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Excess Smoothness and Durable Goods: Evidence from Subjective Expectations Data

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Abstract

This paper derives and estimates a model where durable and non-durable consumption are allowed to be non-separable in utility and individuals face a convex adjustment cost whenever they want to purchase a new durable good. Subjective expectations data allow to identify and estimate the marginal propensity to consume out of permanent shocks, which is a key parameter for the understanding of the excess smoothness puzzle and for policy purposes.

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1 Introduction

One of the main implication of the life cycle/permanent income model is that the consumer reacts differently if the income shock she receives has a permanent or transitory nature.[1]

With quadratic preferences, innovations in labor income, the source of uncertainty, translate into innovations in consumption. This is because of the linearity of the first order conditions. The implications in terms of the propensity to consume out of the permanent and the transitory shocks are clearer when the linear-quadratic case is considered. Thus, the simple quadratic model is a useful benchmark within which we can discuss many issues related to the empirical evaluation of the model.

In the standard model which focuses only on non-durable consumption, quadratic preferences deliver strong predictions on the marginal propensity to consume permanent and transitory shocks. The first is constrained to be equal to one, while consumers do not respond to transitory shocks.[2]

The marginal propensity to consume out of permanent shocks is a key parameter for the understanding of the model and for policy purposes.

If labor income is generated by a random walk, it is easy to show that the ratio of the variance of (non-durable) consumption to the variance of labor income is equal to one. This is due to the propensity to consume permanent shocks being equal to one. Many empirical studies, however, document that this ratio is less than one.[3] This is called the excess smoothness puzzle.

On the other hand, policy issues can be more usefully addressed in a framework where economists are able to predict how consumers respond to shocks. The response of consumers to shocks depends on the marginal propensity to consume, among other things.

Notwithstanding, the marginal propensity to consume out of permanent shocks has received little attention by applied economists. This is mainly due to two things: it may be exactly computed only in the linear-quadratic case; even though the consumption function is avail-

[1]This is true if the consumer might distinguish between the two and if she knows their statistical properties

[2]This is literally true only for the model with infinite life or altruistic agents. If life are finite or agents are selfish, agents consume the annuity value of transitory shocks.

[3]For a survey, see Attanasio (1998).

able (i.e. when preference are quadratic and the budget constraint is linear), the estimation of it is not safe from the Lucas' Critique.

In this paper, I estimate the marginal propensity to consume out of permanent and transitory income shocks. At the odd with the radical version of the theory, I find that the marginal propensity to consume out of the permanent income is less than one. I argue that this finding can be reconciled with the theory once durable consumption enters the picture. In particular, I look at the case when non-durable and durable consumption are eventually non-separable in utility.

Non-separability between non-durable and durable consumption and adjustment costs may explain these findings in that they lower the propensity to consume permanent shocks. If adjustment costs are convex, the marginal adjustment cost is increasing when consumers want to increase the stock of cars. This makes optimal to respond only slowly to shocks. Suppose that the consumer receives a permanent positive shock and wants to increase their shock of cars. If the increase of the stock of cars causes the marginal utility of non-durable consumption to *increase* a less sharp increase of non-durable consumption is needed in equilibrium. In this sense, non-separability between durable and non-durable consumption and adjustment costs provide some leverage for explaining the excess smoothness puzzle.

A number of papers deal with the excess smoothness puzzle, first raised by Campbell and Deaton (1989). Quah (1990) suggests that the excess smoothness of consumption is a statistical artifact due to the econometrician being unable to decompose income shocks in a permanent and transitory components. Goodfriend (1992) introduces the idea of information bias and concentrates more on excess sensitivity, while Pischke (1995) shows how to generate 'smooth' aggregate consumption when individuals have incomplete or no information on aggregate variables.

Another strand of papers (see Deaton (1992) and Heaton (1993)) look at time non-separabilities, such as habit formation and durability, as a source of explanation for the excess smoothness puzzle. This paper fits into this category in that I focus on durable consumption as well as non-durable consumption. The novelty of this work is the estimation of the marginal propensity to consume out of the permanent shock. The magnitude of it depends on a number of parameters, which includes the parameters controlling the degree of durability of the durable good (i.e. the depreciation), the degree of non-separability between durable and non-durable consumption and the adjustment costs.

A representative Italian sample, the Survey of Households Income and Wealth (SHIW), is used and three measures of durable consumption are analyzed: real goods, which group jewels and other valuables; vehicles, typically including cars and motor bikes; small durable goods, which group furniture, "white" and "black" durable goods.

This paper is organized as follows. The first section introduces the structural model. In Section 2 I present the data and few stylized facts. Section 3 discusses econometric issues, while the results are provided in Section 4. Section 5 concludes.

2 The Structural Model

The purpose of this section is to derive a structural relation between consumption and income shocks when durable and non-durable goods are not separable and consumers face a cost when they replace old durable goods. Instantaneous utility is assumed to be a quadratic function of non-durable consumption and of the stock of durable goods, while adjustment costs are characterized by a quadratic function in net expenditures on durable goods.

The consumers objective function is:

$$E_t \sum_{s=0}^{\infty} \rho^{t+s} u(c_{t+s}, K_{t+s}) \tag{1}$$

where ρ is the rate of time preference; c_{t+s} is non-durable consumption and K_{t+s} is the stock of durable goods. Thus, individuals enjoy a flow of services from the durable goods proportional to their stock. I assume here that the time horizon is infinite. Assuming an infinite horizon, the age of consumers does not enter the problem as a state variable, which makes calculations simpler. The instantaneous utility function, $u(\cdot,\cdot)$, is then given by:

$$\begin{gathered} -\frac{a}{2}\left(\overline{c}-c_{t+s}\right)^2-\frac{b}{2}\left(\overline{K}-K_{t+s}\right)^2- \\ d\left(\overline{c}-c_{t+s}\right)\left(\overline{K}-K_{t+s}\right)-\frac{g}{2}\left(K_{t+s}-(1-\delta)\,K_{t+s-1}\right)^2 \end{gathered} \tag{2}$$

where a, b, g are positive scalars while d can be either positive or negative; $\overline{c}$ and $\overline{K}$ are, respectively, the saturation levels of non-durable and durable consumption. If both goods were non-durable and if d and g were both equal to zero, the ratio $\frac{b}{a}$ would be equal to $\frac{\overline{c}-c_t}{\overline{K}-K_t}$. If the parameter d is non-zero, preferences over durable and non-durable goods are said to be non-separable. This is because whenever d is equal to zero, the marginal utility of non-durable consumption (respectively, durable consumption) does not depend on the marginal utility of durable consumption (non-durable consumption). Durable and non-durable goods are said to be substitutes if d is positive, since the marginal utility of non-durable consumption decreases if the stock of durable goods increases. Conversely, durable and non-durable goods are said to be complements when d is negative. Marginal adjustment costs depend on g. The higher is this parameter, the higher are marginal adjustment costs, i.e. the costlier is to adjust the stock of durable goods.

The picture is completed by writing down the dynamic budget constraint and the equation governing the evolution of the stock of durable goods, i.e.:

$$\begin{aligned} A_{t+s+1} &= (1+r)\left(A_{t+s} - c_{t+s} - p_\kappa \kappa_{t+s} + y_{t+s}\right) & (3)\\ \kappa_{t+s} &= K_{t+s} - (1-\delta) K_{t+s-1} & (4) \end{aligned}$$

where A_{t+s} is non-human wealth, r is the interest rate, p_κ the durable goods price, κ_{t+s} is net expenditures on durable goods and y_{t+s} is labor income.

The individual's problem is to find those sequences of non-durable consumption and of the stock durable which maximize (1), under the constraint given in (3) and (4).

The solution is derived using the Pontryagin Maximum principle. The Lagrangean associated to the consumer problem is:

$$L_t = E_t \sum_{s=0}^{\infty} \rho^{t+s} u(c_{t+s}, K_{t+s}) - \\ \lambda_{t+s}(A_{t+s+1} - (1+r)(A_{t+s} - c_{t+s} - p_\kappa \kappa_{t+s} + y_{t+s})) \quad (5)$$

Differentiating (5) with respect to the non-durable good gives:

$$a\left(\bar{c} - c_{t+s}\right) + d\left(\overline{K} - K_{t+s}\right) = (1+r)\,\lambda_{t+s} \quad (6)$$

Differentiating (5) with respect to A_{t+s+1} gives the Euler Equation, i.e.:

$$\lambda_{t+s} = (1+r)\,\rho E_{t+s} \lambda_{t+s+1} \quad (7)$$

Differentiating (5) with respect to K_s and using (7), I obtain:

$$b\left(\overline{K} - K_{t+s}\right) + d\left(\bar{c} - c_{t+s}\right) - g\left(K_{t+s} - (1-\delta) K_{t+s-1}\right) + \\ \rho g (1-\delta) E_{t+s}\left(K_{t+s+1} - (1-\delta) K_{t+s}\right) = \tau (1+r)\,\lambda_{t+s} \quad (8)$$

where $\tau \equiv \left(\frac{r+\delta}{1+r}\right)$. Plugging (6) into (8) I can write:

$$\begin{aligned} 0 &= (b - d\tau)\overline{K} + (d - \tau a)(\bar{c} - c_{t+s}) - \\ &- \left(b - d\tau + g\left(1 + \rho(1-\delta)^2\right)\right) K_{t+s} + \\ &+ \rho g(1-\delta) E_{t+s} K_{t+s+1} + g(1-\delta) K_{t+s-1} \end{aligned} \tag{9}$$

Now, define $\mu_{t+s} = (1+r)\lambda_{t+s}$. I guess that μ_{t+s} is given by:

$$\mu_{t+s} = \alpha_1 + \alpha_2 W_{t+s} \tag{10}$$

where

$$W_{t+s} = \sum_{i=0}^{t+s} (E_i - E_{i-1}) \sum_{j=0}^{\infty} \left(\frac{1}{1+r}\right)^j y_{t+s+j} \tag{11}$$

this last is the stock of income innovations. Equation (10) gives an explicit expression for the marginal utility of non-durable consumption, which is substituted in (9) to give:

$$\begin{aligned} &a\rho(1-\delta) g E_{t+s} K_{t+s+1} \left(1 + \frac{m}{\rho} L + \frac{1}{\rho} L^2\right) \\ &= \overline{K}\left(d^2 - ab\right) - \alpha_1 (d - \tau a) - \alpha_2 (d - \tau a) W_{t+s} \end{aligned} \tag{12}$$

where L is the lag operator and $m = \frac{d^2 - a\left(b + \left(1 + \rho(1-\delta)^2\right) g\right)}{a(1-\delta) g}$. Equation (12) is a second-order stochastic equation whose solution[4] is:

$$K_{t+s} = \xi_1 K_{t+s-1} + \frac{1-\xi_1}{\zeta_1}[\zeta_0 - \alpha_2 (d - \tau a) W_{t+s}] \tag{13}$$

where $\xi_1 = \frac{-m - \sqrt{m^2 - 4\rho}}{2\rho}$, $\zeta_1 = d^2 - a(b + \delta g(1 - \rho(1-\delta)))$ and $\zeta_0 = \left(d^2 - ab\right)\overline{K} - \alpha_1 (d - \tau a)$.

The solution is completed by verifying the guess.[5] This amounts to finding the coefficients α_1 and α_2 in equation (10). I turn first to compute α_2, which is the main parameter of interest for my purposes in that it controls for how much non-durable and durable consumption respond to income shocks. The calculations to find α_1 are trivial once

[4] A sufficient condition for this equation to have two real and distinct roots is $b > \frac{d^2}{a} + \delta\rho g$.

[5] Throughout, I assume $\rho(1+r) = 1$.

α_2 is computed. To compute α_2 notice that the ex-ante intertemporal budget constraint can be written as:

$$E_t \sum_{s=0}^{\infty} \left(\frac{1}{1+r}\right)^s c_{t+s} + E_t \sum_{s=0}^{\infty} \left(\frac{1}{1+r}\right)^s p_\kappa \kappa_{t+s} =$$

$$= A_t + W_t - W_{t-1} + E_{t-1} \sum_{s=0}^{\infty} \left(\frac{1}{1+r}\right)^s y_{t+s} \qquad (14)$$

Differentiating (14) with respect to W_t, I have:

$$E_t \sum_{s=0}^{\infty} \left(\frac{1}{1+r}\right)^s \frac{dc_{t+s}}{dW_t} + E_t \sum_{s=0}^{\infty} \left(\frac{1}{1+r}\right)^s p_\kappa \frac{d\kappa_{t+s}}{dW_t} = 1 \qquad (15)$$

From (6) and (13) I know that:

$$\frac{dc_{t+s}}{dW_t} = -\frac{d}{a}\frac{dK_{t+s}}{dW_t} - \frac{\alpha_2}{a} \qquad (16)$$

$$\frac{dK_{t+s}}{dW_t} = \xi_1 \frac{dK_{t+s-1}}{dW_t} - \frac{1-\xi_1}{\zeta_1}\alpha_2 (d - \tau a) \qquad (17)$$

Equation (16) gives the marginal propensity to consume non-durable goods out of a life-time wealth shock, while equation (17) the marginal propensity to consume durable goods out of a life-time wealth shock. Notice that the linearity of the first order conditions implies that there is no distinction between the marginal and the average propensity to consume. Using the boundary condition that $\frac{dK_{t-1}}{dW_t} = 0$, equation (17) is solved[6] with respect to $\frac{dK_{t+s}}{dW_t}$ to give:

$$\frac{dK_{t+s}}{dW_t} = -\frac{\alpha_2 \left(1 - \xi_1^{s+1}\right)(d - \tau a)}{\zeta_1} \qquad (18)$$

Plugging $\frac{dc_{t+s}}{dW_t}$ and $\frac{dK_{t+s}}{dW_t}$ into equation (15) and solving with respect to α_2 and substituting in for ζ_1 I obtain:

$$\alpha_2 = -\frac{r(ab - d^2 + a\delta g(1 - \rho(1-\delta)))}{(1+r)(b + a\tau - d(1+\tau) + \delta g(1 - \rho(1-\delta)) + \theta_1 + \theta_2)} \qquad (19)$$

where:

$$\theta_1 = \frac{(1-\delta)(1-\xi_1)(d - a\tau)(1 + r + r\xi_1)}{(1+r)(1+r-\xi_1)}$$

$$\theta_2 = -\frac{(a-d)(a\tau - d)\xi_1 r}{a(1+r-\xi_1)}$$

[6]Recall that $\xi_1 < 1$.

With α_2 on hand, α_1 can be computed solving the intertemporal budget constraint. I omit these calculations for brevity. Moreover, knowing α_2 allows us to compute the marginal propensity to consume shocks to the life-time wealth. This is done plugging the value of α_2 into (18) and (16).

Before turning to the computation of an explicit solution for the marginal propensity to consume permanent and transitory income shocks, it is worth noticing (see expressions (16)-(18)) that non-durable and durable consumption are linear functions of W_t. This implies that income innovations translate into consumption innovations in a linear fashion.

2.1 An Explicit Solution

In order to give an explicit solution for the marginal propensity to consume permanent and transitory income shocks, I need to make assumptions on the income process. As in Carroll (1992), I postulate that income is the 'sum' of two components, one which follows a random walk, possibly with drift, and the other which is white noise. Formally,

$$y_{t+s} = p_{t+s} + \varepsilon_{t+s} \tag{20}$$

$$p_{t+s} = p_{t+s-1} + u_{t+s} \tag{21}$$

where ε_{t+s} is termed as the transitory shock and u_{t+s} the permanent shock. I assume that ε_{t+s} and u_{t+s} are uncorrelated at all leads and lags and that both are i.i.d with finite variance. Under this income process, income innovations at time $t+s$ are given by:

$$\Delta W_{t+s} = \left(\frac{1+r}{r} u_{t+s} + \varepsilon_{t+s} \right) \tag{22}$$

Now, inserting (22) into (18) gives:[7]

$$\Delta K_{t+s} = -\frac{\alpha_2 \left(1-\xi_1\right)\left(d-\tau a\right)}{\zeta_1} \left(\frac{1+r}{r} u_{t+s} + \varepsilon_{t+s} \right) \tag{23}$$

This is the innovation at time $t+s$ in the stock of durable goods. To compute the innovation at time $t+s$ in non-durable consumption, I plug equation (23) into the discrete version of (16):

$$\Delta c_{t+s} = -\frac{\alpha_2}{a}[1 - d\frac{\left(1-\xi_1\right)\left(d-\tau a\right)}{\zeta_1}] \left(\frac{1+r}{r} u_{t+s} + \varepsilon_{t+s} \right) \tag{24}$$

[7]Linearity implies that first differences can be approximated by first derivatives.

Thus, the marginal propensity to consume non-durable consumption (henceforth, marginal propensity to consume) out of permanent income shocks is given by:

$$f_1 = -\frac{\alpha_2 (1+r)}{ar}[1 - d\frac{(1-\xi_1)(d-\tau a)}{\zeta_1}] \tag{25}$$

while the marginal propensity to consume transitory income shocks is given by:

$$f_2 = f_1 \frac{r}{1+r} \tag{26}$$

In the next section I analyze the role of non-separabilities and adjustment cost and I spell out under which conditions the presence of non-separabilities and adjustment costs can rationalize the finding of a low marginal propensity to consume permanent income shocks.

2.2 Interpretation

In this section I provide intuition why non-separabilities and adjustment costs can play a role in explaining a low marginal propensity to consume permanent shocks (MPC, henceforth). I consider three cases: separability of non-durable and durable goods; non-separability of non-durable and durable goods; non separability *and* costly adjustment. The first case is obtained setting d and g to zero in (19) and in (25). The second case is obtained setting g to zero in in (19) and in (25). The third case can be seen as the unrestricted case. Comparing the second with the first case allows me to illustrate the role of non-separabilities. Instead, comparing the third with the second case sheds light on the role of the adjustment costs, conditional on preferences not being separable over non-durable and durable goods.

In the first case, it is easy to show :

$$\alpha_2 = -\frac{rab}{(1+r)(b+a\tau^2)} \tag{27}$$

which gives MPC[8] defined as:

$$f_1(a, b, 0, \delta, 0) = \frac{b}{(b+a\tau^2)} \tag{28}$$

Now, consider the case where non-durable and durable goods are non-separable and the stock of durable goods can be adjusted at no cost.

[8] Setting $\delta = 1$ gives $f_1(a, b, 0, 1, 0) = \frac{b}{(b+a)}$.

In this case:

$$\alpha_2 = -\frac{r\left(ab - d^2\right)}{(1+r)\left(b + a\tau^2 - 2d\tau\right)} \tag{29}$$

while the MPC[9] is:

$$f_1\left(a, b, d, \delta, 0\right) = \frac{b - d\tau}{\left(b + a\tau^2 - 2d\tau\right)} \tag{30}$$

A few things are worth noticing. If we set d to zero in (30) we go back to (28). Second, if we set $a = b$, which amounts to requiring that consumers weight non-durable and durable consumption in the same way, (28) is greater than (30) when non-durable and durable goods are complements, while the opposite is true when they are substitutes This means that under complementarity of non-durable and durable consumption non-durable consumption is less responsive to permanent income shocks than in the case of separability. Intuitively, suppose the consumer receives a positive news which causes him to permanently update his life-time wealth. Because of this news, he buys, say, a new car, which reduces the marginal utility of durable consumption. Thus, the marginal utility of non-durable consumption has to decrease, i.e. non-durable consumption must increase. However, when durable and non-durable goods are complement (i.e. $d < 0$), a smaller increase of non-durable consumption is needed at the optimum since the increase in the stock of cars reduces the marginal utility of non-durable consumption. Thus, non-separabilities seem to be important when the response of non-durable consumption to income shocks has to be assessed.

In Table 1 I report the MPC as obtained under a set of assumptions on the depreciation rate, the adjustment costs and the degree of non-separability. For a given degree of complementarity (respectively, substitutability) the MPC decreases when the adjustment costs increases. This number can be very low when the degree of non-separability is particularly high (see the last two columns of the table).

To clarify this, suppose that a consumer receives a negative permanent shock. This causes the optimal level of non-durable and durable consumption to reduce. However, he faces adjustment costs when he tries to reduce his durable consumption. This makes it optimal to reduce durable consumption at a level which is greater than the 'long run' level. This, in turn, increases the marginal utility of durable consumption less than in the case without adjustment costs. The same needs to happen to the marginal utility of non-durable consumption, since,

[9] Setting $\delta = 1$ gives $f_1\left(a, b, d, 1, 0\right) = \frac{b-d}{(b+a-2d)}$.

at the optimum, the marginal rate of substitution between durable and non-durable must be equal to the user cost. If non-durable and durable goods are complements, this effect is reinforced, while substitutability weakens it. However, the overall effect of adjustment costs on the MPC income shocks is negative. The higher are adjustment costs the less responsive is non-durable consumption to permanent income shocks.[10].

This arises form Figures 1-4, where I plot the MPC against the adjustment costs. The four figures differ for the assumptions on the depreciation rate, that goes from 0.10 in Figure 1 to 0.25 in Figure 4. The features arising from Table 1 are confirmed: the MPC decreases if the adjustment costs increase. Interestingly, the difference between the MPC in case of complementarity (i.e. the dashed line in the four graphs) and the MPC in case of substitutability increases as the depreciation rate increases. The bigger is the depreciation rate, the higher is the user cost. Higher user costs cause the consumer to substitute away more from durable to non-durable consumption, which, in turn, makes non-durable consumption more responsive to permanent income shocks. As a limiting case, when the depreciation rate is 1, the MPC in the case of substitutability is very close to 1: intuitively, given that the two goods are substitute and the 'durable' good does not provide services for more than one period, but its stock can be adjusted only at a cost, consumers trade-off the 'durable' good with the non-durable good.

Summarizing, this section has identified how non-separability between durable and non-durable goods and adjustment costs can play a role in explaining why consumers do not seem to react to permanent income shocks in the way predicted by the simple LC-PI model. From Table 1 and 1-4 this general picture arises: non-seprability lowers the MPC if the adjustment costs are positive; the higher are adjustment cost, the lower is the MPC; the MPC is lower in the case of complementarity than in the case of substitutability for each level of the adjustment costs; the higher is the depreciation rate the wider is the gap between the MPC when non-durable and durable consumption are substitutes and the MPC when non-durable and durable consumption are complements.

[10] The marginal propensity to consume permanent income shocks in the standard case (i.e. $d = g = 0$) is .98.

3 The Data

I use a micro-dataset. The main reason for that is to account for individual heterogeneity, while the use of a linear-quadratic model weakens the argument by which microdata are always superior to macro data.

The data are drawn from the 1989 and 1991 waves of the Italian Survey of Household Income and Wealth (SHIW). I use only these two waves due to the identification strategy I follow. The main problem in estimating an equation like (24) is that permanent, u_{t+s}, and transitory, ε_{t+s}, shocks are not observable. Below, I show how subjective information can be used to make permanent and transitory shocks observable. So, I take only those waves which provide them.[11]

The SHIW is ran by the Bank of Italy which surveys a representative sample of the Italian resident population. Sampling is in two stages, first municipalities and then households. Municipalities are divided into 51 strata defined by 17 regions and 3 classes of population size (more than 40,000, 20,000 to 40,000, less than 20,000). Households are randomly selected from registry office records. From 1987 through to 1995 the survey was conducted every other year and each wave sampled about 8,000 households, defined as groups of individuals related by blood, marriage or adoption and that shared the same dwelling. Starting in 1989, each SHIW has re-interviewed some households from the previous surveys. The net response rate (ratio of responses to contacted households net of ineligible units) was 64 percent in 1987, 38 percent in 1989, 33 percent in 1991, 58 percent in 1993, and 57 percent in 1995. Further details on sampling, response rates, processing of results and comparison of survey data with macroeconomic data are provided by Brandolini and Cannari (1994).[12]

I use demographics, such as the number of kids, the family size, the family type, the number of family members aged more than 65 and so on; labor supply variables, such as the number of earners; income variables, such as labor income from employment and self-employment and pensions, net of social security contributions; subjective information variables: the expected inflation and growth rate of income a year

[11] Subjective income variables are available for 1995. They are not used being collected in a completely different way with respect to the 1989 and 1991 waves.

[12] In the panel section, the net response rate was 25 percent in 1989, 54 percent in 1991, 71 percent in 1993, and 78 percent in 1995. The lower attrition rates in 1991-1995 reflect the fact that participation was made voluntary after 1989. According to Bank of Italy statisticians the amount of attrition is relatively modest (Brandolini (1998)).

ahead; and the value of the stock of three categories of durable goods: real goods, such as jewelry and other valuables; vehicles, such as cars and motor bikes; small durable goods, such as furniture and black and white durable goods.

I select in males who are head of the household and discard observation with missing values on the variables used in the empirical analysis (such as labor income and subjective expectation information). This leave me with 1126 households followed for two years.

Few papers have exploited this information on subjective expectations, noticeable exceptions are Guiso, Jappelli and Terlizzese (1992), Jappelli and Pistaferri (1997), Pistaferri (1998) and Duso (1999).

Subjective information are available for the labor income and the pension recipients. They are asked to attribute a probability to given intervals of inflation and nominal income increases one year ahead. Both the 1989 and the 1991 waves of the SHIW contain a set of questions to elicit subjective information on the inflation and on the growth rate of the nominal income one year ahead. The inflation and the growth rate of the nominal income are bracketed in 12, mutually excluding, classes. The respondent is asked to distribute 100 points to these classes. Each of these classes is given a weight, which is zero if the respondent excludes the inflation (respectively, the growth rate of nominal income) from falling in that class. These classes are: less than zero; 0-3; 3-5; 5-6; 6-7; 7-8; 8-10; 10-13; 13-15; 15-20; 20-25; >25 per cent. Following Pistaferri (1998), I cap the upper open interval to 35 per cent.

In order to compute the moments of this distribution, I attribute all the weight that the respondent assigns to a given class to the mid point of it. This second alternative is chosen due to its analytical simplicity. Under this assumption the first moment of the inflation (respectively, the growth rate of nominal income) distribution is computed as:

$$E\left(x_{it+1}|\Im_{it}\right)=\sum_{k=1}^{K}\Pr\left(x_{it+1}\in\left[x_{k-1},x_{k}\right]\right)\frac{x_{k-1}+x_{k}}{2} \qquad (31)$$

while the second moment is:

$$E\left(x_{it+1}^{2}|\Im_{it}\right)=\sum_{k=1}^{K}\Pr\left(x_{it}\in\left[x_{k-1},x_{k}\right]\right)\left(\frac{x_{k-1}+x_{k}}{2}\right)^{2} \qquad (32)$$

To make the subjective information variable operational I use few transformations. First, the *real* growth rate of income is computed

as the difference between the nominal growth rate of income and the inflation rate. Second, given that I estimate a model in *first difference*, in order to identify the income shocks from the expected *growth rate* between period t and period $t+1$, I compute the following:
$y_{it}E\left(\frac{y_{i,t+1}-y_{it}}{y_{it}}|\Im_{it}\right)$

Without entering the debate of how well measured are these expectations, I just point out that there is no reason to believe that the measurement error problems present in any survey are exacerbated when the subjective income expectations are elicited.[13]

The following three subsections provide detailed statistics on the three categories of durable goods surveyed in the SHIW. With the noticeable exception of Brugiavini and Weber (1992), who focus on vehicles, few studies have used this data to analyze the demand for durable goods. To gauge the quality of the data, the sample I used to generate these statistics come from the 1989, 1991, 1993 and 1995 waves of the SHIW. Around 30000 households are interviewed across these four waves of the SHIW.[14] Households with missing information on the stock of durable goods were discarded.[15]

3.1 Real Goods

Real goods data refers to the real goods owned by the household at the end of the calendar year before the interview. They mainly refer to goods like jewelry, paintings, and other valuables. Households are asked if they bought or sold a real good and the amount of money they paid or received.

The mean of value of the stock of real goods is around 2459 Euros, while the median is 841. Conditional on ownership, the mean is 2913 and the median is 1291.[16] Around 16% of the sample does not own any

[13] Another problem is how to compare what a consumer expects with what consumer actually does, given that the subjective expectation refers to a location measure of the future income distribution, while what actually we do observe is just a point of this distribution.

[14] To compute the statistics which follow I do not exclude from the sample the panel component. However, results do not significantly change when the panel component is excluded.

[15] 3787 households have missing stock of real goods, 1137 missing stock of vehicles and 2037 missing stock of small durable goods. Some selection may operate because missing observation are found for less wealthy family. In what follows I check if the sample statistics are robust to endogenous selection.

[16] All these statistics are computed using the sample weights provided by the Bank of Italy.

real goods. These statistics are reported in Table 2. The expenditure in real goods averages around 97 Euros, while this figure reaches 928, when conditioning on the expenditure being positive. In a stationary environment and under the life-cycle model with certainty equivalent, the ratio of the stock of real goods to the non durable consumption is a proxy for the marginal propensity to consume real goods out of the permanent resources. Its average in the sample is 0.15, while the median is around 0.06. After conditioning on the stock of real goods being positive, these numbers become, respectively, 0.18 and 0.08. Moreover, the hypothesis that the unconditional mean of this ratio and the mean conditional to the stock of real goods being positive are the same can be rejected. This suggests that aggregate figures can be a very poor guide to understanding the consumer's choice over durable and non-durable goods.

Interesting features of the data arise when the time-series behavior of the stock of real goods is analyzed. Even if the time series available to me is not very long, they include two significant macroeconomic episodes: the recession in 1993 and the slow recovery in 1995.

The stock of the real goods drops in 1993 by around 25%. This can be due either to a drop in the value of the stock of real goods, which, eventually, comes from households owning less valuable good or more depreciated goods, or to a drop in the proportion of households owning any real good, which may suggest that during recessions individuals run down their 'family jewels', or, obviously, to a composition of the two effects. Given that the number of missing observations is unevenly distributed across the four waves, I control for endogenous selection.[17] This, however, does not change the overall picture: the drop in 1993 is robust to the presence of endogenous selection.

Conditioning on ownership, the stock of real goods is observed to decrease by *only* 11%, thus supporting the intuition that the running down of assets and the drop in ownership are important pieces of the picture. On the other hand, the ratio of the stock of real goods to non-durable consumption, is observed to decrease in the 1993 wave, which may suggest that the elasticity of the stock of real goods to the permanent income is procyclical.

[17]The selection equation depends of the age of the head of the households, her educational attainment and the stock of real asset.

3.2 Vehicles

The data on vehicles refers to the stock of vehicles owned by the household at the end of the calendar year before the interview. Households are asked if they bought or sold a car (and, if so, how much they paid or had been paid for the car).

The mean of the value of the stock of vehicles is 3941 Euros, while the median is 2352. Conditional on ownership, the mean is around 5165 and the median is 3804.[18]

Around 24% of the sample does not own any vehicle. The expenditure for vehicles averages around 772 Euros, while this figure reaches 5912, when conditioning on the expenditure being positive. The proportion of households who are observed to buy a vehicle averages around 13%, while the ratio of the stock of vehicles to annual disposable income is 0.20, reaching 0.27 when those households with no vehicles are removed. This roughly implies that households need to work for around three months to pay for their vehicle.

The mean ratio of the stock of vehicles to the non-durable consumption is around 0.26, while the median is around 0.18. After conditioning on the stock of real goods being positive, these figures become, respectively, 0.34 and 0.27. This confirms that aggregate figures can be a very poor guide to understanding consumers' choices between the durable goods and the non-durable goods. The hypothesis that the conditional and the unconditional ratio are the same is rejected at the 5% level.

Some interesting patterns appear when the time-series behavior of the stock of vehicles is investigated. The stock of the vehicles do not drop in 1993. Also, the number of missing observations for the stock of vehicles is concentrated more in the first two years. Controlling for possible sample selection does not lead to substantial change in the time-series profile of the stock of vehicles.

The proportion of vehicle owners in the sample slightly decreases from 1989 to 1991 and afterwards increases. This may partially explain way I do not observe a drop in the mean of the stock of vehicles similar to the one observed for the stock of real goods. However, conditioning on ownership, the stock of vehicles is observed to decrease by about 8% from 1991 to 1993, which suggests that households do not run down their asset, but delay replacing old vehicles during recession.

Finally, the ratio of the stock of vehicles to the non-durable consumption, is pretty much constant from 1989 to 1995. Thus, the elas-

[18] All these statistics are computed using the sample weights provided by the Bank of Italy.

ticity of the stock of vehicles to the permanent income does not exhibit any particular cyclical behavior.

To give a summary description of the data, I group households in 11 classes, based on the age of the head of the household. The first group includes those households whose head is aged less than 25 and the last those households whose head is aged more than 75.

In Figure 5 I plot the value of the stock of vehicles against age, finding the stock of vehicles profile to be hump-shaped, with a dramatic drop after age 60, as noticed by Brugiavini and Weber (1992).

This decrease may be explained by the decline in the value of the vehicles bought by old people and by the decline of the number of persons owning a vehicle. The first, eventually, comes from old people holding very depreciated vehicles, while the decrease in the vehicle ownership may arise from those individuals who at old ages do not replace their car when they dispose of it.

To control for the possible drop in ownership, Figure 6 plots the observed probability of being car owner at each age, which is seen to decrease at around 60. On the other hand, as Figure 7 shows, when only car owners are selected, the value of the stock of vehicles is quite stable across the age groups until age 65. However, after that age I observe a drop which may be better explained in terms of old households owning older cars.

Another possibility is that the age-profile of the value of the stock of vehicles is mainly driven by the dynamics in the size of the household, especially in the last part of the life-cycle. The argument is that the reduction on the value of the stock of vehicles at old ages reflects the contraction of the family needs. To account for that, I plot in Figure 8 the residuals[19] of the regression of the stock of vehicles on the size of the family against age. Even if less pronounced than in Figure 5, controlling for the number of family components does not clear the hump in the age profile of the stock of vehicles. This suggests that the hump-shape of the age-profile of the stock of vehicles may help to explain the hump shape in the age-profile of non-durable expenditures, beyond the correlation with the family needs.

So far I presented some evidence on the life-cycle profile of the holding of vehicles. However, splitting the sample only according to the age of the households does not allow us to separately identify the age, time and cohort effects. In particular, the hump-shape in the life cycle profile of the stock of vehicles could be due to the fact that

[19] The residuals are normalized to be non-negative.

individuals observed at different ages, but in the same year, belong to different cohorts.

To correctly attribute the hump-shape to the effect of ageing I need to partial out the age affect from the cohort and the year effect. To do that, I select out those households whose head is born before 1910 and after 1970, thus ensuring the age-profile is not contaminated by the presence of extreme outliers, i.e. households whose head is very young or very old.[20]

Cohort membership is based on the year of birth of the head of the household. I split the sample in 12 cohorts. The cohort 1 groups households whose head is born between 1910 and 1915, the cohort 2 those whose head is born between 1916 and 1921 and so on. Households whose head is born between 1965 and 1970 belong to the last cohort.

To estimate the age effect I adopt the methodology proposed in Deaton and Paxson (1994). To achieve identification, the time effect is constrained to be orthogonal to a time trend and to sum up to zero. Whether or not this normalization is appropriate depends on the problem under scrutiny. In other situations, normalizing, say, the cohort effect could be more appropriate.

I estimate a regression on a set of cohort dummies, constrained year dummies and on a third order polynomial in age: the age effect, which is displayed in Figures 9 and 10, is computed as the first derivative of this regression with respect to age. This is a slightly non-standard way of reporting the age-effect, which I use since the overall age-effect depend on the normalization chosen. The age-profile of the stock of vehicles reaches its maximum when the age-effect crosses the x-axis.

In Figure 9 I plot the age effect for the stock of vehicles. It is monotonically decreasing and it crosses the zero x-axis at around age 38. Notice that in Figure 5 the maximum is at around age 50, which means that cohort effect might be responsible for that. However, the graph confirms that the age-profile of the stock of vehicles is hump-shaped.

The same pattern arises when comparing Figure 6 with Figure 10. From this last Figure the ownership starts dropping at around age 60, while in Figure 6 the drop in ownership are observed at an earlier age. Even in this case, the hump-shaped profile is confirmed. For brevity I do not report the age-effect obtained after controlling for ownership and for family size. In both cases, the same pattern as in Figures 5 and

[20] Households headed by very young or very old individuals are likely to be very wealthy.

8 arises. However, cohort effects seem to be responsible of the earlier age at which the age-profile of the stock of vehicles peaks.

3.3 Small Durables

This category is quite broad including durable goods such as furniture and all "white" and "black" durable goods. Households are asked to report the value of the stock of small durable goods owned at the end of the calendar year before the interview. Moreover, households are asked if they bought small durable goods (and, if so, how much they paid).

The mean of the value of the stock of small durable goods is 7089 Euros, while the median is 4652. Conditioning on ownership does not affect these figures. This is because the proportion of household not owning at least one of the goods belonging to the category of small durable goods is virtually zero. Moreover, many of the goods which fall in this category might be considered as 'necessities'.[21]

The expenditure on small durable goods averages around 401 Euros, while this figure reaches 1641, conditioning on positive expenditure. The proportion of households who are observed to buy a small durable good averages around 23%, while the ratio of the stock of small durable goods on the annual disposable income is 0.45, reaching 0.46 after taking out non-owners.[22] This roughly implies that it would take almost six months for a household to pay for its annual small durable purchases.

The ratio of the stock of small durable goods to the non durable consumption is around 0.52, while the median is around 0.37. The figures I obtain when conditioning on ownership do not change. In that respect, micro-data does not seem to have any added value over aggregate data. This can be due to the category, which is termed here as 'small durables', being quite broad, thus suggesting that the very small number of non-owners found in the sample can be due to this broad definition.

[21] I regressed the log of the value of the stock of small durable goods on the log of the non-durable consumption and on a time trend. The coefficient of the log of non-durable consumption, which might be interpreted as the elasticity of the stock of small durable goods to the permanent income, is slightly above 1, while the same number is significatively above 1 for the category of the real goods and around 1 for the vehicles. All these figures are robust to eventual endogenous selection.

[22] Taking out those who do not own small durable goods does not change the picture: the standard error in the case where the non-owners are included is 0.021, while when non-owners are included is 0.020.

Next, I turn to the time-series profile of the stock of small durable goods. I cannot reject the hypothesis, at the 5% level, that the stock of small durable goods is roughly constant from 1989 to 1995. I do not observe a statistically significant drop in 1993, as was the case with the other two categories of durable goods. The number of missing observations for the stock of small durable goods is not uniformly distributed across the four waves of data. However, controlling for selection does not change the time-series behavior of the stock of small durable goods.

The proportion of households who own at least one of the goods belonging to the category of small durable goods is fairly constant across all years and close to one. The 1993 recession does not affect this figure in any substantial way. Households neither run down their stocks nor they delay replacement.

Finally, the ratio of the stock of small durable goods to the non-durable consumption, is fairly constant. This suggests that the elasticity of small durable consumption to lifetime resources does not vary at business cycle frequencies.

I split the sample by age-group. Given that the proportion of non-owners is negligible, I report data obtained by selecting only owners. The proportion of owners reaches its minimum at age 77 (0.98), its maximum (0.99) before age 40 and is generally decreasing.

Figure 11 displays the value of the stock of small durable goods as a function of age. It decreases from age 25 to just before age 40; then, it start increasing and it reaches its maximum at around age 50.[23] This pattern persists when I control for family size. The graph obtained after controlling for the family needs is quite similar to Figure 11, and, thus, is not reported.

I try to separate the influences of the age, cohort and time effects. After regressing the value of the stock of small durable goods on a set of cohort dummies, the restricted time dummies discussed earlier and on a third order polynomial on age, I can separately identify age, cohort and year-effects. Figure 12 plots the age-effect on the stock of small durable goods. This graph supports the picture which arises from Figure 11. The stock of small durable goods start decreasing, then increases and afterwards decreases again. It reaches its maximum earlier than in Figure 11, thus suggesting that cohort effects might be relevant in shaping the age-profile of the value of the stock of small durable goods.

[23]Households renewing just once theirs stock of small durable goods after the start of the family are consistent with these figures.

4 Econometric Issues

4.1 The Consumption Function and the Lucas' Critique

The marginal propensity to consume permanent and transitory income shocks can be recovered from the estimation of equation (24), which is obtained by first differencing the consumption function. Quadratic preferences and the assumed income process allow us to write non-durable consumption changes as a function of income innovations (both permanent and transitory shocks).

The estimation of consumption functions is not free of problems. Notice that equation (24) is not an equilibrium relation, rather it is a behavioral function. To clarify why this might be a problem, suppose that equation (24) is estimated using aggregate time-series data. Abstracting for a while from the set of issues which arise because the permanent and transitory income shocks are not observable, suppose that prices and interest rates change over time in an unpredictable way. Prices and interest rates act as parameters in the estimation of the Consumption Function. This implies that non-durable consumption at date t is drawn from a different distribution than non-durable consumption at date $t+1$. The researcher who estimates the Consumption Function using non-durable consumption at dates t and $t+1$ incurs in the Lucas' Critique: the Consumption Function cannot be estimated and identified from these data because it is a non-*stable* relation.

The conditions under which the consumption function may estimated depend on the nature of the data used in the estimation. If data are drawn from a single-cross-section, I need to assume that the parameters do not vary in the cross-sectional dimension in an unpredictable way, i.e. that all households face the same prices and interest rates.[24]

The next section points out the conditions which allow me to consistently estimate the parameter of interest using cross-sectional data.

4.2 Consistency and the Chamberlain's Critique

The main problem with estimating equations like (24) is that permanent and transitory income shocks are not observed. Thus, they collapse into the error term. However, the Rational Expectation Hypothesis endows this error term with special properties: the error at, say, time t cannot be predicted using information available at time $t-1$.

[24]Notice that varying prices and interest rate imply that each household is endowed with its own marginal propensity to consume permanent and income shocks.

Thus, the error term is weakly exogenous and consistent estimates can be based in the following orthogonality condition:

$$E(\eta_t|\Im_{t-1}) = 0 \tag{33}$$

where $\eta_t = \frac{1+r}{r}u_t + \varepsilon_t$. When panel or pseudo panel data are available, two sample analog of condition (33) are often proposed. One, which takes the conditional average of the error term with respect to t, the time-period, i.e.:

$$p\lim_{T\to\infty} \frac{1}{T}\sum_{t=1}^{T} \eta_{ti}x_{it-1} = 0 \tag{34}$$

where i and t are the household and the time index; x_{it-1} belongs to the information set available at t;[25] while the other takes the conditional average of the error term with respect to i, the number of households, i.e.:

$$p\lim_{N\to\infty} \frac{1}{N}\sum_{i=1}^{N} \eta_{ti}x_{it-1} = 0 \tag{35}$$

As pointed out by Chamberlain (1994) there is no reason to expect the probability limit in (35) to be zero. For instance, common shocks cause expectation errors to be correlated across households, which prevents the probability limit in (35) from converging to zero. This is why consistent estimates need a long panel, i.e. consistency relies on the time-dimension being large.

Subjective price and income expectations allow us to circumvent this problem, (see Hayashi (1985) and Pistaferri (1998)). In the next section, I show how subjective information are used to identify permanent and transitory income shocks. Once these shocks are identified and *observable*, the Chamberlain's Critique is redundant in that income shocks do not fall into the error term.

4.3 Identification of Income Shocks

To simplify the exposition, I will restate the assumptions on the income process made in the theoretical section. Income is the 'sum' of two components, one which follows a random walk, possibly with drift, and the other which is white noise. Formally,

$$y_{it} = p_{it} + \varepsilon_{it} \tag{36}$$

$$p_{it} = p_{it-1} + u_{it} \tag{37}$$

[25] $\Im_t \subset \Re$.

where ε_{it} is termed as the transitory shock and u_{it} the permanent shock. I assume that ε_{it} and u_{it} are uncorrelated at all leads and lags and that both are i.i.d with finite variance.

First differencing equation (37) and taking the expectation with respect to the information available at time $t-1$, I obtain:

$$\varepsilon_{it-1} = -E\left(\Delta y_{it} | \Im_{it-1}\right) \tag{38}$$

Now, subjective price and income expectations make the RHS of equation (38) observable, since individuals are asked what is the price and the income growth they expect one-year ahead. This is the heart of the identification strategy.[26]

After having identified the transitory shock, I can recover the permanent shock, i.e.:

$$u_{it} = \Delta y_{it} - E\left(\Delta y_{it+1} | \Im_{it}\right) + E\left(\Delta y_{it} | \Im_{it-1}\right) \tag{39}$$

Notice that both the expectation term in the RHS of equation (39) are made observable by subjective income and price expectations. Thus, permanent shocks are observed.

4.4 The Estimating Equation

This section presents the equation I estimate and clarifies what parameters the specification chosen can identify.

To recover the marginal propensity to consume I could use the following:

$$\Delta c_{t+s} = -\frac{\alpha_2}{a}[1 - d\frac{(1-\xi_1)(d-\tau a)}{\zeta_1}]\Delta W_{t+s} \tag{40}$$

where $\Delta W_{t+s} = \left(\frac{1+r}{r} u_{t+s} + \varepsilon_{t+s}\right)$ and the marginal propensity to consume is defined as:

$$MPC = -\frac{\alpha_2}{a}[1 - d\frac{(1-\xi_1)(d-\tau a)}{\zeta_1}] \tag{41}$$

Notice, however, that the model with separable preferences (or the model with non-separable preferences and no adjustment costs) delivers

[26] It is worth noticing that the identification of the transitory shocks using the subjective income expectation rests on the assumption that individuals cannot forecast the transitory shocks at time t using the information available at time $t-1$, which amounts to requiring the absence of autocorrelation in the process generating the transitory shock.

an estimating equation like (40). Thus, equation (40) does not identify the key parameters and cannot be used to test if non-separabilities and adjustment costs affect the marginal propensity to consume.

Alternatively, I propose estimating the following:

$$\Delta c_{t+s} = \beta_1 \Delta K_{t+s-1} + \beta_2 \Delta W_{t+s} \tag{42}$$

where $\beta_1 = -\frac{d}{a}\xi_1$, $\beta_2 = -\frac{\alpha_2}{a}[1 - d\frac{(1-\xi_1)(d-\tau a)}{\zeta_1}]$, which is derived from equations (16) and (17). In order to estimate equation (42), I need to construct the innovation at time $t+s$, which depends on the permanent shock, the transitory shock and the interest rate at that time. However, in the present exercise, interest rates are treated parametrically and I let the data to determine the coefficient of the permanent shock and that of the transitory shock. The coefficient of the permanent shock is interpreted as the marginal propensity to consume out of the permanent shocks. This leads to specify the following:

$$\Delta c_{t+s} = \beta_1 \Delta K_{t+s-1} + \beta_2 \varepsilon_{t+s} + \beta_3 u_{t+s} \tag{43}$$

where $\beta_3 = \beta_2 \frac{1+r}{r}$.

Equation (43) is used to estimate the response of individuals to transitory shocks and to test if durable and non-durable consumption are non-separable, which corresponds to β_1 to be equal to zero. In the next section I present the results.

5 Results

Absent measurement error, the fit of equation (43) would be perfect. Thus, I augment equation (43) by a classic measurement error which drives my estimates. The availability of a large cross-section (around 1100 households) ensures consistency.

In the specification above, the change of non-durable consumption at time t depends, among other things, on the change of the stock of durable goods at time $t-1$. This is so because of the non-separabilities and of the presence of convex adjustment costs. The stock of durable goods is observed every other year and at the end of the period. To compute the stock of durable goods at the beginning of the period I iterate back equation (4). To do so I need the net expenditure on durable goods and the depreciation rate. The first are observed, while I experiment with the second. I assume that the depreciation rate may take the following values: 10%, 15%, 20%, 25%.

The estimation of the equation (43) can be used to test a set of assumptions and to estimate the marginal propensity to consume out of permanent shocks. Non-separability between non-durable and durable goods may lower the marginal propensity to consume (see Table 1). In particular, the marginal propensity to consume out of permanent shocks is lower under complementarity than under substitutability. Complementarity between non-durable and durable consumption corresponds to β_1 being positive. Adjustment costs make less intense the response of individuals to shocks. This contributes to lowering even further the marginal propensity to consume out of permanent shocks compared to the case with zero adjustment costs (see Figures 1-4).

In the first column of Table 3, I report the baseline specification, where durable goods do not enter the RHS of the consumption function. The change in consumption is estimated as a function of the change in the family size and the change in the number of earners[27] as well as the permanent and the transitory shocks.

All the coefficients are well determined. The marginal propensity to consume permanent income shocks is around 0.25. Table 1 shows that the marginal propensity to consume permanent income under separability between non-durable and durable goods and no adjustment costs was predicted to be around 0.94, depending on the depreciation rate. The estimated value is below its theoretical counterpart.[28]

In the second column of Table 3, the baseline specification is augmented by the change in the stock of real goods, which enters with a positive coefficient. This is interpreted as evidence of non-separabilities. Moreover, the positive sign of this coefficient suggests that the non-durable and durable consumption are complements. The marginal propensity to consume permanent income shocks decreases to around 0.17, thus confirming that the complementarity between non-durable and durable consumption can explain why individuals do not seem to react much to income shocks.

In the third column of Table 3, the baseline specification is augmented by the change in the stock of vehicles. The coefficient of this variable is positive and significant at standard levels, which means that non-durable consumption and vehicles can be thought as complement. The marginal propensity to consume is around 0.24, which is a value

[27] I assume that either the bliss points of non-durable and durable consumption, i.e. $\overline{c}$ and $\overline{K}$, are function of the family size and of the number of earners.

[28] This comparison between theoretical and estimated values has to be taken with care, since in the theoretical model I assume that the bliss point is constant while here the bliss point depends on family size and the number of earners.

higher than in the case of real goods. This is consistent with the fact that the coefficient on the stock of vehicles is lower than that on the stock of real goods.

In the fourth column of Table 3, the baseline specification is augmented by the change in the stock of small durable goods. The coefficient of this variable is positive and significant at standard levels. Thus, also small durable goods and non-durable consumption can be thought as complements. The marginal propensity to consume permanent income shocks is around 0.22.

The last column of Table 3 reports the baseline specification augmented by an *aggregate* durable good obtained as the sum of the three durable good categories considered in this study. The coefficient of the change of the stock of durable good is positive and significant at standard levels, which confirms that non-durable and durable consumption may be complements. The marginal propensity to consume permanent income shocks reduces to 0.21. This may be due to the fact that the three durable goods categories exhibit different degrees of complementarity with non-durable consumption.

The overall picture arising from this first set of estimates suggests that non-separability and adjustment costs matter in shaping the response of consumers to income shocks. Notably, for some parameters' values the estimated marginal propensity to consume out of permanent shocks can be made consistent with that predicted by the theory (see the last two columns of Table 1 and Figures 1-4).

The results in Table 3 use two important assumptions. First, it is assumed that the time horizon is infinite. In Table 4, I interact the transitory shocks with the age of the head of households, to account for the fact that the marginal propensity to consume transitory shocks change with age. The results shown in Table 4 broadly confirm the picture which arises when consumers are assumed to be altruistic.

Second, it is assumed that the depreciation rate of the three expenditure categories is equal to 10%. Trying with depreciation rates equal to 15%, 20% and 25% does not change the shape of the results. The three categories of durable goods are found to be complement with non-durable consumption. Table 5 reports the marginal propensity to consume permanent shocks under these three assumption on the depreciation rate, if time horizon is infinite, while Table 6 displays the marginal propensity to consume permanent shocks, as a function of the depreciation rate, when account is given for the fact that the time horizon is indeed finite. Table 5 and 6 confirm the general picture: low marginal propensity to consume can be made consistent with the theory when non-durable and durable goods are complements. Overall, these results suggest that the complementarity between non-durable and durable consumption lowers the marginal propensity to consume permanent income shocks and that there are parameter values able to reconcile the evidence with the theory.

6 Conclusions

This paper is made of three main parts. First I develop the theoretical model that compute the marginal propensity to consume out of permanent and transitory income shocks and illustrates how this changes when the deep parameters change. The second part is devoted to the analysis of three categories of durable goods termed as real goods, vehicles, and small durable goods using a sample of households drawn from the SHIW. The third part identifies and estimates the marginal propensity to consume permanent income shocks using subjective information, conditioning on the three durable good categories considered.

In the theoretical section I show first that the marginal propensity to consume permanent income shock is lower when non-durable and durable goods are complements in utility. The presence of adjustment costs lowers even further the marginal propensity to consume permanent income shocks. Thus, complementarity and adjustment costs provide a basis to reconcile the finding of a low marginal propensity to consume with the theory.

The second part offers a summary description of the data using the waves 1989, 1991, 1993 and 1995 of the SHIW. I focus on the three categories of durable goods, surveyed by the Bank of Italy: real goods, vehicles and the small durable goods. The ratio of the real goods over non-durable goods averages around 0.15, while the proportion of non-owners is 16%. The stock of real goods at the household level massively decreased during the 1993 recession. This decrease was mainly due to an increase of non-owners, thus suggesting that macro-data might not be appropriate in characterizing the real good dynamics and, eventually, in estimating the elasticity of the demand for the services from the real goods out of the permanent resources. On the other hand, the stock of vehicles display much less procyclical dynamics, while the proportion of non-owners reaches 23%. The ratio of the stock of vehicles to non-durable goods is 0.26. The stock of vehicles displays a pronounced hump-shape in the age profile, which is robust to possible correlation with the family needs.

Lastly, the proportion of households who do not own any good belonging to the category of the small durable goods is virtually zero. This is mainly due to the fact that this category is quite broad. The ratio of the stock of small durable goods to the non-durable goods is 0.52. The stock of small durable goods has a special age-profile: it starts decreasing, then it increases and peaks at around the age of 50, afterwards it decreases.

In the third part, I identify the marginal propensity to consume permanent income shocks. The identification is made possible by the use of subjective expectations on prices and incomes. The estimate of the marginal propensity to consume permanent shocks averages around 0.21 across experiments, which means that consumers consume 21% of their permanent shocks. This number is not high, but at least I can find values of the deep parameters which deliver a marginal propensity to consume permanent shocks consistent with this evidence.

I test if non-durable goods and durable goods are separable in utility. It turns out that non-durable consumption is complementary in utility to the services from the three categories of durable goods analyzed in the second part. This form of non-separability is consistent with a low marginal propensity to consume permanent income shocks. Thus, non-separability between non-durable goods and durable goods seems to be an important problem for the empirical evaluation of the life-cycle hypothesis, in view of the fact that the proportion of household who borrow to buy real goods, vehicles and small durable goods[29] is modest.

[29] Respectively, 0.05%, 2% and 1%.

Table 1: Marginal Propensity to Consume out of Permanent Shocks, Theoretical Values

	$d=g=0$	$d=0.5$	$d=-0.5$	$d=1$	$d=-1$	$d=0.5$	$d=-0.5$	$d=1$	$d=-1$
		$g=0$	$g=0$	$g=0$	$g=0$	$g=0.5$	$g=0.5$	$g=0.5$	$g=0.5$
$\delta=0.1$	0.9795	1.0587	0.9199	1.1666	0.8744	0.9961	0.8504	0.3011	0.2360
$\delta=0.15$	0.9644	1.0700	0.8917	1.2337	0.8397	1.0154	0.8244	0.3602	0.2533
$\delta=0.20$	0.9456	1.0763	0.8633	1.3087	0.8076	1.0297	0.7992	0.4344	0.2737
$\delta=0.25$	0.9238	1.0768	0.8349	1.3930	0.7778	1.0383	0.7753	0.5203	0.2956

Note: the depreciation rate varies across rows. The first column refers to the baseline case; even columns refers to the case of non-durable and durable being substitutes while odd columns refers to non-durable and durable consumption to be complements. a and b are set to one and ρ is set to 0.95.

Table 2: Summary Statistics

	Real Goods	*Vehicles*	*Small Durables*
Mean	2459	3941	7089
Median	841	2352	4652
Non-Owner	0.16	0.24	0.01
Conditional Mean	2913	5165	n.a
Conditional Median	1291	3804	n.a

Note: The first column report summary statistics for real goods; the second for vehicles and the third for small durables. In the first and in the second row the mean and the mean conditional on ownership are reported; the third and the fourth row report the median and the median conditional on ownership; last row reports the proportion of non-owner. All figures are in Euros.

Table 3: Estimates, Infinite Horizon

	I	II	III	IV	V
Permanent Shock$_t$	0.2519	0.1772	0.2434	0.2284	0.2180
	(0.0383)	(0.0435)	(0.0400)	(0.0388)	(0.0443)
Transitory Shock$_t$	0.2569	0.4011	0.2769	0.2468	0.3875
	(0.1578)	(0.2015)	(0.1601)	(0.1684)	(0.2077)
Change in Family Size$_t$	1.5905	1.3910	1.7917	1.7538	1.0789
	(0.8864)	(1.1092)	(0.9343)	(0.9792)	(1.1591)
Change in Number of Earners$_t$	5.9819	5.7859	6.2639	5.6501	5.6023
	(0.8093)	(1.0097)	(0.8520)	(0.8562)	(1.0647)
Change in the Stock of Durables$_{t-1}$		0.1547	0.0432	0.0862	0.0558
		(0.0240)	(0.0121)	(0.0104)	(0.0068)
R^2	0.0970	0.1430	0.1134	0.1653	0.1761

Table 4: Estimates, Finite Horizon

	I	II	III	IV	V
Permanent Shock$_t$	0.2519	0.1778	0.2432	0.2286	0.2178
	(0.0383)	(0.0436)	(0.0400)	(0.0388)	(0.0444)
Transitory Shock$_t$	0.0049	0.0072	0.0049	0.0047	0.0046
	(0.0028)	(0.0036)	(0.0029)	(0.0031)	(0.0037)
Change in Family Size$_t$	1.6233	1.4584	1.8181	1.7963	1.2031
	(0.8868)	(1.1119)	(0.9351)	(0.9803)	(1.1626)
Change in Number of Earners$_t$	5.9581	5.7317	6.2500	5.6213	5.5798
	(0.8098)	(1.1011)	(0.8527)	(0.8569)	(1.0673)
Change in the Stock of Durables$_{t-1}$		0.1547	0.0427	0.0862	0.0556
		(0.0240)	(0.0121)	(0.0104)	(0.0068)
R^2	0.0972	0.1430	0.1132	0.1655	0.1754

Note to Table 3 and 4: The dependent variable is the change in consumption over the years 1989-1991. In the first column I report the baseline specification. In the second column, the baseline specification is augmented by the change of the stock of real goods. In the third column, the baseline specification is augmented by the change of the stock of vehicles. In the fourth column, the baseline specification is augmented by the change of the stock of small durable goods, while in the last column the specification includes the change of the stock of durable goods, defined as the sum of the stock of real goods, vehicles and small durables.

Table 5: Marginal Propensity to Consume out of Permanent Shocks, Estimated Values, Infinite Lives

	$\delta = 0.1$	$\delta = 0.15$	$\delta = 0.20$	$\delta = 0.25$
Real Goods	0.1772	0.1772	0.1772	0.1773
Vehicles	0.2434	0.2434	0.2435	0.2434
Small Durables	0.2284	0.2284	0.2285	0.2284
Total	0.2180	0.2180	0.2180	0.2180

Note: the depreciation rate varies across columns. Each column is associated to a value of the depreciation rate. Each row refers to a durable good category. The last row refers to the total.

Table 6: Marginal Propensity to Consume out of Permanent Shocks, Estimated Values, Finite Lives

	$\delta = 0.1$	$\delta = 0.15$	$\delta = 0.20$	$\delta = 0.25$
Real Goods	0.1777	0.1777	0.1777	0.1777
Vehicles	0.2431	0.2432	0.2432	0.2432
Small Durables	0.2285	0.2286	0.2285	0.2286
Total	0.2178	0.2178	0.2178	0.2178

Note: the depreciation rate varies across columns. Each column is associated to a value of the depreciation rate. Each row refers to a durable good category. The last row refers to the total.

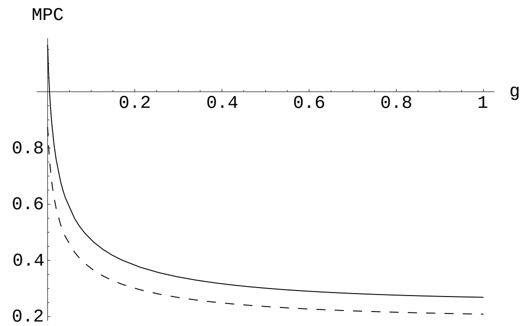

Figure 1: Marginal Propensity to Consume out of Permanent Shocks, $\delta = 0.10$, $\rho = 0.95$, $a = b = 1$

Note to Figure 1-4: The figures plot the marginal propensity to consume out of permanent shocks as a function of the adjustment cost, g. The dashed line corresponds to non-durable and durable consumption to be complements, while the continuous line to non-durable and durable consumption to be substitutes.

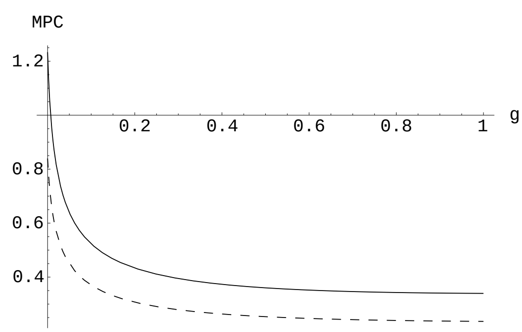

Figure 2: Marginal Propensity to Consume out of Permanent Shocks, $\delta = 0.15$, $\rho = 0.95$, $a = b = 1$

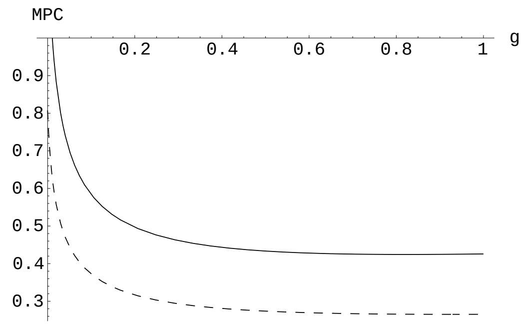

Figure 3: Marginal Propensity to Consume out of Permanent Shocks, $\delta = 0.20$, $\rho = 0.95$, $a = b = 1$

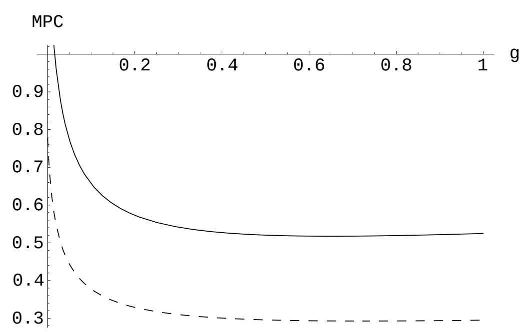

Figure 4: Marginal Propensity to Consume out of Permanent Shocks, $\delta = 0.25$, $\rho = 0.95$, $a = b = 1$

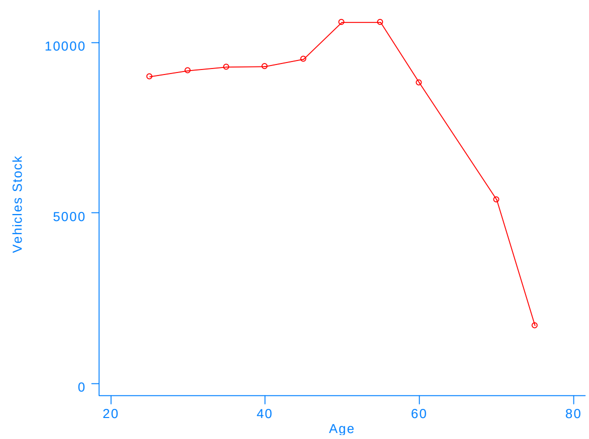

Figure 5: Household Stock of Vehicles

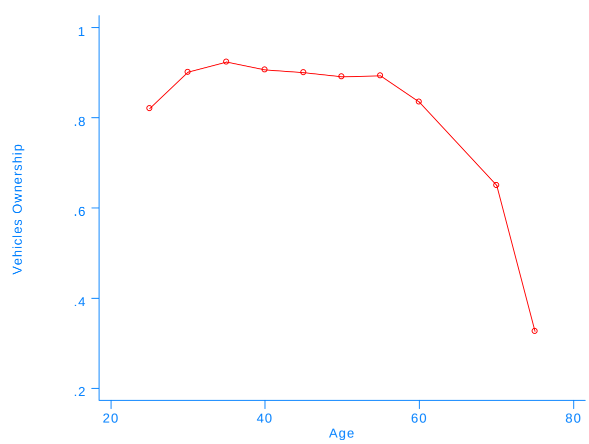

Figure 6: Vehicles Ownership

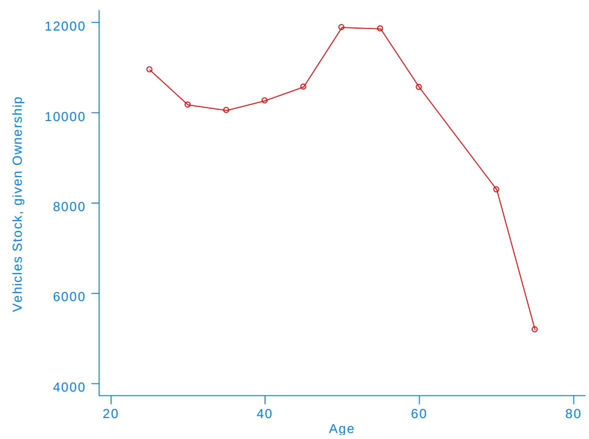

Figure 7: Household Stock of Vehicles given Ownership

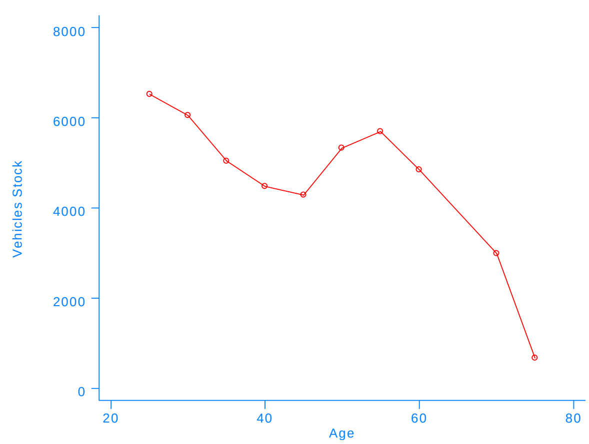

Figure 8: Household Stock of Vehicles corrected by Family Size

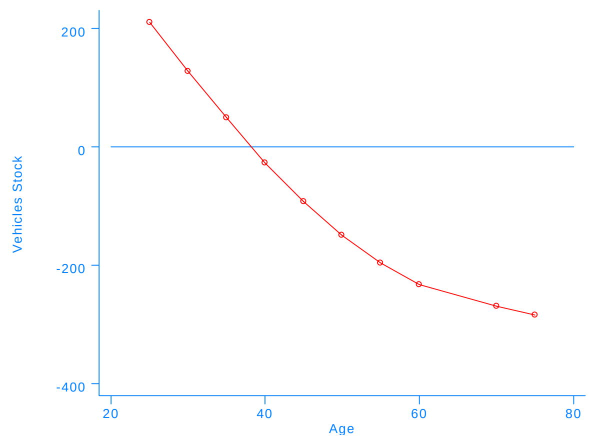

Figure 9: Household Stock of Vehicles, Age Effect

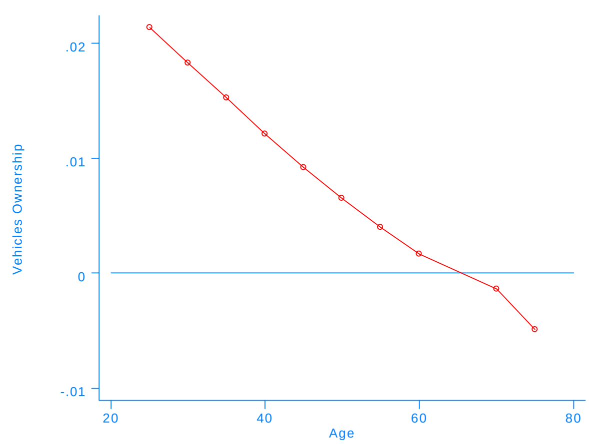

Figure 10: Vehicles Ownership, Age Effect

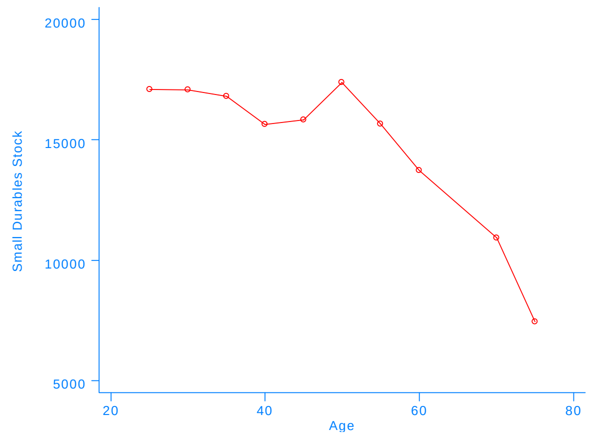

Figure 11: Household Stock of Small Durables

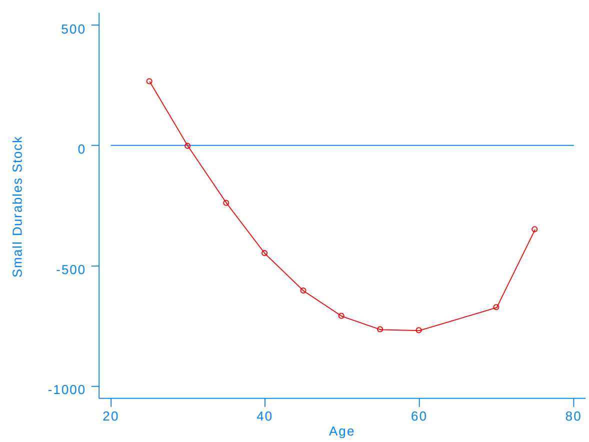

Figure 12: Household Stock of Small Durables, Age Effect

References

Attanasio, Orazio P., "Consumption," in James B. Taylor, and Michael Woodford (eds.), *Handbook of Macroeconomics* (Amsterdam: Elsevier Science (forthcoming), 1998).

Brandolini, Andrea, "The Personal Distribution of Incomes in Post-War Italy: Source Description, Data Quality and the Time pattern of income Inequality," manuscript, Banca d'Italia, Research Department (1998).

———, and Luigi Cannari, "Methodological Appendix: The Bank of Italy's Survey of Household Income and Wealth," in Albert Ando, Luigi Guiso, and Ignazio Visco (eds.), *Saving and the Accumulation of Wealth: Essays on Italian Households and Government Behavior* (Cambridge: Cambridge University Press, 1994).

Brugiavini, Agar, and Guglielmo Weber, "Durable and Non Durable Consumption: Evidence from Italian Household Data," in Albert Ando, Luigi Guiso, and Ignazio Visco (eds.), *Saving and the Accumulation of Wealth* (Cambridge: Cambridge University Press, 1992).

Campbell, John Y., and Angus Deaton, "Why Consumption is so Smooth?," *Review of Economic Studies* 56, 357–374, (1989).

Carroll, Cristopher D., "Buffer-Stock Saving and the Life-Cycle/Permanent Income Hypothesis," *Quarterly Journal of Economics* 112, 1–56, (1992).

Chamberlain, Gary, "Panel Data," in Zvi Griliches, and Michael D. Intriligator (eds.), *Handbook of Econometrics* (Amsterdam: Elsevier Science, 1994).

Deaton, Angus, "Understanding Consumption," (Oxford: Oxford University Press, 1992).

———, and Christina Paxon, "Saving, Aging and Growth in Taiwan," in David Wise (ed.), *Studies in the Economics of Aging* (Chicago: Chicago University Press, 1994).

Duso, Tomaso, "Complete Markets in Italy: An Analysis on Micro Data," *Giornal degli Economisti e Annali di Economia* 58, 1–25, (1999).

Goodfriend, Marvin, "Information Aggregation Bias," *American Economic Review* 82, 508–519, (1992).

Guiso, Luigi, Tullio Jappelli, and Daniele Terlizzese, "Earnings Uncertainty and Precautionary Saving," *Journal of Monetary Economics* 30, 307–337, (1992).

Hayashi, Fumio, "The Effect of Liquidity Constraints on Consumption: A Cross-Section Analysis," *Quarterly Journal of Economics* 100, 183–206, (1985).

Heaton, John, "The Interaction Between Time-Nonseparble Preferences and Time Aggregation," *Econometrica* 61, 353–385, (1993).

Jappelli, Tullio, and Luigi Pistaferri, "Using the Subjective Income Expectations to Test the Excess Sensitivity of Consumption to Predocted Income Growth," European Economic Review, forthcoming (1997).

Pishcke, Jörn-Steffen, "Individual Income, Incomplete Information and Aggregate Consumption," *Econometrica* 63, 805–839, (1995).

Pistaferri, Luigi (1998), "Superior Information, Income Shocks and the Permanent Income Hypothesis," University College London, Discussion Paper No.98-04.

Quah, Danny, "Permanent and Transitory Movements in Labor Income: An Explanation for 'Excess Smoothness' in Consumption," *Journal of Political Economy* pp. 449–475 (1990).