A behavioral model of consumption

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Abstract

This paper studies whether anomalies in consumption can be explained by a behavioral model in which agents do not have rational expectations and make predictable errors in forecasting income. We use a micro-data set containing subjective expectations about future income. The paper shows that, the null hypotheses of rational expectations is rejected in favor of the behavioral model, as that consumption responds to predictable forecast errors. On average agents who we predict are too pessimistic increase consumption after the predictable positive income shock. On average agents who are too optimistic reduce consumption. (JEL classification: D11, D12, D84)

Key words: Behavioral Economics, Subjective Expectations, Rational Expectations, Consumption and Saving.

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1 Introduction

The stochastic version of the permanent income hypothesis/life cycle hypothesis (PIH/LCH) under rational expectations states that predictable changes in income should not help to explain the change in consumption. Under assumptions including the absence of liquidity constraints, the change in consumption should depend only on innovations. We show that an apparent economic anomaly, predictable changes in consumption, may be explained relaxing the rationality hypothesis in favor of a behavioral model where agents are irrationally optimistic/pessimistic or are not endowed with the mathematical tools of a rational agent. As stated by the theory, since the path of future income is uncertain, the agent makes consumption decisions based on his subjective expectation about future uncertain events. The PIH/LCH is our null hypothesis, the alternative is a behavioral model of consumption. Our agent aims to maximize his subjective expected utility over the life cycle, but in making such an effort he makes predictable (for the econometrician) systematic errors in forming subjective expectations on future income. Hence, on average an individual who has been too pessimistic in making his prediction experiences a positive surprise when income is realized and is induced to revise his consumption decision upward. Conversely, if the agent has been overly optimistic he experiences a negative shock on income and decides to lower consumption.

Abandoning the assumption of rationality, our model implies a new formulation of the Euler equation. Hence, the model suggests that previous works on excess sensitivity of consumption to predictable changes in income, may be biased not only for the reasons considered in the literature but also because of not properly taking into account irrationality. We will show how the coefficient on predictable changes in income change once we introduce the predictable forecast error in the Euler equation. In particular, irrational pessimism and irrational optimism seem to be a more statistically significant explanation of the apparent anomaly in consumption than precautionary savings and liquidity constraints.

Despite the theoretical statement that actual actions depend on subjective expectations about future events, economists engaged in empirical research tend to be skeptical on the use of data on subjective expectations. The main practice has become that of inferring expectations from realizations. The attempt to infer from the distribution of realizations requires the knowledge of the information set of the agent and how he uses it. Typically the researcher states a common model of the data generating process, which under the assumption of rational expectations describes also how individuals form their expectations.

The estimation strategy is hypothesize a stochastic process for income dynamics, estimate it and project it one year into the future exploiting the orthogonality condition implied by the rational expectations hypothesis (see Hall and Mishkin, 1982).

In contrast direct elicitation of subjective expectations may eliminate the need for such assumptions, see Dominitz and Manski (1997), Flavin (1999) and Dominitz (1998, 2001). It allows for complete heterogeneity of income expectations formation and permits one to overcome the problem of the econometrician's information set being not rich enough to reproduce the agent's one.

Our data set consists of more than 5000 individual observations for Netherlands and contains detailed information on wealth, income, work and demographic characteristics and different kind of subjective expectations stated by the respondents, covering the period that goes from 1993 to 2000.

We instrument forecast errors. The weak exogeneity of the adopted instrument is assured, once again, by the null hypotheses of a rational agent. We instrument the agent's prediction error with different specification of the information set. In the second step of the two stage instrumental variable estimator we regress the first difference of the logarithm of consumption variation on the fitted (hence predictable) error and find strong evidence in support of our behavioral model stating that consumption responds to predictable errors in income forecasts.

It is often argued that works on the predictability of forecast errors, either rejecting or accepting the rational expectations hypothesis, do not supply evidence of the fact that the elicited expectations really correspond to those affecting the agent's behavior. Showing that, once the rational expectations hypotheses is rejected, it is possible to explain agents consumption decisions should therefore be of interest.

Section 2 contains our theoretical model. We show that eliciting subjective probabilities directly from the agents offers the possibility to answer the theoretical puzzle of consumption responding to predictable changes in income. We show that this anomaly may be the result of irrationality, where irrationality may be seen as excessive pessimism or optimism in predicting future incomes. Section 3 describes our data set. We use a micro-data set containing income and wealth measures. After describing the data we compare stated subjective expectations with realizations and describe the way we build a measure of consumption starting from wealth and income data. Section 4 describes the empirical version of the models and discusses the estimation strategy. To estimate our model we will instrument the subjective forecast error to evidence that consumption variation is explained by predictable forecast error. Section 5 contains our empirical evidence that support the behavioral model versus the rational one. Section 6 performs excess sensitivity test of consumption in our modified version of the Euler equation. We show that irrationality is a statistically significant explanation, alternative and compatible with precautionary saving and liquidity constraints. We argue that previous empirical evidence of excess sensitivity based on the latter explanations may be biased because of the assumption of rational expectations. Section 7 concludes.

2 The model

Since the path of future income is uncertain, the individual must make his consumption plan on the basis of his subjective expectation about future uncertain events. With this consideration in mind, the conventional model of life-cycle consumption under uncertainty, which calls for an additive and separable (between periods and states) utility function, consumers maximizing expected utility function and perfect credit markets, becomes:

$$Max_{c_1,...,c_T} E_t^{su}[\sum_{s=0}^{\infty}(1+\delta)^{-s}u(c_{t+s})|\Omega_t] \tag{1}$$

subject to

$$a_{t+s+1} = (1+r)(a_{t+s} + y_{t+s} - c_{t+s}) \qquad s = 0, 1, ..., \infty \tag{2}$$

$$a_t \qquad \text{given} \tag{3}$$

$$lim_{t\to\infty} a_t \geq 0 \tag{4}$$

where E_t^{su} is the subjective probability conditional on all information available at time t, indicated with Ω_t, and stated at the end of the period, δ is the intertemporal rate of time preference, $u(.)$ is the one-period utility function (strictly concave), c is consumption, y is total family net income, r is the real rate of interest assumed constant over time and a represents assets apart from human capital. This sequence problem is equivalent to solving the following Bellman equation that represents the maximum value of the subjective expected utility, measured at time t, that a consumer may obtain from the optimal consumption path and the wealth endowment a_t:

$$V(a_t) = max_{c_1,...,c_T} E_t^{su}[\sum_{s=0}^{\infty}(1+\delta)^{-s}u(c_{t+s})] \tag{5}$$

which may be also written as:

$$V(a_t) = max_{c_t,a_{t+1}} u(c_t) + (1+\delta)^{-1} E_t^{su}[V_{t+1}(a_{t+1})] \tag{6}$$

Differentiating eq.(6) with respect to the control variable c_t, we obtain the first order condition for a max:

$$u'(c_t) - (1+\delta)^{-1} E_t^{su}[(1+r)V'_{t+1}(a_{t+1})] = 0 \tag{7}$$

Considering the envelope condition, which tells us that at the optimum the marginal utility of wealth should be equal to the marginal utility of consumption, we eventually obtain the Euler equation:

$$u'(c_t) = (1+\delta)^{-1} E_t^{su}[(1+r)u'(c_{t+1})] \tag{8}$$

Assuming that agents preferences are represented by an isoelastic utility function, we get to the following formulation of the Euler equation:

$$E_t^{su}(c_{t+1}^{-\gamma}) = \frac{1+\delta}{1+r} c_t^{-\gamma} \tag{9}$$

Let's assume that agents have a subjective distribution over the consumption growth rate, which is normal:

$$\Delta \log c_{t+1} | \Omega_t \sim N(\mu_c; \sigma_c^2) \tag{10}$$

where $\mu_c = E_t^{su}(\Delta \log c_{t+1})$ and $\sigma_c^2 = Var_t^{su}(\Delta \log c_{t+1})$, that, for the seek of simplicity, will be assumed constant over time. Under this assumption we can write down eq. (9) as the following:

$$E_t^{su} exp[-\gamma \Delta \log c_{t+1} + \log(1+r) - \log(1+\delta)] = 1 \tag{11}$$

which, in turn, is equal to

$$exp[-\gamma\mu_c + (1/2)\gamma^2\sigma_c^2 + \tilde{r} - \tilde{\delta}] = 1 \tag{12}$$

where we have exploited the property that if $x \sim N(\mu; \sigma)$, than $E(e^x) = exp[\mu + (1/2)\sigma^2]$, and to save on notation we have assumed $\tilde{r} = \log(1+r)$ and $\tilde{\delta} = \log(1+\delta)$. Taking the logs we have

$$-\gamma E_t^{su}(\Delta \log c_{t+1}) + (1/2)\gamma^2\sigma_c^2 + \tilde{r} - \tilde{\delta} = 0 \tag{13}$$

Splitting the logarithm and taking the exponential of both sides of the equation we are left with:

$$E_t^{su}(c_{t+1}) = c_t e^{((1+\gamma)/2)\sigma_c^2 + (\tilde{r}-\tilde{\delta})/\gamma} \tag{14}$$

where we have again used the property of exponentials of normally distributed variables. Given the subjective expectations about future income held in period t, the individual's perceived budget constraint can be expressed as:

$$\sum_{s=0}^{\infty}(1+r)^{-s}E_t^{su}(c_{t+s}) = a_t + \sum_{s=0}^{\infty}(1+r)^{-s}E_t^{su}(y_{t+s}). \tag{15}$$

where y_t is labor income exogenously given at the end of the period. Substituting in eq. (4) gives

$$\sum_{s=0}^{\infty}(1+r)^{-s}e^{s[((1+\gamma)/2)\sigma_c^2 + (\tilde{r}-\tilde{\delta})/\gamma]}c_t = a_t + \sum_{s=0}^{\infty}(1+r)^{-s}E_t^{su}(y_{t+s}). \tag{16}$$

That, assuming that $e^{((1+\gamma)/2)\sigma_c^2 + (\tilde{r}-\tilde{\delta})/\gamma} < 1 + r$, leaves us with

$$c_t = [a_t + \sum_{s=0}^{\infty}(1+r)^{-s}E_t^{su}(y_{t+s})][1 - \frac{e^{((1+\gamma)/2)\sigma_c^2 + (\tilde{r}-\tilde{\delta})/\gamma}}{(1+r)}] \tag{17}$$

Define $\zeta = 1 - \frac{e^{((1+\gamma)/2)\sigma_c^2 + (\tilde{r}-\tilde{\delta})/\gamma}}{(1+r)}$ so

$$c_t = \zeta[a_t + \sum_{s=0}^{\infty}(1+r)^{-s}E_t^{su}(y_{t+s})] \tag{18}$$

Let's assume that agents apply the law of iterated expectations in forming subjective expectations, $E_t^{su}(E_{t+s}^{su}(x_{t+s})) = E_t^{su}(x_{t+s})$. Such an assumptions means that agents are convinced to be rational now and in the future. Moreover, a_{t+1} is known at time t, so

$$c_{t+1} - E_t^{su}(c_{t+1}) = \zeta\sum_{s=0}^{\infty}(1+r)^{-s}[E_{t+1}^{su}(y_{t+s+1}) - E_t^{su}(y_{t+s+1})] \tag{19}$$

Using for the third time the assumption that consumption is log normally distributed this implies that

$$\begin{aligned}\Delta\log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r}-\tilde{\delta}}{\gamma} + \\ + \frac{\zeta}{E_t^{su}(c_{t+1})}\sum_{s=0}^{\infty}(1+r)^{-s}[E_{t+1}^{su}(y_{t+s+1}) - E_t^{su}(y_{t+s+1})]\end{aligned} \tag{20}$$

Under the assumption that the eventual systematic or orthogonal error components in subjective expectations are uncorrelated with subjective expectations of subsequent periods, i.e. $E^{su}_{t+1}(y_{t+s+1}) - E^{su}_t(y_{t+s+1}) = 0$ for $s > 0$, and considering that because of the timing of the model, expectations get stated at the end of the period, so that $E^{su}_{t+1}(y_{t+1}) = y_{t+1}$ as y_{t+1} is contained in the information set, the previous equation becomes:

$$\Delta \log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r} - \tilde{\delta}}{\gamma} + \frac{\zeta}{E^{su}_t(c_{t+1})}[y_{t+1} - E^{su}_t(y_{t+1})] \tag{21}$$

If agents have been too pessimistic, i.e. $y_{t+1} > E^{su}_t(y_{t+1})$ they revise their consumption decision upward. If they have been optimistic,they revise their consumption decision down. ζ is less than $\frac{r}{1+r}$. To keep into account what we have just said and for coherence with the empirical version of the model, we write down the precious equation in the following way:

$$\Delta \log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r} - \tilde{\delta}}{\gamma} + \frac{\zeta y_{t-1}}{E^{su}_t(c_{t+1})}\frac{[y_{t+1} - E^{su}_t(y_{t+1})]}{y_{t-1}} \tag{22}$$

More generally if actual forecast error is non negatively correlated with the subjective expectations of subsequent periods, $E^{su}_{t+1}(y_{t+s+1}) - E^{su}_t(y_{t+s+1}) = \rho^s[E^{su}_{t+1}(y_{t+1}) - E^{su}_t(y_{t+1})]$ and $\rho > 0$, we get to the following equation:

$$\Delta \log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r} - \tilde{\delta}}{\gamma} + \frac{1+r}{1+r-\rho}\frac{\zeta y_{t-1}}{E^{su}_t(c_{t+1})}\frac{[y_{t+1} - E^{su}_t(y_{t+1})]}{y_{t-1}} \tag{23}$$

That's the case if the agents have some kind of persistence of the shock on their subjective probabilities. If $\rho = 1$, agents believe Y_t is a random walk with $E^{su}_t(Y_{t+s+1} - Y_{t+s}) = 0$. Alternatively, if $\rho = 1$ and agents believe Y_t is an integrated moving average of the first order (IMA(1)) with MA coefficient equal to $-\Theta$, we have that $E^{su}_t(Y_{t+s+2} - Y_{t+s}) = 0$ for $s \geq 0$ and $E^{su}_t(Y_{t+2} - Y_{t+1}) = \Theta[Y_{t+1} - E^{su}_t(Y_{t+1})]$. That's the case if agents experience a surprise in period $t+1$ and they are convinced that the shock will persist in the future. In this case eq. (20) becomes:

$$\Delta \log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r} - \tilde{\delta}}{\gamma} + \frac{1+r+\Theta}{r}\frac{\zeta y_{t-1}}{E^{su}_t(c_{t+1})}\frac{[y_{t+1} - E^{su}_t(y_{t+1})]}{y_{t-1}} \tag{24}$$

As ζ is less than $\frac{r}{1+r}$ and $Y_{t-1} > E^{su}_t(C_{t+1})$, for $\Theta = 1$ the coefficient of the forecast error is around 2.

The presented model has the desirable feature of presenting consumption growth rate and consumption variation as the result of a precautionary saving motive plus a term that depends on the agents' forecast errors. The second term capture the idea of a behavioral model of consumption of irrationally optimistic agents who, stating larger expectations, experience a bitter surprise once the income realizes and revise their consumption decision downward. Conversely, irrationally pessimistic agents experience a positive shock as the income realize and revise their consumption decisions upward.

If agents were rational, the model would state the common result that excess sensitivity is due to precautionary saving or liquidity constraints. In this case, not properly taking into account the variance term may result in omitted variable problem. Hence, overreaction of consumption to predictable changes in income may appear because of their correlation with the error term that now contain the variance of consumption. This has little to do with what we aim at explain with our behavioral model. The presence of the forecast error is not due to the fact that we want to perform an omitted variable test. The model asserts that, if agents are irrational or myopic, consumption variation is a function of the forecast error. John Muth (1961) rational expectations hypotheses implies expectations that should be unbiased and forecast error that should be distributed independently of the anticipated value, implying that the variance of realizations is larger than the variance of the expectations. To obtain the fully rational expectations setup Hall required the expectations to be *sufficient*, where sufficient is to be intended in a way closely related to that of a sufficient statistic. This continues to be true also into a model with precautionary saving or liquidity constraints. Despite the fact that consumption is a function of predictable changes in income, constrained or prudent agents, if rational, do not make systematic errors in predicting future income. So, prediction error is a term of the Euler equation only if agents are irrational or myopic, which also explains the apparent theoretical anomaly. On the contrary, if our model is true, previous evidence of excess sensitivity may be interpreted not only because of the omitted variance term, but also because of the assumption of rationality, or, which is the same, because of the omission of the prediction error term[1].

Finally, we want make some remarks on the use of subjective expectations. Theoretical work has been influenced by the prevailing skepticism of applied economists toward subjective data on expectations. When the researcher has no data on subjective expectations the main practice is that of inferring expectations from realizations. The attempt to infer from frequentist distribution of realizations requires the knowledge of the information set of the

[1] This conclusion should not be new to an economist. It was clearly an implication of the original work of Friedman on permanent income (Friedman (1957), where agents were myopic and time horizon was shorter than the entire life. Oddly, this explanation have been forgotten by the literature that have come after Hall (1978).

agent and how he uses it to form them. Typically the researcher states a common model of the income generating process, which under the assumption of rational expectations describes also the way individuals form rational expectations. The structural estimation strategy is to specify a stochastic process for income dynamics, estimate it and project it one year into the future exploiting the orthogonality condition supplied by the rational expectations hypotheses, which brings us to the best linear predictor (i.e. Hall and Mishkin, 1982).

Direct elicitation of subjective expectations, as underlined by Dominitz and Manski (1997), Flavin (1999) and Dominitz (1998, 2001), may reduce the need for restrictive assumptions. It allows for complete heterogeneity of income expectations formation and permits one to overcome the problem of the agent's superior information, otherwise stated as the problem that the econometrician's information set is not rich enough to reproduce the agent's one. Moreover, while previously it was necessary to assume rational expectations, subjective expectations can be used to test rational expectations jointly with a specification of agents' loss function.

Relaxing the assumption on expectation formation in favor of a behavioral model where agents may be irrationally optimistic or pessimistic, we get to a model where the forecast error is not exclusively due to innovations. In particular if agents' optimism brings the agents to do not use the available information efficiently, the forecast error is not anymore orthogonal to the information set. This brings us not only to a test of the joint hypothesis of rational expectations and quadratic loss function but also to an explanation of the apparent theoretical anomaly that the first difference of consumption is a function of predictable changes in income.

There is also another way to look at our results, which is that of the literature on prediction error and test of the rational expectations hypothesis. One of the main critique to the evidence coming from this literature is that, when rejecting the rational expectations hypothesis, it is not investigated if this corresponds to a subsequent agents behavior. On the contrary, we show that once the rational expectations hypotheses is rejected, it is possible to explain agents consumption decisions. These result should be of interest also for those who consider the assumption of a quadratic loss function overly restrictive.

3 The data

We use a micro data set containing detailed information on subjective expected future income, realized income and wealth. The data are taken from the VSB panel which is part, since 1993, of a project started by and administered by CentER at the University of Tillburg. In this section, after a brief description of the way in which the data have been collected, we will focus our attention to expectations and wealth data.

The VSB is an unbalanced panel. When the survey started it consisted of two panels, one representative of the Dutch population (RE), covering roughly 2000 households, and the other made of households drawn from the top 10 percent of the income distribution (HI), encompassing approximately 800 observations. The last wave of the panel consists of 1732 households in the RE panel and only 40 in the HI panel[2]. The big reduction in the panel representative of the higher decile of the income distribution is due to the fact that since 1997 it has not been updated, so it has quickly shrank as the higher income families exited the panel.

The VSB consists of six questionnaires, presented to all the people aged 16 or over within the family, that collect detailed information on demographics, work, health status, family composition, individual and family incomes and wealth. Moreover, it collects different kinds of subjective expectations on the future family income level, inflation, the future family income growth rate and information on agents psychological attitudes toward risk and time preferences. Being a saving survey, it doesn't collect data on consumption directly, but the wide variety of data on wealth and income makes possible to construct a measure of consumption.

The panel runs from 1993 to 2000 and every wave contain flow information for the previous year and stock information at January 1 of the current year. The households were interviewed once a year over the period that, with the exception of the first year[3], goes from May to December. 85% of the interviews took place between May and July of each year. The survey method is completely computerized. Each household is provided with a

[2]For more exhaustive information relative to questionnaires, income and wealth aggregation, response rate and so on, refer to the CentER web page and to the documentation that supported the VSB panel.

[3]The collection of information for the first wave ended on April 1994, while the interviews for the second wave started on May of the same year. As only one month passed between the two, it has seemed useless to repeat all the questions to the respondents of the first wave, so many questions were only asked to new entrants to the panel. For those already in the panel, where needed, information from the previous wave has been used.

personal computer, receives the questionnaires by modem, answers the questionnaires on its home computer and returns the answers to the CentER by modem again.

Two supplementary data sets have been obtained aggregating, at the household level, information on personal income and those on assets, liabilities and mortgages. Expectations on the income growth rate and inflation have been collected in the form of a point probability meanwhile, expectations on the income level have been obtained by means of a module that, under a parametric assumption, allows one to obtain an estimate of the subjective probability distribution of next year's income level.

3.1 Point expectations

The structure and the wording of the questionnaire is similar for both income growth rate and inflation expectations.

After having defined what should be intended as total net income of the household, the respondents are asked to answer a preliminary question that is the following:

> *Do you think, taking into account possible changes within the household, the total net income of your household will increase, remain the same, or decrease, in the next 12 months?*

The possible answer to such a question are: increase, remain the same and decrease. If the respondents indicates either an increase or a decrease as the likely future event, he is asked the following supplementary question

> *By what percentage do you think the total net income of your household will increase (decrease) in the next 12 months?*

In this way it is possible to construct a variable representing the expected growth rate of family total net income, that takes values equal to the declared percentages if the respondent expects an increase or a decrease, or that takes value 0 if he expected total net family income to remain the same. When the respondent is asked what he expects the prices to do in the next 12 months, the only difference is that he answers the second question only if he expects an increase in prices. For this reason we have decided to input value 0 also if the respondent has declared that he considers a price decrease probable. That's the case of 196 observations in the pooled data set.

Table 1 shows that the questionnaire containing the module described above has been presented to a decreasing number of respondents. We also note that the questions on the

Table 1: Number of respondents and response rate, at the questions on next year and next year price change.

	1993	1994	1995	1996	1997	1998	1999	2000	Pooled
Respondents	3791	4219	4055	3384	2660	1365	1368	1923	22765
Next year	3365	3810	3649	3070	2396	1256	1295	1345	20186
Response rate	.89	.90	.90	.91	.90	.92	.95	.70	.89
Price change	3337	3808	3639	3046	2386	1253	1287	1345	20101
Response rate	.88	.90	.90	.90	.90	.92	.94	.70	.88

two kind of expectations have been answered by more or less the same respondents and that the response rate are high and increase over time with the exception of the last wave.

The response rates for expected next year's income growth rate and last year's income growth are almost perfectly equal. In particular 20159 respondents stated their last year income growth rate, which are just a little less than those who have answered the questions on expected income growth rate. The response rate to both the expectations module and realized income growth rate vary with respondents characteristics. While men and women respond at the same rate, a much smaller fraction of people younger than 30 respond (.44) than the others (.96-.97). The response rate increases with education. This may be interpreted as evidence in favor of the hypotheses that more educated people find the questionnaire easier to understand. Response rates look rather homogeneous conditioned on geographical variables and to the inclusion of the respondent in the representative or high income panel. Moreover employed[4] (.94) and retired (.97) people respond at a higher rate than those who declare that their main activity is looking for a job (.89) or other (.78).

These questions were asked just after a series asking for the total net family income in the last 12 months and the nature of such an income (unusually high, regular, unusually low). In particular, the respondents were also asked to answer the same questions on the total net income of the family in the last 12 months. As these are facts that the respondents should know, we can imagine that answering such questions might have furnished a sort of training and might have helped them understand the questions on expectations. This

[4]The questionnaire asks for what the respondents consider to be their main activity. That's different from the usual questions on employment status, i.e. a working mother may easily retain that her main activity is to be an homemakes and hence be included in "other" instead of "employed".

would contribute to the reliability of such data.

3.2 The probability distribution of next years family income

The data on expected next year income are collected by a module that is similar to that adopted in the Survey of Economic Expectations (SEE), and discussed in Dominitz and Manski (1997).

In the VSB panel, the respondents are first asked to answer two questions about the range in which their family income is expected to fall in the next twelve months; the precise wording, translated into English by CentER, is the following:

> *What do you expect to be the LOWEST (HIGHEST) total net income your household may realize in the next 12 months?.*

After answering these questions the interview software determines four income thresholds by means of the following algorithm:

$$threshold_K = Y_{min} + 0.2k(Y_{max} - Y_{min}) \tag{25}$$

and $k = 1, ...4$. Then, the respondents are asked to report the percent chance that their net family income will be between Y_{min} and each threshold. The precise wording of the question is as follows:

> *What do you think is the probability that the total net income of your household will be less than $threshold_K$ in the next 12 months? Please fill in a number between 0 to 100.*

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After division by 100, I obtain the subjective cumulative distribution function of next year's net family income, calculated at the thresholds. Differently from Dominitz and Manski (1997), we will make two different assumption on the subjective distribution of the respondents. Because of the structure of the questionnaire we decided to use distributions with bounded support. The beta and piecewise linear. The beta is estimated by non-linear least squares. Estimated results for the mean are in line with those of Dominitz and Manski (1997) in term of average absolute deviations.

The questionnaire on *health and income*, containing the module described above, was presented, during the period that goes from 1995 to 2000, to a decreasing number of

Table 2: Number of respondents at the questions on lowest and highest possible income and cumulative subjective probability distribution. Response rate in brackets.

	1995	1996	1997	1998	1999	2000	Pooled
All observations	4854	4250	3513	2392	2250	1052	18311
Valid [Y_{min};Y_{max}]	2335	2035	2847	1966	1863	1037	12083
Response rate	.48	.48	.81	.82	.83	.98	.66
Declare for probabilities	2010	1741	2195	1483	1372	899	9700
Response rate	.41	.41	.62	.62	.61	.85	.53
No monotonicity	307	295	311	212	202	184	1511
Share	.06	.07	.09	.09	.09	.1	.08
Final	1703	1446	1884	1271	1170	715	8189
Response rate	.35	.34	.54	.53	.52	.68	.45

respondents. As shown in table 2 a little less of the half (.45) of the total amount of respondents answered all of the questions. Response rates, at every level, are small for the first two years (.35), but increase over time to .68.

More than the half (.53) answered the questions on next year family's income distribution. Two thirds (.67) stated at least Y_{min} and Y_{max}. It should be underlined that the respondents were not asked the subsequent questions if the difference between Y_{max} and Y_{min} is smaller than 5 Dutch florins (dlf.). This is the case of 1816 observations.

The VSB panel suffers a problem of non monotonicity in the stated subjective cumulative distribution function. A brief analysis of the answers of these 1511 respondents reveals that some people are not able to articulate their expectations using the theory of probability and/or commit typing and recording errors.

The response rates for expected future family income response rate (.45) and last year family's income (.49) are in line once again. This time the realized income response rate is larger but this is due only to the loss of observation due to the non monotonicity condition.

As previously underlined by Dominitz and Manski (1997), the response rates are evidence that questions about income result in substantial non-response. Moreover, it appears that questions eliciting subjective probability draw more responses than realized income questions. Some of the non-responses that we register are in fact due to non monotonicity of the answers across the thresholds.

At the end of the schedule eliciting subjective probabilities respondents are asked about the correctness of their answer and how often they used the possibility to correct them.

If they respond that their answer are mostly or all wrong, they are also asked about the source of incorrectness of the answer for each of the questions mentioned above. This is the case of 200 respondents of our final sample. So the large majority of the sample, 7701 respondents, report that their answers were all or mostly correct.

Table 3: Self-reported understanding level of the questionnaire.

Self-reported answer				Difficulties	
Answer	Freq.	Percent	Cum.	Problems[a]	Freq.
Don't Know	244	3.00	3.00	The questions didn't suit my situation	50
Correct	3244	39.83	42.82	No possibility to correct the answer	47
Mostly correct	4457	54.72	97.54	Computer error in recording	2
Mostly wrong	171	2.10	99.64	The questions were to complicated	24
Wrong	29	0.36	100.00	Answer too hard/too much work to answer	105
				Other reasons	54

[a]More than an answer is possible.

With respect to the possibility of correcting the answers, the respondents are asked about a qualitative scale that goes from 1 (never) to 5 (very often). The use of the possibility to correct the answers is distributed in the following way: 1(never)-2856, 2-4020, 3-879, 4-148, 5(very often)-134. This results in evidence in favor of the fact that agents do not exploit the possibility of changing their answers.

The analysis of the lowest and highest possible incomes reveals that there are 29 respondents who have declared a highest possible income inferior to 100 Dlf. These values seem implausible to us and we decided to drop these observations.

The mean value of the lowest possible income is 43969 with stated values that vary from 0 to 850000, while the mean value of the highest possible income is 78394 in a range that goes from 100 to 100000000.

Our analysis is based on data from all the questionnaires with the exceptions of the disaggregate data on assets and liabilities and on accommodation and mortgages. In particular it draws heavily upon the part on health and income where, from the third wave of the panel (1995) on, subjective expectations on next year's income were collected, and upon the part on psychological concepts where subjective expectations on income growth rate and inflation were collected from the first wave of the panel (1993) on.

For the estimation of the model, we need of at least three consecutive waves of data, starting from the year in which one of the respondents answer one of the modules on expectations, on families which reported full information about family income and wealth.

Following the CentER we do not input values of missing data on aggregated income and wealth, and drop the families for which the aggregate family income and wealth are not measurable[5].

Other observations are not considered due to lack of data on relevant variables like sex, age, education, etc. but they are very few and substantially negligible.

Merge of the data from all the questionnaires brings us to a pooled data set for all waves which contains 9758 households. However, since we will use only observations that remain in the panel for at least three consecutive years, the number of available households is reduced to 5237. 1539 observations remain in the panel for only three waves while 80 families stay for the entire duration of the panel. The mean duration is 4.5 with the first and third quartiles of the distribution equal to 3 and 5.

The distribution of the families between years and panel types is presented in the first part of table 4. As it is evident, only one third of the potentially useful observations contains subjective income expectations while expected income and price growth rate are rarely missing. The frequencies reported in the table refer to the families for which at least one member's expectations is available.

When, within a family, more than one prediction is available we use that stated by the head of the household. That's the case of 1511 over 1777 observations in the case of expectations on income level. Moreover, the head of the household is male in 1342 of the 1511 considered cases. Alternatively we switch to those stated by the spouse (241) or the cohabitant (25).

When looking at expected income growth rate or price change we have 4939 expectations stated by the head of the household, which is almost the totality of the sample and the potentially useful observations. Again the head of the household is prevalently male, 4213 observations, and when the expectations are not declared by the head of the household they are declared by the spouse or the cohabitant, who are 238 and 23.

A final feature of the data which must be described is the way consumption is derived from wealth data. The VSB data set includes data on wealth so we can roughly define saving as the difference of family wealth between two subsequent years, and consequently

[5]The CentER considers, among the others, 14 components of the individual gross income. If one of these components is a missing value, the personal gross income is not computed and is a missing value itself. So it was sufficient that one of these component was missing value for one of the income recipients of a family, to have a missing value for family gross income, also if the incomes of the other recipients were calculated. The same story applies to the data on wealth, where the categories considered are even more numerous.

Table 4: Analysis of the panel.

	1993	1994	1995	1996	1997	1998	1999	2000	Total
	Number of households								
All observations	813	996	1133	928	667	392	257	51	5237
RE	470	611	734	658	534	373	247	49	3676
HI	343	385	399	270	133	19	10	2	1561
	Expected income - Beta distribution								
All observations	0	0	550	451	390	208	149	29	1777
RE	0	0	306	272	298	197	141	27	1241
HI	0	0	244	179	92	11	8	2	536
	Expected income growth rate								
All observations	805	995	1130	926	665	385	256	38	5200
RE	467	610	731	656	533	367	246	36	3646
HI	338	385	399	270	132	18	10	2	1554

consumption as the difference between total family income and saving.

As underlined by Alessie and Lusardi (1996) there is no correct definition of wealth but rather measures that are more or less useful depending on the purposes. In table 5 we present all the components of wealth that have been collected in the VSB panel and then we explain how we sum them to have different measure of wealth. The data listed in the table have been reported by the agent at individual level and then aggregated by the CentER at the household level. If the respondent declared ownership of a particular asset but didn't report its value he was asked to choose among several value intervals. If he choose a range, the midpoint of the range is imputed by the CentER, otherwise no value is reported.

We measure consumption as the difference between income and savings, where savings are obtained as the difference of wealth into two subsequent years. To accurately focus on that part of income that is not saved each year, we need to avoid, or try to avoid, the problem of capital gains and losses. In particular wealth changes between one year and the other may be due to savings or to variation in the value of some assets. In order to measure consumption we would like to separate the first from the second.

The benchmark measure of wealth is obtained considering durable goods as a component of wealth together with savings, checking accounts, bonds, stocks, debts and real estates. So, the reference measure of consumption will be the following:

$$C_t = Y_t - S_t =$$

Table 5: Overview of all asset, debt and mortgages components.

	Savings, checking accounts, bonds and stocks
B_1	Checking accounts
B_2	Employer-sponsored saving plans
B_3	Savings arrangements, linked to a postbank account
B_4	Deposit books
B_5	Savings or deposit accounts
B_6	Savings certificates
B_7	Single-premium annuity insurance policies
B_8	Savings or endowment insurance policies
B_9	Combined life insurance policies
B_{10}	Pension scheme, not partly paid for by employer
B_{11}	Growth funds
B_{12}	Mutual funds and/or mutual funds accounts
B_{13}	Bonds and/or mortgage bonds
B_{14}	Stocks and shares
B_{15}	Put-options bought
B_{16}	Put-options written
B_{17}	Call-options bought
B_{18}	Call-options written
B_{19}	Money lent out to family or friends
B_{20}	Savings or investments not mentioned before
	Durable goods
B_{21}	Cars
B_{22}	Motorbikes
B_{23}	Boats
B_{24}	Caravans
	Real estates
B_{25bp}	Buying price of the first house
B_{25m}	Mortgages on the first house
B_{26av}	Actual value of a second house
B_{26m}	Mortgages on second house
B_{27av}	Actual value of pieces of real estate, not being used for own accommodation
B_{27m}	Mortgages on pieces of real estate, not being used for own accommodation
	Debts
S_1	Private loans
S_2	Extended lines of credit
S_3	Outstanding debts on hire-purchase contracts, debts based on payment by installment and/or equity based loans
S_4	Outstanding debts with mail-order firms, shops or other sorts of retail business
S_5	Loans from family or friends
S_6	Study loans
S_7	Credit card debts
S_8	Loans not mentioned before

$$Y_t - [\sum_{i=1}^{20} \Delta_t B_i + \sum_{i=21}^{24} \Delta_t B_i + \Delta_t B_{25bp} - \Delta_t B_{25m} + \Delta_t B_{26av} - \Delta_t B_{26m} + \Delta_t B_{27av} - \Delta_t B_{27m} - \sum_{i=1}^{8} \Delta_t S_i]$$

The second summation considers the variations in the self-reported market value of durable goods. If no new purchase intervene, the difference is a measure of depreciation of the durable good that contribute to consumption. On the contrary, a new purchase is entirely attributed to the saving of the period. B_{25bp} is the buying price of the first house. Its variation, a new purchase, is attributed to the saving of the period. The second house (B_{26av}) and the other real estates (B_{27av}) are self-reported actual market values that are subject to capital gains. If there is a growing trend in the house's market, agents will upward their valuations and this will downward biased our measure of consumption. The reductions of the mortgages' values on all the houses and real estates ($\Delta_t B_{25m}$, $\Delta_t B_{26m}$, $\Delta_t B_{27m}$) are attributed to saving.

Alternative measures of consumption have been obtained by different combination of the variables reported in table 5. In particular, to deal with capital gains in real estates it is possible to consider the values of the second house and the other real estates as constant. This is equivalent to not introducing the variables B_{26m} and B_{27m} in the calculation of saving and, if no new purchase intervene, will upward biased our consumption level measure but will leave the consumption growth rate, the variable we are interested in, unbiased. If a new purchase intervenes even the consumption variation will be upward biased.

More generally, to deal with the problem of capital gains and losses in assets and real estates, we consider households that we believe to have a lower possibility of having experienced them, i.e. those who report a zero value in the sum of the variables that go from B_{11} to B_{18} and that do not own a second house or other real estates. We estimate regressions for such households and for the entire panel.

Wealth measures of our kind are noisy and differentiating two noisy variable, to build up savings, results in a very noisy measure. For this reason, and to deal with the fact that subjective expectations are characterized by the presence of extreme values, we decided to run, following Flavin (1991, 1999), Browning and Lusardi (1996) and Attanasio (1993), robust regressions.

4 The empirical version of the model and testing procedure

Our approach is that of estimating the implications of the presented model keeping the rational expectations hypothesis as the null and using instrumental variable.

The idea is that non rational pessimistic /optimistic agents commits systematic, hence predictable by the econometrician, errors in forecasting income. Agents that have been irrationally pessimistic experience a positive surprise as income realizes and upward revise their consumption decisions. Conversely, irrationally optimistic agents experience a bitter surprise and downward revise their consumption decisions. This all explaining excess sensitivity.

To implement the theoretical statement we use a two step procedure. At the first stage we instrument the forecast errors. That is, we run an orthogonality test regressing the forecast errors on data that were in the agents' information set at the time the expectations were stated. All it is required for a variable to be a good instrument is that it is exogenous with respect to the dependent variable. This requirement is automatically met under the null for all the data that were part of the information set of the agent when he stated the expectations. If the null of rational expectations is rejected, we are able to predict agents' systematic forecast errors or, otherwise stated, the systematic surprises that they experience as income realizes. So, we test our behavioral model of consumption, allowing for the Euler equation presented in the eqs. 30 and 31, that represent the second step of the procedure.

We firstly go further on the first step of the estimation procedure, which is slightly different depending on the subjective expectations used, than we analyze the empirical version of the Euler equation.

4.1 First stage: point expectations

When considering the point expectations on the growth rate of income, first stage orthogonality test has the following form:

$$\Delta y_{t+1} - E_t^{su}(\Delta y_{t+1}) = X_t \hat{\beta} + Z_t \hat{(\gamma)} + \epsilon_t \tag{26}$$

where X_t is a matrix of data contained in the agents' information set and Z_t is a matrix of controls. Under the null of rational expectations we have that $\beta = 0$. We refer to the left hand side of eq. (25), $\Delta y_{t+1} - E_t^{su}(\Delta y_{t+1})$, as the forecast error.

Under the null of rational expectations any variable that is known to the agent at the time the expectation have been stated must be uncorrelated with the forecast error. In this sense our model is not a structural forecasting model, since no process that governs expectations formation is specified. That is, no model that explains the alternative to the null hypotheses is specified[6]. Despite this, it performs better than the model with rational expectations, in the sense that it explains the apparent anomaly that consumption reacts to predictable changes in income.

For our purpose the main limitation of our panel remains its short time dimension, 8 years in this case. The conditional expectation of the disturbance terms $E(\epsilon_{t+1})$, according with permanent income hypothesis with rational expectations, must be zero. The empirical analog of $E(\epsilon_{t+1})$ is an average calculated on a long time span, in fact, as pointed out

[6]Our theoretical model, and the empirical evidence that will be furnished in the next sections are perfectly compatible with learning, quasi-rationality, evolution, diffusion and behavioral explanations.

by Chamberlain (1984), the increase of the cross section dimension do not guarantee its convergence to zero. Even though the forecast error should be zero on average if calculated on a long time period, this may not be the case in short panels. Otherwise stated, when performed with short panels, the orthogonality test, is a joint test of the orthogonality condition and of the maintained assumption that forecast errors are not correlated across households. Rejection of the null in favor of our behavioral model, may be attributed to the inconsistency of the estimator. To control for macroeconomic shocks we have included controls in both steps of the estimation procedure. In particular we allow for the presence of time dummies, geographical dummies and sectoral dummies. As underlined in Giamboni (2003) the choice between regressors and controls is someway arbitrarily left to the econometrician and controls cannot be used to test the null. For this reason we will allow for different specification of the information set.

Moreover, as always, an orthogonality test is not only a test of the orthogonality condition and a particular structure of the forecast error but, it involves also an implicit assumption over the agent' loss function. We use LAD and Stata robust regressor in the first stage to take into account for the shape of the loss function.

4.2 The first stage with subjective probability distribution of the level

The possibility to control for the shape of the loss function, in particular for linex loss function, is better taken into account when we use subjective probabilities on next year income level.

Christoffersen and Diebold (1997) have shown that prediction problems involving asymmetric loss structures imply an optimal predictor of the form

$$\hat{y}_{t+s} =_t \mu_{t+s} +_t \lambda_{t+s} \tag{27}$$

where ${}_t\mu_{t+s}$ is the conditional mean of $y_{t+s}|\Omega_t$ and ${}_t\lambda_{t+s}$ depends on all the, possibly time varying, conditional moments of order two or higher and on the loss function defined on the s-step-ahead prediction error. If $y_{t+s}|\Omega_t$ is assumed to be conditionally normal, $N({}_t\mu_{t+s};_t \sigma^2_{t+s})$, then, ${}_t\lambda_{t+s}$ depends on the conditional prediction error variance ${}_t\sigma^2_{t+s}$ and on the loss function. Generally, also assuming normality, it is not possible to get to an analytical solution for the form of a general asymmetric loss function. Closed form solution are possible for the linex loss function introduced by Varian (1974) and Zellner (1986) and for the lin-lin[7] loss function firstly used by Granger (1969). When ${}_t\sigma^2_{t+s}$ is not observed, as in Batchelor and Peel (1998), it is possible to perform a rationality test making an additional assumption about the process that governs the variance of the variable to be predicted. On the contrary, directly observing the subjective variance of expected family income, we do not need any additional assumption. For the easier of interpretation we will refer to the linex loss function, which has the following form:

$$L_t = \frac{\beta}{\alpha^2}[exp(\alpha x_t) - \alpha x_t - 1] \tag{28}$$

where α and β are constants (and $\beta > 0$) and x_t is the forecast error. α is the parameter that determines the degree of asymmetry of the loss function. If $\alpha > 0$, losses are approximately exponential when forecast errors are positive ($x_t > 0$), and approximately linear if forecast errors are negative. Here and throughout the article, forecast error is defined as the difference between realization and prediction. This corresponds to a case in which under-predictions are considered as more costly than over-predictions by the agent. The converse when $\alpha < 0$. We are back to a symmetric loss function as $\alpha \to 0$

Christoffersen and Diebold (1998) have shown that, under conditional normality, $Y_{t+s}|\Omega_t \sim N(\mu_{t+s|t}; \sigma^2_{t+s|t})$, the optimal predictor is of the form [8]

$$\hat{y}_{t+s} = \mu_{t+s|t} + \frac{\alpha}{2}\sigma^2_{t+s|t} \tag{29}$$

Thus, our specification of the rationality test, with respect to our model will be the following:

$$\frac{Y_{t+1} - E^{su}_t(Y_{t+1})}{Y_t} = X_t\hat{\beta} + \frac{\alpha}{2}\frac{Var^{su}_t(Y_{t+1})}{Y_t} + Z_t\hat{(\gamma)} + \epsilon_{t+1} \tag{30}$$

where X_t is the agent information set comprehensive of the stated expectation, Z_t is a matrix of control variables and $Var^{su}_t(Y_{t+1}) \setminus Y_t$ is the subjective variance of the real

[7]In this case the analytical solution doesn't rely on the assumption of conditional normality.

[8]Assuming a lin-lin loss function,

$$L(Y_{t+s} - \hat{Y}_{t+s}) = \begin{cases} a|Y_{t+s} - \hat{Y}_{t+s}|, & if(Y_{t+s} - \hat{Y}_{t+s}) > 0 \\ b|Y_{t+s} - \hat{Y}_{t+s}|, & if(Y_{t+s} - \hat{Y}_{t+s}) < 0 \end{cases}$$

and assuming conditional normality, Christoffersen and Diebold (1997) show that the optimal predictor if the following,

$$\hat{y}_{t+s} = \mu_{t+s|t} + \sigma_{t+s|t}\Phi^{-1}(\frac{a}{a+b})$$

where $\Phi(x)$ is the $N(0,1)$. Not allowing for conditional normality, we are back to the classical case of quantile regressions, where $\hat{Y}_{t+s} = F^{-1}(\frac{a}{a+b}|\Omega_t)$ and $\hat{Y}_{t+s}$ is the $\frac{a}{a+b}th$ conditional quantile.

net family expected income divided by real net family income. The efficiency of rational expectations implies that $\hat{\beta}$ must be zero. As pointed out by Giamboni (2003), as the variance is considered to control for the asymmetry of the loss function, the rationality test won't rely on its estimated coefficient. Controls for macroeconomic shocks are again included as panel's time span reduces to 5 years.

4.3 Remarks on the observed forecast errors

Some final remarks on our test strategies that are common to both the types of collected expectations. We have underlined in section 2 that the 0.85% of the interviews take place between May and July. The remaining interviews are spread all over the second half of the year. As the questionnaires ask for the expected income in the next 12 months, predictions and realizations rarely coincide. In the majority of the cases we are left with the following situation:

$$FE = Ydec_t - E(Ymay_t|\Omega may_{t-1}) \quad (31)$$

This forecast error may easily decomposed into

$$FE = [Ydec_t - E(Ydec_t|\Omega may_{t-1})] + [E(Ydec_t|\Omega may_{t-1}) - E(Ymay_t|\Omega may_{t-1})] \quad (32)$$

where the first term in square brackets is the true forecast error and the second one is the error that we commit using the expectations that are conditional on the May information set instead of those condition on the December information set. Our prediction error coincides with the true forecast error only when the agents have been interviewed on December, which is the case of 341 observations of those analyzed in chapter 2.

Is this a problem for an orthogonality test like ours? The spirit and the intuition of the test are completely safe. Even if income measure refers to some months after the reference point of the expectations, under the null, the difference between these two measures should be dependent only on innovations with respect to the information set available to the agent at the time the forecast was stated. Otherwise, if we want to interpret the observed forecast error as the unbiased one, we need to assume that respondents do not update their information set between the end of the previous year and the date of the interview, or if they do, their updating does not affect subjective expectations of income. This is a strong assumption if respondents receive, in that period, relevant news that may influence the evolution of their future income but, as underlined by Pistaferri (2001, 2003) is the common assumption, explicit or not, of all the literature that makes use of subjective expectations[9].

4.4 Second stage: the Euler equation

If the hypothesis of rational expectations is rejected with point expectations, we test our behavioral model of consumption estimating the following Euler equation:

$$log(\frac{c_{t+1}}{c_t}) = \alpha_1 \widehat{X_t\beta} + \alpha_3 E_t^{su}\Pi_{t+1} + \gamma(controls) + \eta_t \tag{33}$$

where $\widehat{X_t\beta}$ is the predicted forecast error and $E_t^{su}\Pi_{t+1}$ is the agent subjective inflation expectation.

If the hypothesis of rational expectations is rejected with subjective probability of levels, we test our behavioral model of consumption estimating the following Euler equation:

$$log(\frac{c_{t+1}}{c_t}) = \alpha_1 \widehat{X_t\beta} + \alpha_2 Var_t^{su}(y_{t+1}) + \alpha_3 E_t^{su}\Pi_{t+1} + \gamma(controls) + \eta_t \tag{34}$$

where $\widehat{X_t\beta}$ is the predicted forecast error, $Var_t^{su}(y_{t+1})$ is the variance of the subjective distribution of next year family income and $E_t^{su}\Pi_{t+1}$ is the agent subjective inflation expectation.

The conditional variance term[10] is included in the regression to allow for the fact that if utility exhibits decreasing risk aversion, prudent consumers, to an extent that depends on prudence, reduce consumption now with respect to future as reaction to an increase in consumption risk. No variance measure is disposable when we allow for point probabilities on income growth rate. Ludvingson and Paxson (1997) and Jappelli and Pistaferri (2000) have pointed out that the failure to properly taking into account consumption risk will bias the coefficient of the inter-temporal elasticity of substitution, and, furthermore it will generate spurious evidence of excess sensitivity. The same reasoning applies to our behavioral model.

We have also included the expected inflation, $E_t^{su}\Pi_{t+1}$. Theoretically, the expected values of the real interest rate should enter the Euler equation, as a relevant variable in saving decision. Our data set to not collect subjective expectations about next year real

[9]To our knowledge this timing problem is present in all the surveys that collect subjective expectations, i.e. VSB, SEE, SHIW, ecc.. To have examples of works that relies on such an assumption refer to Pistaferri (2001, 2003), Jappelli and Pistaferri (2000), Guiso, Jappelli and Terlizzese (1992) among the others.

[10]Generally omitted because of difficult observability. This is correct only the certainty equivalence version of the model which calls for quadratic utility function.

interest rate, but it is possible to proxy it using expected inflation. This approximation is exact if financial market is perfect. In this case there were only one interest rate and expected real interest rate would differ only because of agents inflation expectations.

The main limitation of our panel continues to be its short time dimension that makes it susceptible of the Chamberlain(1984)'s critique. As summarized by Jappelli and Pistaferri (2000), the excess sensitivity test, when performed on a short panel is a joint test of the null and of an assumed structure of the disturbance term, η_{t+1}. Apparent excess sensitivity may arise as the result of not properly taking into account the cross correlation of disturbances. To control for evenly and unevenly distributed macroeconomic shocks we have included controls in both steps of the estimation procedure. In particular we allow for the presence of time dummies, geographical dummies and sectoral dummies.

A similar problem may arise, because of the failure of the separability assumption. If consumption and leisure are not separable, today's decision will be affected by predictable changes in households' labor supply. This implies that consumption is correlated with hours of work, which are in turn correlated with income growth. Failure to consider for non separability may bring us to spurious evidence of excess sensitivity. Therefore, between the controls at the second step we have explicitly included variables describing the composition of the family and hence predictable changes in labor supply.

5 Results

In this section we present the empirical evidence concerning the models presented in the second paragraph. As already underlined, to perform our test we need of observations that stay in the panel for, at least, three consecutive years. Moreover, we need three consecutive years starting from a year in which the respondent answers the questions on subjective probabilities. This will reduce the number of available observations when running regressions with expectations calculated assuming beta distribution function.

To deal with the noise contained in the measured wealth, and hence in measured consumption, and with the extreme values contained in the expectations we have run a robust estimator. The estimator is robust with respect to outliers either in the space of X, in the regressors' space, and in the ϵ's space, or in the space of residuals.

The null is rejected with OLS and Stata's robust regressor. We use the robust estimates as our linear prediction of the systematic error component to use in the second step.

The assumption of rational expectations implies that our instruments are weakly exogenous, so all we have to take care of is to use instruments that were in the agents' information sets. For these reasons, and to show that our results are not due to a particular specification of the information set, we have dealt with different specifications of it.

Table 6 shows two examples, based on point expectations, of our estimation procedure. All the variables are in real terms. They have been divided by the private consumption deflator, with the exception of the subjective expectation. In this case we obtain the agent's expected deflator of private consumption adopting the declared expected price change in the following way: $E^{su}_{t-1}(DPC_t) = DPC_{t-1}(1 + E^{su}_{t-1}(\Pi_t))$.

The first two columns report results for two alternative specifications of the first stage. The reported P-value for both the regressions reject the joint hypotheses of rational expectations and quadratic loss function at any conventional significance level. The last columns report results for the estimation of the corresponding second stage Euler equations. Both shows that predictable forecast errors explain consumption variations which is evidence in favor of our behavioral model.

Let's look at the reported first stages. We start, in the first column, regressing the forecast error on a huge amount of regressors and on a set of controls that are included but not reported. This set of controls is the same we allow at the second stage and that is reported in the last two columns. Regressors include variables on household's structure, wealth and income, and variables describing the head of the household (indicated with 1 at the end of the label), and, when present, variables that refer to that spouse or the cohabitant of the head of the household (indicated with 2 at the end of the label). The reported F test is based on the set of regressors but not on the controls.

Expectations show a significant negative coefficient, which may reflect the fact that people that have been too optimistic are going to experience a bitter surprise in the realization and the converse if they have been too pessimistic.

As already mentioned, how to model the information set, that is how to choose between regressors and controls, is someway left to the econometrician. So we have calculated the F test on different sub-sample of the regressors. For example considering as controls all the variable with the exception of those that we use also in the second column brings us to a $F(18, 2426) = 13.25$ which rejects the null at any conventional level. The extreme possibility is that of consider the stated expectation as the only regressor completely immune to the influence of macroeconomic shocks and all the other variables as controls. In this case the orthogonality test reduces to a t test. Reported results continue to support the rejection of the null even in this last case[11].

The second column report results for an alternative specification of the information set. Here we consider a smaller subset of regressor taking but use the same set of controls. The reason for doing so is to avoid over-prediction in the IV estimator. If that were the case, our predicted forecast error may capture events that were genuinely unpredictable, resulting in spurious evidence in favor of our behavioral model.

Euler equation estimates report results in favor of our behavioral model. Predictable errors in forecasting income explain consumption variation, confirming that irrational pessimistic/optimistic consumers upward/downward revise their consumption decision as income realizes. In particular, large predictable forecast error's estimated coefficient should be interpreted as evidence of agents showing strong persistence in forming future expectations, like the case of overreaction or overconfidence we have described in eq.(23). The coefficient on expected inflation is not statistically significant and the controls are not statistically significant.

Table 7 reports our main results obtained using point expectations. From now on we will follow the convention of labelling (1) the results obtained allowing for the large set of instruments at the first stage, and (2) those obtained with the smaller set of instruments. For every orthogonality test, we have reported the number of observations, the number of variables and the F-test results. Second stage results constitute of the estimated coefficients of the predictable forecast errors, of the expected inflation and of the controls for non separability between consumption and leisure.

Model A refers to the estimates that we have already presented in table 6. Model B is the more troubling. As explained in section 3, we have tried to deal with the problem of capital gains, restricting the sample to those that do not posses wealth components that have a larger probability of being affected by this capital gain aspect. Here, the estimated coefficients decline at least by a standard error and are both not statistically significant. To go further on this point, in Model D, we have run the same regression allowing for a LAD estimator at the two stages. In this case, estimated coefficients turn out to be significant but a little smaller with respect to those obtained with the robust estimator applied to the entire sample. We have also allowed for different combination of the estimators. Theoretically, LAD estimator is used in the first stage to keep into account

[11]Rejection of the null is stronger when such a test is performed with expectations calculated under the beta distribution assumption. In this case the estimated coefficient is around .8 and the t statistics is over 40.

Table 6: An example of regressions with point expectations.

First stages. Dependent FE=$\Delta Y_{t+1} - E^{su}(\Delta Y_{t+1})$					Second stages. Dependent $\log(C_{t+1}/C_t)$				
Var.[a]	Coeff.	t-stud.	Coeff.	t-stud.	Var.	Coeff.	t-stud.	Coeff.	t-stud.
$E^{su}\Delta Y_{t+1}$	-.937	-3.05	-1.003	-3.34	$\widehat{FE}$	2.382	2.59	2.383	2.06
$E^{su}\Pi_{t+1}$	2.50e-04	0.13	-1.98e-04	-0.10	$E^{su}\Pi_{t+1}$	-.014	-1.89	-.014	-1.63
ΔY_t	.019	0.91	.025	1.26	Δ(housecomp)	-.010	-0.12	-.010	-0.11
wealth/Y_t	-2.35e-04	-1.80	-2.63e-04	-2.10	Δ(recipients)	.019	0.20	.014	0.15
age1	-.006	-2.74	-.006	-2.83	Δ(looking)	-.084	-0.50	-.054	-0.32
ages1	4.64e-05	2.30	4.49e-05	2.33					
age2	.004	1.65	.003	1.41	*controls*				
ages2	-3.08e-05	-1.40	-2.42e-05	-1.21	south	.053	0.86	.049	0.80
emp1	-.011	-0.63	-.003	-0.25	east	-.040	-0.65	-.042	-0.68
ownbus1	-.117	-4.37	-.083	-3.71	west	-.051	-0.57	-.048	-0.54
retired1	-.013	-0.77	-.005	-0.48	manager1	-.637	-1.25	-.635	-1.24
student1	-.067	-1.89	-.068	-2.03	manager2	-.640	-1.30	-.648	-1.25
emp2	-.004	-0.23	.003	0.40	professionist1	-.049	-0.35	-.041	-0.29
ownbus2	-.008	-0.24	-.016	-0.55	professionist2	-.002	-0.02	-.007	-0.05
retired2	-.015	-0.71	.002	0.10	technician1	-.038	-0.26	-.030	-0.20
student2	.095	2.00	.074	1.67	technician2	.216	1.05	.213	1.03
absent2	.081	1.05	.079	1.58	clerk1	.259	0.91	.253	0.89
typed	-.012	-0.33	-.034	-1.73	clerk2	.283	0.64	.283	0.64
housecomp	.014	0.72			marketsaler1	.150	0.75	.146	0.72
househchild	-.008	-0.39			marketsaler2	-.891	-1.95	-.863	-1.85
son18	-.011	-1.29			agricultor1	.001	0.01	-.005	-0.03
type-a[b]	.035	0.94			agricultor2	-.315	-2.90	-.322	-2.93
type-b	-.006	-0.46			craft1	-.010	-0.06	-.028	-0.15
type-c	.002	0.06			craft2	-.148	-0.45	-.134	-0.41
recipients	.010	0.78			plantoper1	.062	0.37	.048	0.29
looking	-.020	-1.36			plantoper2	-.028	-0.17	-.029	-0.18
fem1	.009	0.85			elementary1	.017	0.22	.011	0.14
fairh1	.017	1.95			elementary2	.002	0.03	-.001	-0.01
poorh1	-.046	-2.40			institution1	.027	0.46	.032	0.54
ed11	-.009	-0.29			institution2	-.003	-0.05	-.002	-0.04
ed21	-.006	-0.21			public1	-.047	-0.77	-.044	-0.72
ed2voc1	-.009	-0.31			public2	-.037	-0.51	-.038	-0.52
ed31	-.008	-0.26			year-93	-.367	-2.22	-.371	-2.23
ed3voc1	-.005	-0.15			year-94	-.192	-1.14	-.195	-1.14
temp1	-.005	-0.40			year-95	-.197	-1.15	-.203	-1.16
esp1	-1.96e-05	-0.12			year-96	-.344	-1.97	-.343	-1.95
fem2	.014	0.96			year-97	-.096	-0.55	-.097	-0.55
fairh2	-.005	-0.47							
poorh2	.012	0.58							
positie2	-.002	-0.18							
ed12	-.011	-0.48							
ed22	-.022	-0.92							
ed2voc2	-.014	-0.62							
ed32	.025	0.97							
ed3voc2	-.009	-0.39							
temp2	-.004	-0.34							
esp2	-1.15e-04	-0.57							
Y_t	-2.32e-07	-1.16							
Y_t^2	1.31e-12	1.59							
Intercept	-.058	-0.19	.036	0.12	intercept	2.598	2.72	2.599	2.17
Observations	2506		2507		Observations	1750		1751	
F-test[c]	$F_{(48,2426)}$	5.81	$F_{(18,2458)}$	13.57					
	Pr>F	0.0000	Pr>F	0.0000					

[a]All the variables are in real terms.

[b]Type-a: single. Type-b: living together with partner, children living at home. Type-c: other.

[c]Controls included in the first stages, result not reported. Control variables used at the first stage are the same we have included in the second stage. Control variables not used to perform the F-test.

for a different shape of the loss function with respect to the quadratic one. There is no *a priori* to run a LAD estimator at the second stage, if we except for the fact that is a way to obtain more robust estimates with respect to OLS. If we run a robust regression at the second stage, after a LAD estimator, we obtain a coefficient of 2.232 and a t statistics of 2.51. This results, together with those obtained using the subjective probabilities on income level, make us comfortable that our results do not depend entirely on capital gains. Notwithstanding capital gains seems to have an effect on the magnitude of the estimated coefficient of the predictable forecast error.

Model C applies LAD to the entire data set. Once again, coefficients obtained with this estimator are smaller but significant. If we allow for a combination of the two estimator we are back to a coefficient of 2.228 with a t statistics of 2.26. What is common to all these models is that the effect of predictable forecast errors on consumption growth turn out be persistent.

We have also tested the model allowing for different measures of consumption. The estimated coefficients of the predictable forecast errors, considering both the sets of instruments, are always significant and vary into a range that goes from a minimum of 1.981 to a maximum estimated value of 2.597[12].

Table 8 shows results obtained using subjective expectations over next year family income level, calculated assuming a beta distribution function. Models (1) and (2) continue to label the set of regressors previously introduced. As explained in the previous paragraph, to take into account asymmetry in the agents' loss function, we have introduced the term $\mathrm{Var}^{su}(\mathrm{Y}_{t+1})/\mathrm{Y}_t$ in both the specifications of the first stage. Moreover, we estimate the complete form of the Euler equation as in eq(33), by introducing the variance term, $\mathrm{Var}^{su}(\mathrm{Y}_{t+1})$. Regressing the forecast error on the subjective income variance we have an

[12]The alternative measures of consumption are obtained calculating saving in the following ways:

$$S_{1,t} = \sum_{i=1}^{20} \Delta_t B_i + \sum_{i=21}^{24} \Delta_t B_i + \Delta_t B_{25bp} - \Delta_t B_{25m} - \Delta_t B_{26m} - \Delta_t B_{27m} - \sum_{i=1}^{8} \Delta_t S_i$$

$$S_{2,t} = \sum_{i=1}^{20} \Delta_t B_i + \sum_{i=21}^{24} \Delta_t B_i + \Delta_t B_{25bp} - \sum_{i=1}^{8} \Delta_t S_i$$

$$S_{3,t} = \sum_{i=1}^{20} \Delta_t B_i + \sum_{i=21}^{24} \Delta_t B_i + \Delta_t B_{25bp} + \Delta_t B_{26av} + \Delta_t B_{27av} - \sum_{i=1}^{8} \Delta_t S_i$$

$$S_{4,t} = \sum_{i=1}^{20} \Delta_t B_i + \Delta_t B_{25bp} - \sum_{i=1}^{8} \Delta_t S_i$$

Table 7: Estimation results with point expectations.

	A		B		C		D	
	(1)[a]	(2)[b]	(1)	(2)	(1)	(2)	(1)	(2)
Firststage								
Observations	2506	2507	1625	1627	2507	2507	1625	1627
Variables	79	48	79	48	79	48	79	48
$E_t^{su}\Delta Y_{t+1}$	-.937	-1.003	-.919	-1.015	-1.029	-1.058	-1.120	-.940
	(-3.05)	(-3.34)	(-2.50)	(-2.83)	(-6.09)	(-4.50)	(-6.39)	(-3.67)
F-Test	5.81	13.57	4.06	9.24	22.96	28.83	16.47	18.73
Pr>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Secondstage								
$\widehat{FE}^c$	2.382	2.383	1.702	.920	1.419	1.290	2.011	1.780
	(2.59)	(2.06)	(1.82)	(0.72)	(1.94)	(1.39)	(3.07)	(1.72)
$E_t^{su}\Pi_{t+1}$	-.014	-.014	-.012	-.007	-.010	-.009	-.012	-.013
	(-1.89)	(-1.63)	(-1.55)	(-0.72)	(-1.79)	(-1.37)	(-2.63)	(-1.80)
Δ(housecomp)	-.010	-.010	-.135	-.129	-.031	-.022	-.115	-.113
	(-0.12)	(-0.11)	(-1.44)	(-1.37)	(-0.46)	(-0.33)	(-1.73)	(-1.53)
Δ(recipients)	.019	.014	.050	.035	.142	.132	.128	.147
	(0.20)	(0.15)	(0.47)	(0.33)	(1.92)	(1.78)	(1.60)	(1.66)
Δ(looking)	-.084	-.054	-.046	-.037	-.140	-.111	-.112	-.093
	(-0.50)	(-0.32)	(-0.28)	(-0.22)	(-1.17)	(-0.89)	(-0.89)	(-0.69)
Observations	1750	1751	1208	1209	1751	1751	1208	1209

[a]Forecast errors instrumented with the large set of instruments.
[b]Forecast errors instrumented with the small set of instruments.
[c]$FE=\Delta Y_{t+1}-E_t^{su}(\Delta Y_{t+1})$

estimated degree of asymmetry that is .15. This supporting evidence in favor of agents that consider under-predictions more costly than over-predictions.

Model A1 reports results obtained from the estimation of the model on the entire available data set. As it is evident, the use of this kind of expectations implies a relevant reduction of the sample size. There is statistically significant support for our behavioral model but the estimated coefficient of .346 is much smaller than the coefficient obtained with point expectations. Model B1 is estimated in the restricted sample that should be less biased by capital gain and losses. In both the cases the estimated coefficient continue to be significant and around the value obtained in Model A1. Model C1 exploits the module of the questionnaire that asks for the comprehension level of the respondents. Here, we have used predictions of only those respondents who declare that their answers were all correct or mostly correct[13]. This should result into a measure that is less biased because of the understanding of the questionnaire or because of measurement errors. Surprisingly, the effect of predictable forecast error looks stronger in this subset of data, resulting in two estimated coefficients of .5 and .44

Once again, results supporting our model are robust to the adoption of the alternative

[13]Comprehension level is referred to the entire questionnaire, not only to the module that collects subjective expectations.

Table 8: Estimation results with subjective expectations on next year income level. Expectations calculated assuming a beta distribution function.

	A1		B1		C1	
	(1)[a]	(2)[b]	(1)	(2)	(1)	(2)
Firststage						
Observations	565	566	349	350	321	322
Variables	77	46	77	46	77	46
$E_t^{su}(Y_{t+1})$	-.983	-.948	-.994	-.958	-.915	-.919
	(-53.09)	(-60.33)	(-41.76)	(-45.96)	(-40.94)	(-50.29)
$Var_t^{su}(Y_{t+1})/Y_t$	.724	-.518	2.184	-.656	-.348	-.431
	(4.58)	(-3.69)	(8.79)	(-2.91)	(-1.38)	(-2.00)
F-Test	72.51	233.40	47.09	139.91	50.29	162.50
Pr>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Secondstage						
$\widehat{FE}^c$	.346	.383	.394	.435	.503	.441
	(2.81)	(3.15)	(2.85)	(3.23)	(3.38)	(2.96)
$Var_t^{su}(Y_{t+1})$	2.41e-05	2.94e-05	3.40e-05	5.68e-05	2.59e-05	2.39e-05
	(1.34)	(1.61)	(1.47)	(2.36)	(1.26)	(1.16)
$E_t^{su}\Pi_{t+1}$	-.052	-.051	-.061	-.059	-.078	-.075
	(-1.84)	(-1.81)	(-2.10)	(-1.99)	(-2.05)	(-2.00)
Δ(housecomp)	.248	.253	.295	.321	.268	.265
	(0.89)	(0.91)	(1.10)	(1.21)	(1.18)	(0.76)
Δ(recipients))	-.080	-.079	.031	.010	6.75e-05	.009
	(-0.44)	(-0.44)	(0.16)	(0.05)	(0.01)	(0.04)
Δ(looking	-.608	-.581	-.618	-.613	-.739	-.705
	(-1.60)	(-1.53)	(-1.50)	(-1.47)	(-1.38)	(-1.32)
Observations	431	432	277	278	246	247

[a]Forecast errors instrumented with the large set of instruments.
[b]Forecast errors instrumented with the small set of instruments.
[c]$FE=Y_{t+1}-E_t^{su}(Y_{t+1})$

measures of consumption. The estimated coefficients of the forecast errors, allowing for both the sets of instruments, are significant and vary into a range that goes from an estimated value of .229 to a value of .378.

Rejection of the null, and hence the evidence in favor of our behavioral model, may be biased because of the way the CentER calculates income level. In particular they, correctly, sum up all the individual income component, while the respondent, making predictions, may refer only to the more important family income components such as wages. This could cause a systematic bias in the forecast error. Indeed, forecast income is on average significantly lower than income as measured by CentER [14]. This problem, may also explain the low point estimate of the coefficient on the predictable forecast error. In particular differences across households in the set of income components considered when forecasting income would, in effect, add noise or measurement error to the forecasts. Also our calculation of the subjective mean from the subjective probabilities will introduce noise. For both reasons differences in forecasts are not entirely due to different levels of optimism and pessimism.

[14]we thank Tullio Jappelli for bringing this issue to our attention

Since the forecast is an instrument for the forecast error, this noise would be included in the predicted forecast error and would bias the coefficient towards zero.

In an attempt to address these issues, we have also used for a self reported measure of family income, which is an interval measure, instead of income calculated by CentER. This does not affect results at the first stage. Rejection of the null is achieved by regressions with both the income measures. At the second stage we obtain an estimated coefficient of the predictable forecast error of .18 with a t statistics of 1.30. This regression is based on only 300 observations.

Although we are not able to give a structural interpretation of the parameters, our estimates show that precautionary saving and interest rates, may be playing some role in consumption decision. On the contrary, non separability of consumption and leisure looks less relevant.

6 Irrationality and excess sensitivity

This last section of the chapter aims at investigate the importance of irrationality in explaining excess sensitivity with respect to liquidity constraints and precautionary saving.

Theoretically, the rejection of the hypothesis that consumption is a random walk, can be attributed to the presence of liquidity constraints, precautionary savings and irrationality or myopia. Oddly, in the extensive literature on testing the permanent income hypothesis, the possibility that rejection is due to expectational errors is rarely mentioned, let alone explored. From Hall's article (Hall, 1978) on, all the effort in testing the Euler equation and excess sensitivity of consumption to predictable income changes have concentrated on liquidity constraints and precautionary saving. Although, as pointed out by Carroll (1992), it is vary hard to distinguish empirically between precautionary saving and liquidity constraints as households may increase saving today if they will be liquidity constrained in the future.

Here, we are not interested in discerning between the two classical sources of excess sensitivity. We aim at demonstrate the importance of irrationality as an alternative sources of excess sensitivity.

We estimate the following Euler equation, modified to allow for irrationality.

$$\Delta \ln C_{i,t+1} = \alpha \Delta D_{i,t+1} + \rho^{-1}(E(r_{i,t+1}|\Omega_t) - \delta) +$$

Table 9: Irrationality and excess sensitivity. Point expectations.

	(1)[a]			(2)[b]			(3)[c]
$\widehat{FE}^d$	1.878		2.271	1.66		2.224	1.555
	(1.79)		(2.32)	(1.30)		(1.82)	(1.25)
$E(\Delta \ln yY_{t+1})$	.566	1.356		.774	1.379		1.008
	(0.58)	(1.50)		(0.69)	(1.24)		(1.09)
$E_t^{su}\Pi_{t+1}$	-.011	2.45e-04	-.013	-.009	2.22e-04	-.013	-.009
	(1.34)	(0.05)	(-1.72)	(-1.04)	(0.04)	(-1.45)	(-0.99)
Observations	1633	1633	1633	1634	1634	1634	1633

[a]Forecast errors instrumented with the large set of instruments.
[b]Forecast errors instrumented with the small set of instruments.
[c]Forecast errors instrumented with the small set of instruments. Predictable income growth instrumented with the large set of instruments.
[d]FE=$Y_{t+1} - E_t^{su}(Y_{t+1})$

$$\frac{\rho}{2} var_{i,t}(\Delta \ln C_{i,t+1} - \rho^{-1}(r_{i,t+1}))+$$
$$\beta E \Delta \ln(y_{i,t+1}|\Omega_t) + \gamma E[y_{i,t+1} - E_t^{su}(i, y_t)|\Omega_t)] + \varepsilon_{i,t+1}, \quad (35)$$

where i is an household index, $C_{i,t+1}$ is our measure of consumption, $D_{i,t+1}$ is a vector that includes our controls for households' preferences, non separability between consumption and leisure, and macroeconomic shocks, $r_{i,t+1}$ is the real after tax rate of interest, δ the rate of time preferences, and ρ^{-1} is the inter-temporal elasticity of substitution. Predicted income growth, $E\Delta\ln(y_{i,t+1}|\Omega_t)$, and predicted forecast error,$E[y_{t+1} - E_t^{su}(y_t)|\Omega_t)]$, are added to the Euler equation in order to test the orthogonality condition, i.e. that $\beta = 0$ and $\gamma = 0$. We choose a log specification for income growth and instrument it with the same set of variables we use to instrument the forecast error.

For every regression we report the estimated coefficients of the predictable forecast error, the predictable change in income, the subjective variance and the expected rate of inflation. The first column shoes that when the excess sensitivity test is performed the coefficients on the predictable forecast error remains large and significant. This demonstrates that irrationality is still a possible explanation for excess sensitivity of consumption, even when other explanations are considered. The second column shows that running the excess sensitivity test under the rational expectations hypothesis gives a higher and statistically significant coefficient of the predictable changes in income. This may be interpreted as evidence of the fact that not taking into account irrationality may bias upward the coefficient of the predictable changes in income. This is not decisive for rejection of the absence of excess sensitivity, but it shows that what may appear as precautionary saving or the effect of a liquidity constraint may instead be the effect of irrationality or partially the effect of irrationality. In this sense, the previous works, not taking into account irrationality may

Table 10: Irrationality and excess sensitivity. Subjective expectations on next year income level. Expectations calculated assuming a beta distribution function.

	(1)[a]			(2)[b]			(3)[c]
$\widehat{FE}^d$	.326		.342	.374		.373	.379
	(2.60)		(2.71)	(2.98)		(2.98)	(3.03)
$E(\Delta \ln Y_{t+1})$	1.812	1.991		-.123	.515		1.891
	(2.31)	(2.57)		(-.013)	(0.54)		(2.40)
$\text{Var}_t^{su}(\text{Y}_{t+1})$	1.13e-05	-7.43e-07	1.69e-05	2.21e-05	4.15e-06	2.19e-05	1.71e-05
	(0.61)	(-0.04)	(0.92)	(1.16)	(0.23)	(1.17)	(0.90)
$\text{E}_t^{su}\Pi_{t+1}$	-.057	-.059	-.054	-.053	-.057	-.053	-.055
	(-1.92)	(-2.02)	(-1.83)	(-1.80)	(-1.94)	(-1.82)	(-1.87)
Observations	413	413	413	413	413	413	413

[a]Forecast errors instrumented with the large set of instruments.

[b]Forecast errors instrumented with the small set of instruments.

[c]Forecast errors instrumented with the small set of instruments. Predictable income growth instrumented with the large set of instruments.

[d]$\text{FE}=\text{Y}_{t+1}-\text{E}_t^{su}(\text{Y}_{t+1})$

have results in biased evidence in favor of the first explanations.

The third column present results for the equation without considering predictable changes in income. The estimated coefficient for the forecast error is significant and similar to the one estimated when also predictable income changes are considered. This is evidence of the fact that irrationality is an explanation that stands on its own. Hence, irrationality is generated by something else and predictable forecast error coefficient seems to be not biased if precautionary savings and liquidity constraint s are not properly taken into account.

The model label (2) consider prediction obtained with the smaller set of instruments, and confirm results previously underlined. The last column consider predictable forecast errors obtained with smaller set of instruments (model (2)) and predictable changes in income from the larger set of instruments (model (1)). Also in this last case our main results are confirmed.

Table 10 shows results obtained with subjective probabilities on nest year income level, where expectations and subjective variances have been calculated using beta distribution distribution. The evidence is always in favor of our behavioral model. In this case the variance is not an important regressor anymore.

To investigate further on the role of irrationality and the other explanations of excess sensitivity, we have also run regressions splitting the sample by non-human wealth in the way suggested by Zeldes (1989). We have considered three rate of non-human wealth over income, above which the possibility of being liquidity constraint should be smaller. The first threshold level is 0, then we consider as not constraint families in which the total wealth is at lest equal to two months of family income (0.16) or three months of family income (0.25). The estimated coefficients of the predictable forecast errors are not statistically different with respect to those reported in model A and A1. When allowing for point expectations, estimated coefficients obtained for the three different thresholds, with both the set of instruments, vary in the interval [2.225; 2.421]. The same regressions, allowing for expectations of next year income level, bring to forecast errors' estimated coefficients that vary in the interval [.334; .388]. Thus, we are confident that our evidence is capturing the effects of irrationality instead of the effects of liquidity constraints[15].

Previous results may be criticized as the presence of liquidity constraints should be tested with a more liquid measure of wealth than the entire non human wealth. So, we split the sample by asking for a positive checking balance in the years the respondents state the expectations and in the years next to these. Results for both the sets of instruments are contained in the interval [1.562; 2.225], when allowing for point expectations, and in the interval [.235; .322] when subjective expectations over next year family income level are considered. Once again, beside the more restrictive rule to split the samples, results support our behavioral model of consumption.

7 Conclusions.

We propose a model to investigate whether anomalies in consumption, here the fact that consumption reacts to predictable changes in income, can be explained by a behavioral model in which agents do not have rational expectations and make predictable errors in forecasting income. To consider this possibility we have used a data set containing different kinds of subjective expectations. We tested and rejected the null of rational expectation and quadratic loss function.

It is possible that our inability to reconcile the rational expectations hypothesis with the empirical evidence belongs from the implicit assumptions on the agent's loss function. However the fact that we find strong evidence in support of our behavioral model, stating that consumption is a function of predictable changes in income, should be interesting even to those who consider the assumptions of quadratic, or in the absolute deviations, loss

[15] Running the classical excess sensitivity test we have obtained, for the two different set of instruments (but the subjective expectations) used in table 9 and table 10, the following series of estimated coefficients of: 1.597 (all the sample), 1.213 (threshold 1), 1.166 (threshold 2), 1.005 (threshold 3) and .910 (All the sample), .521 (threshold 1), .248 (threshold 2), .008 (threshold 3).

function overly restrictive.

Moreover, we find considerable evidence in favor of the fact that assuming rational expectations may bias the excess sensitivity test in favor of explanations based on precautionary savings and liquidity constraints while part of the evidence may be reinduced to irrationality or myopic behavior.

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