total net worth.

Introducing illiquid wealth, even in the simple way outlined above, requires a modification of the calibration strategy. We can still use total wealth to compute the wealth to income ratio as before, but now we also need to pin down the composition of wealth, which is governed by τ. We calibrate β, γ, δ, and τ jointly to match the same statistics as in the previous section plus the liquid to illiquid wealth ratio for working age households. Since W_t^{noliq} captures the net value of illiquid assets (with the exception of consumer durables), it is unclear how the borrowing limit should be specified in the two-asset case. We choose to maintain $\alpha = 0$, so the results are directly comparable to our main exercise. The calibration of this two-asset economy is presented in the last column of Table 3. Two things are worth noticing in Table 3. First, the value of τ obtained resembles the fraction of lifetime earnings held as wealth at retirement. Using the PSID, Hendricks (2007) estimates the average lifetime earnings of a household by computing the capitalized sum of earnings over the life cycle, and finds that average wealth at retirement amounts to 8% of that measure.[21] Second, the discount factor is lower than in the single asset case (first

[21] In our model, average total wealth at retirement, which includes liquid assets and durable goods, is 10% of lifetime earnings, computed in the same way as Hendricks (2007).

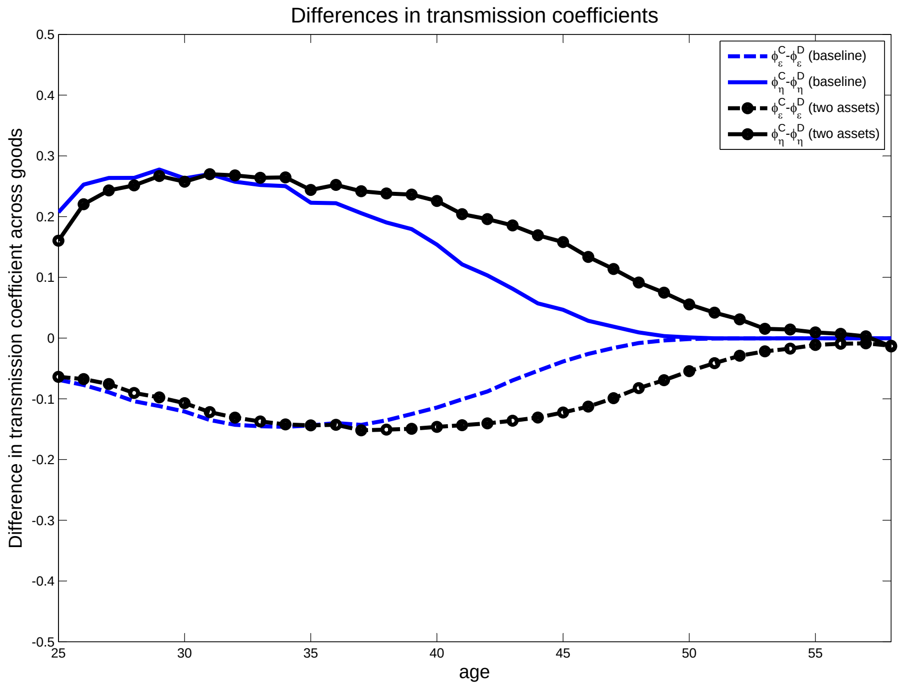
column), as a consequence of the timing assumed for illiquid wealth accumulation. Figure 6 shows that adding the illiquid assets leads to an anticipation of wealth accumulation. This is a result of savings in retirement accounts being proportional to income throughout the working life, whereas in the single-asset economy, savings for retirement are concentrated towards the end of working life.[22] However, liquid wealth held by workers is lower in the two-asset economy, which translates into less self-insurance. Remarkably, the main differences in liquid wealth accumulation between the two economies arise after the age of 40, when life-cycle motives for saving become more important.

Figure 7 shows that, early in life, rebalancing effects are equally important in the two economies, but they disappear much later in the two-asset case, leading to a higher overall incidence of rebalancing and a flatter age profile for transmission coefficients. This reflects the presence of rich constrained households in the two-asset model. These are households in the second half of their working life, who own a significant amount of assets, but are nevertheless constrained in terms of liquidity, since most of their wealth is accounted by the illiquid asset. The coefficients generated by the two-asset model are reported in the second column of Table 4. Consumption responses are in general larger in this version of the model, since self-insurance is restricted to only a fraction of total wealth. Compared to the baseline model, the transmission of transitory shocks into non-durable consumption increases from 19.6% to 23.6%, whereas the transmission of permanent shocks increases from 78.2% to 82.9%. A closer examination of panels (b) and (c) of Table 4 reveals that most of the differences come from older households: while the differences in transmission coefficients are slightly above 2 percentage points for households below 40 years old, they can be as large as 9.8 percentage points for older households. The same decomposition by age applies to the bias of transmissions due to rebalancing. The differences are small for young households, while households above 40 drive most of the increase in the overall bias.

The conclusions of this exercise are important. If we think that not all household wealth can be used cheaply to accommodate unexpected income changes, a standard life-cycle model of consumption predicts much less insurance than measured in the data. Hence, the excess smoothness puzzle could be severe. From an empirical point of view, our preliminary exercise highlights the importance of distinguishing constrained households in terms of access to liquidity, rather than in terms of levels of net worth.

[22] It is not obvious how the timing of illiquid wealth accumulation may differ from that of liquid wealth when both assets are endogenously chosen. We refer to Kaplan and Violante (2012) for a recent analysis of wealth composition when all assets are chosen endogenously.

Figure 7: Difference in transmission coefficients



5.2 Housing

Our main exercise is focused on consumer durables such as cars, furniture, appliances, and smaller durable goods. It is our view that our simple framework captures, in a stylized way, the main features of these goods, but it is a poorer approximation to the characteristics of housing. However, for the sake of completeness, we performed an alternative calibration including housing in the durable goods bundle. In practice, this amounts to a reassessment of the durability of goods, δ, and the required down payment on durables, θ

Equation (18) states that a high durability (a low depreciation rate) of durable goods increases the extent of rebalancing. In our baseline calibration, we obtain a value for δ of 12.92%, which is consistent with the aggregate ratio between expenditures and stocks of consumer durables. However, when housing is included, the value of this statistic decreases dramatically, as houses outlives most other durable goods. This leads to a lower calibrated depreciation rate, $\delta = 4.52\%$.

At the same time, equation (18) shows that rebalancing is less important the lower is the down payment $(1 - \theta)$. Our benchmark calibration featured high down payments, as θ was slightly lower than 0.12. This was a result of bundling goods with a high collateral value, such as cars, with many other goods with practically no collateral value. When we include housing, a highly collateralizable asset that accounts for a large fraction of durable goods holdings, the ability of households to borrow against durables has to increase significantly. Following the housing literature, we set a down payment of 20%, which amounts to $\theta = 0.80$.

We recalibrate our model economy accordingly, keeping the rest of the targets at their baseline level. The results of this calibration are summarized in the second column of Table 3. There is little impact on the parameters other than δ and θ. Figure 8 shows no sign of significant changes in the timing of wealth accumulation, which is reassuring in the sense of δ not playing an important role in the age composition of constrained households.

Figure 9 illustrates the effect on rebalancing of decreasing δ and increasing θ. There is a sizable reduction in the extent of the rebalancing throughout the life cycle, more so for permanent shocks. These results are straightforward given the massive increase in θ, which more than compensates the amplification of rebalancing induced by a lower depreciation rate. Remarkably, there are only minor differences in the transmission coefficients for nondurables. A comparison of the first and the third columns of Table 4 reveals that the main difference between the baseline economy and the one with housing is the level of transmission of shocks to durable goods, which is much closer to its counterpart for nondurables.

The main conclusion of this exercise is that the response of nondurables to shocks does not depend much on the level of down payment requirements, but its accuracy as a measure of overall insurance does. Hence, estimating θ correctly is not important for measuring the responses of nondurables to shocks, but it is crucial for the interpretation of these responses. At the same time, we are cautious about concluding that housing is not important in order to study the transmission of income shocks to consumption. As the results in the previous section suggest, a careful consideration of the liquidity of housing as an asset may lead to a largely different result. A proper analysis of this sort is beyond the scope of this paper.

5.3 Unsecured borrowing

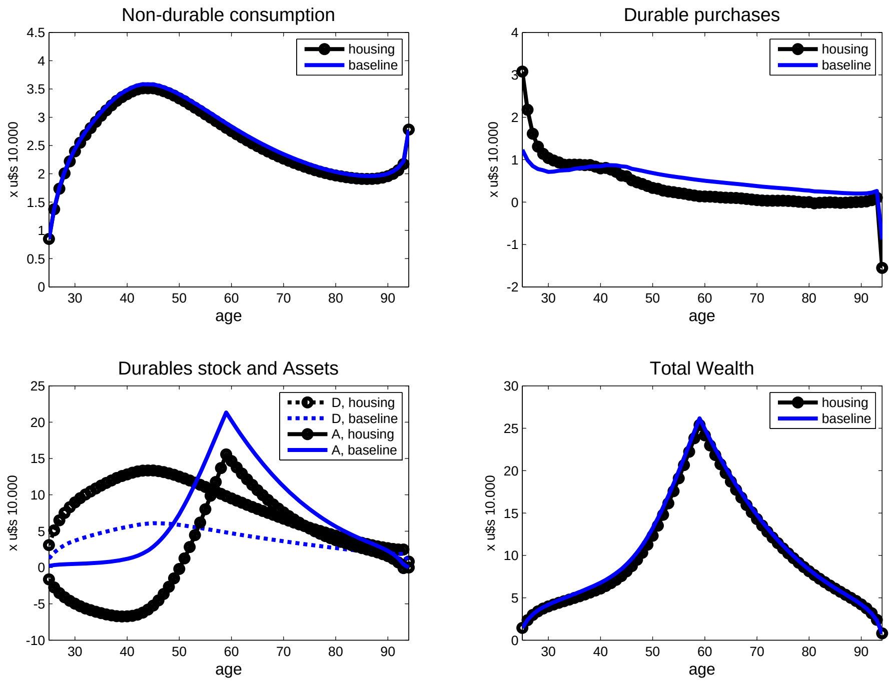
In our description of the model, we allow for both collateralized and uncollateralized debt, with θ and α, respectively, measuring the tightness of the borrowing limit with respect to each type of debt. Our baseline calibration, however, precludes unsecured borrowing altogether. This can be rationalized as the natural outcome from a limited enforceability problem where the seizure of tangible assets is the only punishment for

Table 4: Alternative parameterizations: transmission of income shocks.

Specification	Baseline	Illiquid wealth	Housing	Unsecured debt
Transmission (all)				
ϕ^c_ε	19.6	23.6	21.0	13.0
ϕ^c_η	78.2	82.9	80.8	73.6
ϕ^d_ε	26.5	32.9	24.1	16.6
ϕ^d_η	65.8	67.0	77.1	66.5
$\phi^c_\varepsilon - \phi^v_\varepsilon$	-1.5	-2.0	-0.7	-0.8
$\phi^c_\eta - \phi^v_\eta$	2.7	3.4	0.8	1.6
Transmission (young)				
ϕ^c_ε	31.2	33.4	33.6	20.2
ϕ^c_η	101.4	102.2	105.4	96.2
ϕ^d_ε	43.4	45.0	39.1	28.7
ϕ^d_η	77.1	77.6	98.2	79.5
$\phi^c_\varepsilon - \phi^v_\varepsilon$	-2.6	-2.5	-1.2	-1.9
$\phi^c_\eta - \phi^v_\eta$	5.2	5.3	1.6	3.8
Transmission (old)				
ϕ^c_ε	11.5	16.8	12.2	7.9
ϕ^c_η	62.2	69.6	63.8	57.9
ϕ^d_ε	14.7	24.5	13.5	8.2
ϕ^d_η	58.1	59.8	62.6	57.6
$\phi^c_\varepsilon - \phi^v_\varepsilon$	-0.7	-1.7	-0.3	-0.1
$\phi^c_\eta - \phi^v_\eta$	0.9	2.1	0.3	0.1

Note: transmission coefficients are expressed in percentage points.

Figure 8: Average Life Cycle Profiles

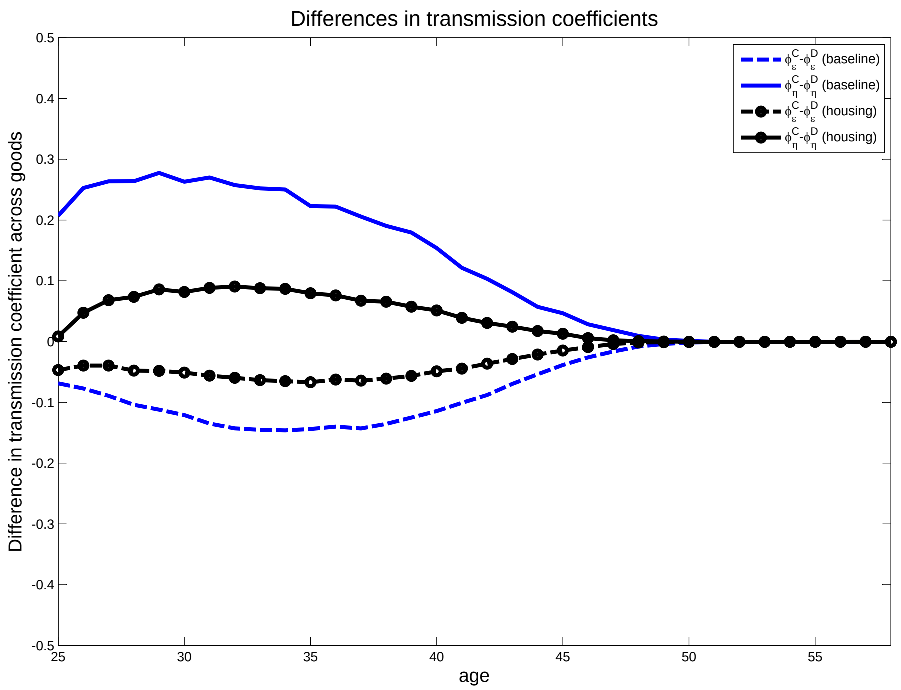


defaulting households.[23] Furthermore, our definition of the borrowing limit $\underline{A}_t$ is very restrictive as a consequence of the assumed earnings process, which allows for realizations of income arbitrarily close to zero. This leaves little room for unsecured debt in any case. However, since our model economy features no risk after retirement, the borrowing capacity of households can increases as retirement approaches whenever $\alpha > 0$.

In order to check the importance of unsecured borrowing for the life-cycle profile of binding constraints and rebalancing effects, we compute a version of the model with $\alpha > 0$. In order to calibrate α, we focus on the fraction of the population with zero or negative net worth in the US. We acknowledge, however, that the level of wealth held by a household is far from being a perfect measure of liquidity constraints. First, the observed distribution of debt and savings reflect not only restrictions to borrow, but also preferences over time and risk and the potential heterogeneity of such preferences. More patient or risk averse households will avoid hitting the constraint, and will display higher levels of savings when the constraint is very restrictive, implying that their borrowing capacity is higher than the debt they actually hold. On the other hand, less patient or risk averse households will use debt more intensively, and will accumulate debt levels

[23]See section 2.5 for a discussion on the parametric restrictions implied by such an assumption.

Figure 9: Difference in transmission coefficients



closer to the actual borrowing limit. Therefore, inferring the nature of borrowing limits from the observed cross-sectional distribution of wealth holdings requires taking a stand on the distribution of preferences, which we assume homogeneous and summarized by σ and β. Second, owning assets does not necessarily grant having access to liquidity whenever needed. A thorough empirical analysis of the actual availability of liquidity to American households could shed some light on the best strategy to quantify the tightness of borrowing constraints in consumption models.

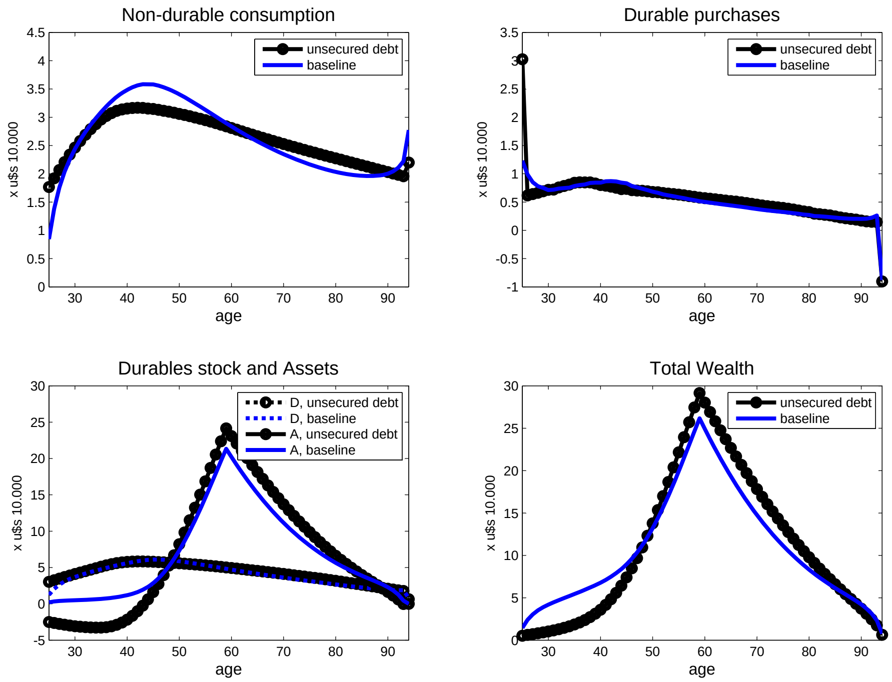
The fourth column of Table 3 shows the results of this calibration. The taste for nondurable goods and the depreciation rate are unaffected by the change in α. However, the looser borrowing limit induces lower precautionary savings with respect to our benchmark. Hence, a higher discount factor is needed to match the observed level of wealth. Figure 10 shows the role of unsecured debt over the life cycle. Nondurable consumption grows slower and exhibits a smaller hump in the economy with unsecured borrowing compared to the baseline economy. As a consequence of the higher discount factor, it also decreases less rapidly after its peak. At the same time, allowing for unsecured debt creates a counter-factual initial spike in expenditure on durables, concentrating the creation of a stock of durables at the initial stages of working life. Overall, total expenditure is higher early in life, due to the additional means to finance it. The composition of wealth over the life cycle changes as well: while the average stock of durables is essentially the same, the average holdings of financial assets shifts towards older households in the alternative economy. This shift is a combination of three forces: first, allowing for unsecured borrowing mechanically decreases the net worth of constrained, young households; second, for given preferences and income risk, a looser borrowing limit induces lower precautionary savings; and third, the discount factor required to match a given wealth to income target is higher when $\alpha > 0$, effectively compressing the wealth distribution.

We find that when unsecured debt is available, the rebalancing effects are smaller and are present over a shorter period of life. Figure 11 shows that, for both types of shocks, rebalancing is smaller for young people and it remains different from zero 5 years less than in the baseline calibration. As discussed above, the availability of unsecured debt increases with age until retirement, contributing to the marked age profile in transmission of income shocks to consumption. Table 4 shows that also the level of transmission coefficients is lower in the economy with unsecured debt at all ages. Hence, unsecured debt increases the overall ability to smooth shocks, but more so for older households. This is in contrast with the previous exercise, where an increase in the availability of collateralized debt lead to lower rebalancing at all ages, but it did not change much the level of transmission for nondurables. The fourth column in Table 4 shows how rebalancing translates into the difference between transmission to nondurable consumption and insurance. The overall bias decreases from -1.5 to -0.8 in the case of transitory shocks, and from 2.7 to 1.6 in the case of permanent shocks. Some of the decrease in the bias come form young households, but the most salient result in the last column of Table 4 is the absence of bias for households above 40.

6 Conclusions

In this paper, we have analyzed the responses to income shocks of households that care for both durable and non-durable goods and face borrowing constraints. The main purpose of the analysis was twofold. First, we wanted to characterize the specific responses of the consumption of each type of good. Second, we wanted to asses the impact of neglecting durables in measuring consumption insurance. To this end, we have constructed a life-cycle, incomplete markets model with two goods of different durability. We used the model to characterize the consumption responses to income shocks as a function of liquidity restrictions, the persistence of the shocks, and the durability of the goods. Then, we calibrated the model to replicate the US economy in order to measure the quantitative

Figure 10: Average Life Cycle Profiles



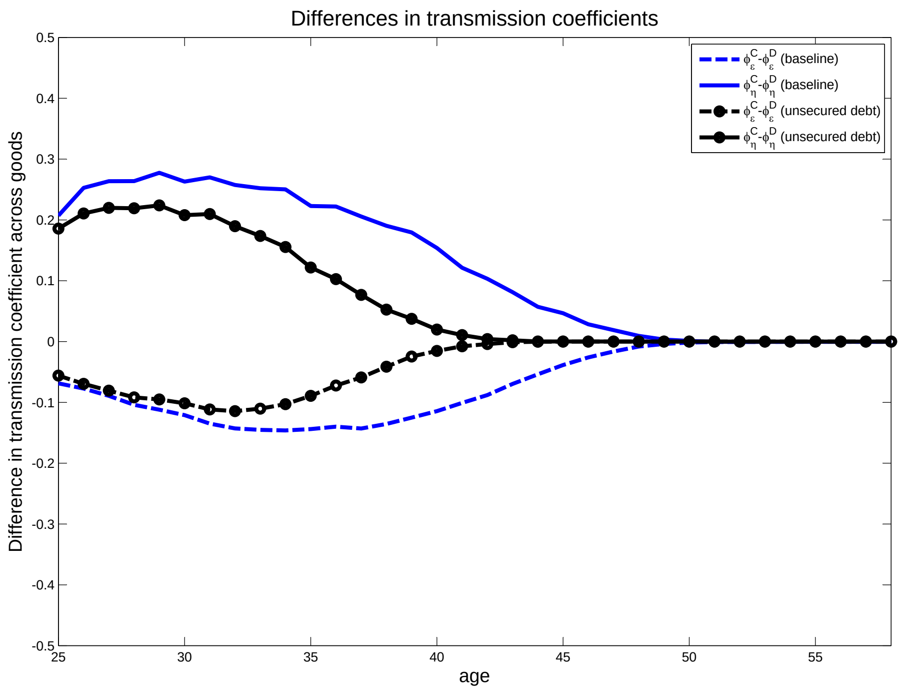
importance of durable goods for measuring the extent of insurance.

Our main qualitative findings can be summarized as follows. First, we have shown that, in the absence of binding borrowing constraints, the consumption of both durable and non-durable goods responds equally to income shocks. This implies that both goods are consumed in the same proportion regardless of the shock. However, when borrowing constraints bind, there is a rebalancing effect that shifts consumption towards one of the goods depending on the persistence of the shock. When the shock is permanent, non-durable consumption reacts more than durable consumption, whereas the opposite is true when the shock is transitory.

Second, we have shown that insurance, defined as the ability to smooth a comprehensive measure of consumption across states, is a function of the transmission of income shocks to non-durable consumption and the extent of rebalancing. Therefore, the response to shocks of non-durable consumption alone, even if correctly measured, is not an exact measure of insurance for constrained households.

The quantitative results of the calibrated model are the following. First, we found rebalancing effects to be moderate and concentrated at young ages. The latter result is a consequence of liquidity constraints being more important for younger households.

Figure 11: Difference in transmission coefficients



Second, the impact of rebalancing on our measure of insurance is small, especially for transitory shocks. In our baseline calibration, the difference between the transmission of shocks to non-durable consumption and insurance was 1.5 percentage points. This difference was bigger for permanent shocks and for young households, where the bias can be as high as 5 percentage points.

We conducted a series of robustness checks that confirmed the limited role of rebalancing in consumption insurance. These exercises delivered some additional results. In particular, we found that savings' liquidity can potentially play a role both in the level and the age profile of consumption rebalancing as a response to income shocks. A more careful study of the use of illiquid assets and its links with precautionary and life-cycle motives for wealth accumulation would be needed to draw further conclusions on this issue. We also found that the size of the bias caused by measuring insurance as the transmission to non-durable consumption alone depends on the required down payment on, and the durability of the other good, although the transmission itself does not. Finally, we found that the availability of uncollateralized loans matters both for the level of transmission and the age distribution of constrained households, and hence for the incidence of rebalancing over the life cycle. These two exercise combined imply that not only the level of credit available, but also its type (either collateralized or unsecured) is important to understand the size of the responses of non-durable consumption to income shocks and its accuracy as a measure of insurance.

References

Aaronson, D., S. Agarwal, and E. French (2011): "The Spending and Debt Response to Minimum Wage Hikes," forthcoming *American Economic Review*.

Bils, M., and P. Klenow (1998): "Using Consumer Theory to TEst Competing Business Cycles Models," *Journal of Political Economy*, 106(2), 233–261.

Blundell, R., L. Pistaferri, and I. Preston (2008): "Consumption Inequality and Partial Insurance," *American Economic Review*, 98(5), 1887–1921.

Browning, M., and T. Crossley (2009): "Shocks, Stocks, And Socks: Smoothing Consumption Over A Temporary Income Loss," *Journal of the European Economic Association*, 7, 1169–1192.

Campbell, J., and A. Deaton (1989): "Why is Consumption so Smooth?," *Review of Economic Studies*, 56(3), 357–374.

Campbell, J., and Z. Hercowitz (2003): "The Dynamics of Work and Debt," Chicago Fed Working Paper 2004-05.

Cerletti, E. A. (2011): "Life-cycle patterns in consumption insurance: evidence from the Spanish Household Budget Survey," Mimeo, CEMFI.

Chah, E. Y., V. A. Ramey, and R. M. Starr (1995): "Liquidity Constaraints and Intertemporal Consumer Optimization: Theory and Evidence from Durable Goods," *Journal of Money Credit and Banking*, 27(1), 272–287.

Fernández-Villaverde, J., and D. Krueger (2006): "Consumption over the Life Cycle: Facts from the Consumer Expenditure Survey," *Review of Economics and Statistics*, 3(89), 552–565.

——— (2011): "Consumption And Saving Over The Life Cycle: How Important Are Consumer Durables?," *Macroeconomic Dynamics*, 5(15), 725–770.

Gourinchas, P. O., and J. A. Parker (2002): "Consumption Over the Life-Cycle," *Econometrica*, 70, 47–89.

Hall, R., and F. Mishkin (1982): "The Sensitivity Of Consumption To Transitory Income: Estimates From Panel Data On Households," *Econometrica*, 50, 461–481.

Harris, E., and J. Sabelhaus (2000): "Consumer Expenditure Survey. Family-level Extracts, 1980:1 - 1998:2," Mimeo, Congressional Budget Office.

Heathcote, J., F. Perri, and G. Violante (2010): "Unequal We Stand: An Empirical Analysis of Economic Inequality in the United States, 1967- 2006," *Review of Economic Dynamics*, 1(13), 15–51.

Hendricks, L. (2007): "Retirement Wealth and Lifetime Earnings," *International Economic Review*, 48(2), 421–456.

Johnson, D., R. McClelland, and J. Parker (2011): "Consumer Spending and the Economic Stimulus Payments of 2008," NBER Working Paper 16684.

Kaplan, G. (2012): "Moving Back Home: Insurance Against Labor Market Risk," Mimeo, NYU.

Kaplan, G., and G. Violante (2010): "How Much Consumption Insurance Beyond Self-Insurance?," *American Economic Journal: Macroeconomics*, 2(4), 53–87.

Kaplan, G., and G. L. Violante (2012): "A Model of the Consumption Response to Fiscal Stimulus Payments," manuscript.

Luengo-Prado, M. J. (2006): "Durables, Nondurables, Down Payments and Consumption Excesses," *Journal of Monetary Economics*, 53(7), 1509–1539.

Nakajima, M., and I. Telyukova (2011): "Home Equity in Retirement," mimeo.

Storesletten, K., C. Telmer, and A. Yaron (1999): "The Risk Sharing Implications of Alternative Social Security Arrangements," *Carnegie-Rochester Series on Public Policy*, 50, 213–259.

——— (2004): "Consumption and Risk Sharing over the Life Cycle," *Journal of Monetary Economics*, 51(3), 609–633.

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