Evaluating how predictable errors in expected income affect consumption*

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Abstract

This paper studies whether anomalies in consumption can be explained by a behavioral model in which agents make predictable errors in forecasting income. We use a micro-data set containing subjective expectations about future income. The paper shows that the null hypothesis of rational expectations is rejected in favor of the behavioral model, since 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).

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1 Introduction

Under rational expectations the stochastic version of the permanent income hypothesis/life cycle hypothesis (PIH/LCH) 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 or pessimistic.

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. In this second model the agent aims to maximize his subjective expected utility over the life cycle, but 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[1].

Our behavioral model implies a new formulation of the Euler equation where predictable errors in income forecasts help explain the first difference of consumption. This suggests that, not properly taking into account irrationality, previous research on excess sensitivity of consumption may be not correctly specified. We will show whether the coefficient on predictable changes in income changes once the predictable forecast error is introduced in the Euler equation. In particular, irrational pessimism and irrational optimism seem to be more statistically significant explanations 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 of the

[1] Brown and Taylor (2006) rely on financial expectations and realizations to link past financial optimism and pessimism with current financial prediction accuracy and determine how it affects saving and consumption. They find that past financial optimism has a positive effect on current expectations formation whilst past financial pessimism has a negative effect. Financial optimism is inversely associated with saving and that current financial expectations serve to predict future consumption. From a consumer confidence survey dataset covering 10 European countries over 22 years, Bovi (2009) compare average values of the differences between prospective views versus retrospective views as well as personal views versus general views on economic stances. Findings suggest the presence of structural psychologically driven distortions in people's judgments and expectations formation.

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 imposes a model of the data generating process, which under the assumption of rational expectations describes how individuals form their expectations. The estimation strategy is to 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; Dominitz, 1998, 2001; Kaufmann and Pistaferri, 2009; Kapteyn et al., 2009). It allows for complete heterogeneity of income expectations formation and permits one to overcome the problem that the econometrician's information set is not rich enough to reproduce the agent's information set. Kapteyn et al. (2009) find evidence in support of this argument. Using data from the DNB Household Survey (DHS), which is the same dataset we use in this paper, the authors use direct subjective information on respondents' expectations in Euler equation estimation of intertemporal consumption model. Moreover they use information on individual preferences to estimate a welfare function of income and derive knowledge on respondents' utility function. Using such direct subjective information on respondents' expectations and preferences allows to reduce the number of assumptions needed to estimate the Euler equation of intertemporal consumption models. Kapteyn et al. find that welfare functions and expectations have predictive power for the variation in consumption across households. Furthermore, their estimation of the intertemporal elasticity of substitution based on the estimated welfare functions is in line with other estimates found in literature.

We use data from the Dutch DNB Household Survey (DHS). This dataset consists of approximately 5000 individual observations for each wave in the 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 starts in 1993.

We calculate the forecasts errors as the difference between realized family income and the mean of the elicited subjective distribution of future family income. We instrument the agent's prediction error with various specifications of the information set. The weak exogeneity of the adopted instrument is assured by the null hypothesis of agents' rationality. In the second step of the two stage instrumental variable estimator we regress the first difference of the logarithm of consumption 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 to support the claim that the elicited expectations really correspond to those affecting the agent's behavior. Hence, it is important and interesting to show that, once the rational expectations hypothesis is rejected, it is possible to explain agents consumption decisions.

As underlined by Kapteyn et al. (2009), one limitation with using the DHS dataset is that one is not provided with a direct measure of consumption but needs to derive it by subtracting savings to income. Another limitation is that income and savings are reported in brackets. Moreover, savings can take only non-negative values in the DHS.

Souleles (2004) analyzes the household-level data that underlies the Michigan Index of Consumer Sentiment, a dataset called the Michigan Survey of Consumer Attitudes and Behavior (CAB). The CAB contains the answers each household gave to the five questions that comprise the Michigan Index of Consumer Sentiment. To study how sentiment is related to spending, Souleles uses the most comprehensive household-level dataset on consumer expenditures, the Consumer Expenditure Survey (CEX), which also contains a rich set of household demographic indicators. Souleles links the household-level sentiment data with consumer spending by imputing the sentiment levels of households who participated in the Consumer Expenditure Survey from demographically similar households who participated in the survey of Consumer Attitudes and Behavior. Using the imputed values of expectations, Souleles finds that they are inefficient as forecast errors are found to be correlated with demographic characteristics. Moreover, he finds some, though not all, of the excess sensitivity appears to be due to such systematic heterogeneity in forecast errors.

Souleles's need to construct a pseudo panel in order to match data on elicited forecasts and data on consumption has a heavy cost as it is not possible to use an individual forecast to predict that individual's forecast error. Since there is huge variation in the income forecasts of demographically similar individuals, a very powerful candidate indicator of irrational optimism or pessimism simply can't be used with a pseudo panel. We find that the individual forecast is by far the most powerful instrument for the individual forecast error. Some of our more striking results are based on using the forecast as our only indicator - instrumenting irrational optimism with optimism directly.

A potential problem with panel instrumental variables estimation can be caused by correlation of disturbances across individuals. One way to check for this is to see if the results are changed if variables which might pick up those common shocks are included in the second stage. For example workers in manufacturing might suffer a correlated unpredictable income shock in a recession. In this case, the apparent violation of the standard Euler equation would be eliminated if indicator variables for worker in manufacturing in period t are added to the regression. Unfortunately this removes exactly the identifying variance which is necessary in a pseudo panel regression. True panel data makes it much more possible to evaluate the relevance of concerns about cross sectional correlations of disturbances. For these reasons we believe that our paper makes a useful addition to the project begun by Souleles.

2 The model

The path of future income is uncertain, so individuals must make their consumption plans on the basis of their subjective expectations about future uncertain events. The conventional model of life-cycle consumption under uncertainty, with isoelastic time separable utility, consumers maximizing expected utility function and perfect credit markets, becomes:

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

subject to

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

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

$$lim_{s\to\infty}(1+r)^{-s}a_s = 0 \tag{4}$$

where E_t^{su} is the subjective expectations operator conditional on all information available at time t and stated at the end of the period, δ is the rate of time preference, c is consumption, y is total family net income, r is the real rate of interest, which is assumed to be constant, and a represents assets apart from human capital.

Differentiating with respect to consumption and considering the first order condition of equality of wealth's and consumption's marginal utilities at the optimum, we obtain the following Euler equation:

$$E_t^{su}(c_{t+1}^{-\gamma}) = \frac{1+\delta}{1+r}c_t^{-\gamma} \tag{5}$$

To illustrate our behavioral model, let us assume, for instance, that agents have a subjective distribution over the consumption growth rate, which is normal:

$$\Delta \log c_{t+1} | \Omega_t \sim N(\mu_c; \sigma_c^2) \tag{6}$$

where Ω_t indicates all information available at time t; $\mu_c = E_t^{su}(\Delta \log c_{t+1})$ and $\sigma_c^2 = Var_t^{su}(\Delta \log c_{t+1})$, that, for the sake of simplicity, will be assumed constant over time. We also assume that $e^{((1+\gamma)/2)\sigma_c^2 + (\tilde{r}-\tilde{\delta})/\gamma} < 1 + r$ and that the law of iterated expectations applies to subjective expectations, $E_t^{su}(E_{t+s}^{su}(x_{t+s})) = E_t^{su}(x_{t+s})$. Such an assumption means that agents are convinced that they are rational and that they will be rational in the future. We can write down Eq. 5 as the following:

$$E_t^{su} exp[-\gamma \Delta \log c_{t+1} + \log(1+r) - \log(1+\delta)] = 1 \tag{7}$$

which, in turn, is equal to

$$exp[-\gamma \mu_c + (1/2)\gamma^2 \sigma_c^2 + \tilde{r} - \tilde{\delta}] = 1 \tag{8}$$

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 defined $\tilde{r} \cong \log(1+r)$ and $\tilde{\delta} \cong \log(1+\delta)$. Taking the logs we have

$$-\gamma E_t^{su}(\Delta \log c_{t+1}) + (1/2)\gamma^2 \sigma_c^2 + \tilde{r} - \tilde{\delta} = 0 \tag{9}$$

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

$$E_t^{su}(c_{t+1}) = c_t e^{((1+\gamma)/2)\sigma_c^2 + (\tilde{r}-\tilde{\delta})/\gamma} \tag{10}$$

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:

$$\sum_{s=0}^{\infty} (1+r)^{-s} E_t^{su}(c_{t+s}) = a_t + \sum_{s=0}^{\infty} (1+r)^{-s} E_t^{su}(y_{t+s}) \tag{11}$$

where y_t is labor income which is exogenous and is paid at the end of the period. Substituting in Eq. 10 gives

$$\sum_{s=0}^{\infty}(1+r)^{-s}e^{s[((1+\gamma)/2)\sigma_c^2+(\tilde{r}-\tilde{\delta})/\gamma]}c_t = a_t + \sum_{s=0}^{\infty}(1+r)^{-s}E_t^{su}(y_{t+s}) \tag{12}$$

Using the assumption that $e^{((1+\gamma)/2)\sigma_c^2+(\tilde{r}-\tilde{\delta})/\gamma} < 1+r$, we obtain

$$c_t = \zeta[a_t + \sum_{s=0}^{\infty}(1+r)^{-s}E_t^{su}(y_{t+s})] \tag{13}$$

where we have defined $\zeta = 1 - \frac{e^{((1+\gamma)/2)\sigma_c^2+(\tilde{r}-\tilde{\delta})/\gamma}}{(1+r)}$.

Moreover, a_{t+1} is known at time t, so

$$c_{t+1} - E_t^{su}(c_{t+1}) = \zeta\sum_{s=0}^{\infty}(1+r)^{-s}[E_{t+1}^{su}(y_{t+s+1}) - E_t^{su}(y_{t+s+1})] \tag{14}$$

The assumption that consumption is log normally distributed implies that

$$\begin{aligned}\Delta\log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r}-\tilde{\delta}}{\gamma} + \\ + \frac{\zeta}{E_t^{su}(c_{t+1})}\sum_{s=0}^{\infty}(1+r)^{-s}[E_{t+1}^{su}(y_{t+s+1}) - E_t^{su}(y_{t+s+1})]\end{aligned} \tag{15}$$

Expectations are stated at the end of the period so $E_{t+1}^{su}(y_{t+1}) = y_{t+1}$. If one assumes that the error in subjective forecasts of y_{t+1}, $y_{t+1} - E_t^{su}(y_{t+1})$, is uncorrelated with subjective expectations of subsequent periods, i.e. $E_{t+1}^{su}(y_{t+s+1}) - E_t^{su}(y_{t+s+1}) = 0$ for $s > 0$, the previous equation becomes:

$$\Delta\log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r}-\tilde{\delta}}{\gamma} + \frac{\zeta}{E_t^{su}(c_{t+1})}[y_{t+1} - E_t^{su}(y_{t+1})] \tag{16}$$

If agents have been too pessimistic, they revise their consumption decision upward. If they have been too optimistic, they revise their consumption decision down. More generally, if current forecast error is non negatively correlated with the subjective expectations of subsequent periods, $E_{t+1}^{su}(y_{t+s+1}) - E_t^{su}(y_{t+s+1}) = \rho^s[E_{t+1}^{su}(y_{t+1}) - E_t^{su}(y_{t+1})]$ and $\rho > 0$, we get to the following equation:

$$\Delta\log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r}-\tilde{\delta}}{\gamma} + \frac{1+r}{1+r-\rho}\frac{\zeta[y_{t+1} - E_t^{su}(y_{t+1})}{E_t^{su}(c_{t+1})} \tag{17}$$

That is the case if the agents believe that income innovations are persistent. If $\rho = 1$, agents believe that the unpredicted disturbance to y_t is a random walk with $E_t^{su}(y_{t+s+1} - y_{t+s}) = 0$. Alternatively, if $\rho = 1$ and agents believe that the unpredicted disturbance to y_t is an integrated moving average of the first order (IMA(1)) with MA coefficient equal to $-\theta$, we have that $E_t^{su}(y_{t+s+2} - y_{t+s}) = 0$ for $s \geq 0$ and $E_t^{su}(y_{t+2} - y_{t+1}) = \theta[y_{t+1} - E_t^{su}(y_{t+1})]$. 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. 15 becomes:

$$\Delta \log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r} - \tilde{\delta}}{\gamma} + \frac{\zeta(1+r+\theta)}{r}\frac{[y_{t+1} - E_t^{su}(y_{t+1})]}{E_t^{su}(c_{t+1})} \tag{18}$$

Our model has the desirable feature of presenting the growth rate of consumption as the result of a precautionary saving motive plus a term that depends on agents' forecast errors. The second term is consistent with the idea of a behavioral model of consumption of irrationally optimistic agents who, having high expectations, experience a bitter surprise, once income is realized, and revise their consumption decision downward. Conversely, irrationally pessimistic agents experience a positive shock as income is realized and revise their consumption decisions upward.

If agents were rational, the model would state the common result for a model without liquidity constraints that, apart from the unpredictable income innovation, excess sensitivity is due to precautionary saving, $\Delta \log c_{t+1} = (1/2)\gamma\sigma_c^2 + \frac{\tilde{r}-\tilde{\delta}}{\gamma}$. In this case, ignoring the variance term may result in omitted variable bias. Hence, overreaction of consumption to predictable changes in income may appear because of their correlation with the error term which depends on the variance of consumption.

That is not the case in our model, as it asserts that, if agents are irrational or myopic, consumption variation is a function of predictable forecast errors.

John Muth's (1961) rational expectations hypothesis implies that expectations are unbiased and forecast errors are distributed independently of the anticipated values. This continues to be true in 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 non-random term of the Euler equation if agents are irrational or myopic.

On the contrary, if our model is valid, previous evidence of excess sensitivity may be re-interpreted not only because of the omitted variance term and for liquidity constraints, but also because of the assumption of rationality, that is, because of the omission of the predictable forecast error.[2] Thus consideration of irrationality can help explain the anomaly of predictable changes in consumption.

3 Data

For the empirical implementation of the model, a micro dataset containing detailed information on subjective expected future income and realized income is necessary. The data are taken from the DNB Household Survey (DHS) that since 1993 has been part of a project started and administered by CentER, a research institute at the University of Tilburg.[3] In this section, after a brief description of the way in which the data have been collected, we will focus our attention on subjective income expectations and self reported realized income.

The DHS is an unbalanced panel. As reported in Table 1, when the survey started, it consisted of two panels, one representative of the Dutch population (RE), covering 1,760 households, and the other representative of the top 10 percent of the income distribution (HI), encompassing approximately 900 families, with a share of 66% and 34%, respectively. The last wave of the panel consists of 1,800 households in the RE panel and only 29 in the HI panel. The severe reduction in the HI panel is due to the fact that since 1997 new families have not been recruited for the HI panel, so it quickly shrank as the higher income families exited the panel.

[Table 1 About Here]

The DHS consists of six questionnaires, presented to all the people aged 16 or over within the family, which collect detailed information on demographics, work, health status, family composition, individual and family incomes and wealth.[4] Moreover, the DHS is one of the few surveys that collects different kinds of subjective expectations on the future family income and inflation and information on agents' attitudes toward risk and their time

[2] 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 follows Hall (1978).

[3] Since 2003, the project is managed in collaboration with De Nederlandsche bank (DNB).

[4] The survey method is completely computerized. Each household is provided with a personal computer, receives the questionnaires by modem, answers the questionnaires on its home computer and returns the answers to the CentER by modem again. This means that the questionnaires are self-administered and the respondents can answer the questionnaires at a time that is convenient for them.

preferences. Being a savings survey, the DHS panel doesn't collect data on consumption directly, but an estimate can be obtained by taking the difference between income and savings.

Each wave contains flow and stock information for the previous year. The period we consider in our analysis runs from 1995 to 2002, as some variables of interest were collected only in these years. In the next sections, we focus on some variables: the household's expected income, realized income and savings. Expectations concerning the next year's income level were obtained by reports of the subjective probabilities that it will fall in intervals. Using two different parametric assumptions, we estimate the subjective probability distribution over next year's income. Realized income and savings were reported according to categories.

3.1 The probability distribution of next years family income

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

In the DHS, 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: $threshold_{\kappa} = Y_{min} + 0.2\kappa(Y_{max} - Y_{min})$ and $\kappa = 1, ...4$. 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.*[5] After division by 100, we obtain 4 point values, corresponding to the thresholds, for the subjective cumulative distribution function of next year's net family income. We will make two different assumptions 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 the piecewise linear. The beta is estimated by non-linear least squares.

The questionnaire on health and income, containing the module described above, was

[5]The percent chance of $y <= y_{max}$ is not asked and it is implicitly assumed to be 100.

presented to a decreasing number of respondents during the period that goes from 1995 to 2000 and to around 2,000 individuals in the subsequent years. As shown in Table 2, 72% of the respondents stated at least Y_{min} and Y_{max}. It should be underlined that they were not asked the subsequent questions if the difference between Y_{max} and Y_{min} was smaller than a fixed amount which corresponds to 5 Dutch florins (dlf.) until 2002 and 5 euros for the following years. This is the case for 2277 observations (10%).

The DHS suffers a problem of non monotonicity in the stated subjective cumulative distribution function. The cases which present this problem are 2251 (10%). A brief analysis of the answers reveals that some people are not able to articulate their expectations using the theory of probability and/or commit typing and recording errors. The final response rate is around half (48%) of respondents. It is small for the first two years (35%), but increases over time to 63%.

[Table 2 About Here]

The analysis of the lowest and highest possible incomes reveals that 64 respondents have declared a highest possible income inferior to 100 euros and 14 far superior to 500,000 euros. These values seem implausible to us and we decide to drop the corresponding observations. The mean value of the lowest possible income is €18,587 with stated values that vary from 0 to 385,900, while the mean value of the highest possible income is €23,176 in a range that goes from 100 to 500,000.

3.2 Measuring consumption

An important feature of the data is the way consumption is estimated since it is not directly observed. Consumption can be defined as the difference between income and savings.

In our empirical analysis, we use respondent's answers on self reported family savings. In particular, we refer to a pair of questions that are part of the section on psychological concepts which we report below:

Did you put any money aside in the past 12 months?

If the answer is yes, the respondent is also asked the following question about the amount:

About how much money has your household put aside in the past 12 months?

0) don't know

1) less than Dfl. 3,000 (€1361,34)

2) 3,000 - 10,000(€1361,34 and €4537,80)

3) 10,000 - 25,000 (€4537,80 and €11344,51)

4) 25,000 - 40,000 (€11344,51 and €18151,21)

5) 40,000 - 75,000 (€18151,21 and €34033,52)

6) 75,000 - 150,000 (€34033,52 and €68067,03)

7) 150,000 or more (€68067,03)

Because of the difficulty in providing accurate responses to questions about either earnings, income, savings and wealth, and in order to reduce the rate of item non-response, surveys have increasingly used classes as possible answers. Here, respondents are expected to report the amount of money put aside by choosing one of the seven predetermined classes or the non-informative "don't know". Out of this information we have constructed a variable by taking the midpoints of each class. Since the last interval is right censored, no midpoint can be calculated. To overcome this problem, we assume that the highest bound corresponds to €100,000.

A possible source of data on income comes from CentER which aggregates self reported financial information in order to calculate a comprehensive personal income measure. However, they correctly sum up all the different types of income, while respondents, making predictions, may refer only to the more important family income components such as wages.[6] This could cause a systematic bias in the forecast error. Indeed, forecast income is on average significantly lower than income as measured by CentER. Moreover, differences across households in the set of income components considered when forecasting income would, in effect, add noise or measurement error to the forecasts. For these reasons we choose to deal with the available self reported information on household net income. This should help to avoid spurious evidence against the null hypothesis of rational expectations.

We construct an estimate of family income deriving it from a question where respondents are asked to indicate the interval which corresponds to the income realized over the last twelve months. The precise wording of the question is reported below:

Into which of the categories mentioned below did the total net income of your household go in the past 12 months? If you really don't know, use "don't know".

[6] CentER also allows for processes of grossing-up when only net income components are available. Moreover, it calculates net income, simulating the Dutch tax and benefit system, starting by the gross one.

0) don't know

1) less than Dfl. 20,000 (€9075,60)

2) 20,000 - 28,000 (€9075,60 and €12705,85)

3) 28,000 - 43,000 (€12705,85 and €19512,55)

4) 43,000 - 80,000 (€19512,55 and €36302,42)

5) 80,000 - 150,000 (€36302,42 and €68067,03)

6) 150,000 or more (€68067,03)

The estimate of income is constructed similarly to estimated savings assigning the midpoints of the intervals indicated by the respondent. For the respondents that indicate the sixth interval, as above we assign the value of €100,000 as the highest bound. We subtract subjective expected next year's income from this income estimate to calculate the error in predicting future income.

As shown in Table 3, on average 87% of all respondents answered to the questions on family income. Response rates are smaller for the modules on savings (63%). A negligible number of families does not answer to the question about savings because they spend all income. We opt to exclude observations reporting no savings from most of our estimations in order to avoid errors from possible misreporting.

[Table 3 About Here]

Our analysis is based on data from most of the questionnaires of the DHS panel. In particular, it draws heavily upon the part on health and income, where subjective expectations on next year's income were collected, and upon the part on psychological concepts where subjective inflation forecasts and self reported previous years realized income and savings were collected.

The sample used in the empirical analysis below includes only heads of households. Table 4 reports summary statistics for the variables and the observations used in the regression analysis. Forecast error (I) is positive for 333 observations and negative for 33 observations. This means that the majority of observations has higher next year's income realizations than expected. The estimated mean values of the subjective expected income distribution - expected income (I) and (II), in the case, respectively, a beta or a piecewise linear distribution is assumed - show similar means and standard errors, suggesting that it is not much sensitive to the choice of the distribution.

[Table 4 About Here]

As will be clarified below, to estimate the model, we need at least three consecutive waves of data. Since some questions of interest on subjective income were collected only from 1995 to 2002, we only consider eight waves. We do not make use of imputation in the cases of item non response. Instead we drop the families for which variables on expected and realized income are not available. Other observations are not considered due to lack of data on relevant variables but they are very few and substantially negligible. Finally, heads of households aged more than 70 are excluded because these individuals are mostly retired and are generally on a fixed income, other than inflation increases, and, therefore, can easily predict their future income.

Merging the data from all the questionnaires produces a pooled dataset for all waves which contains 7,383 individuals. However, since we use only observations that remain in the panel for at least three consecutive years, the number of available respondents is reduced to 3,062. 1,120 of them remain in the panel for only three waves while 75 stay for the entire duration of the panel. Considering all observations, the mean duration is of 2.7 years with the first and third quartiles of the distribution equal to 1 and 4 years, respectively.

To deal with the fact that subjective expectations are characterized by the presence of extreme values, we decided to estimate robust regressions, following Flavin (1991, 1999), Browning and Lusardi (1996) and Attanasio (1998).

4 Empirical implementation of the model and testing procedure

We estimate the model presented in section 2 using instrumental variables in order to test the null of rational expectations and isoelastic separable utility. The idea is that non-rational pessimistic/optimistic agents commit systematic errors in forecasting income, which can be predicted by the econometrician. Agents that have been irrationally pessimistic experience a positive surprise when income is realized and revise their consumption decisions up. Conversely, irrationally optimistic agents experience a bitter surprise and downward revise their consumption decisions down.

To implement the theoretical statement we use a two step procedure. In the first stage, we instrument forecast errors. That is, we run an orthogonality test regressing forecast errors on data that were in the agents' information set at the time the expectations were stated. For a variable to be a good instrument, it is necessary it to be correlated to the endogenous variable and exogenous with respect to it. The latter requirement is automatically met under the null for all the data that were part of the information set of the agent when he stated his expectations. If the null of rational expectations is rejected, we are able to predict agents' forecast errors, that is, the systematic surprises that they experience as income realizes. Thus we test our behavioral model of consumption, estimating the modified Euler equation presented in the Eqs. 15 and 18, as the second step of the procedure.

4.1 The first stage

Considering expectations on the growth rate of income, a general first stage orthogonality test has the following form:

$$fe_{t+1} = X_t\beta_1 + Z_t\beta_2 + \epsilon_{t+1} \tag{19}$$

where the dependent is the forecast error ($fe_{t+1} = y_{t+1} - E_t^{su}(y_{t+1})$), X_t is a set of excluded variables including income expectation and Z_t is a matrix of controls including the ratio of the variance of expected income and actual income, actual income, income squared, expected inflation, change in the number of family members, dummy on whether any member is looking for a job, change in the number of members who are income recipients, and time and regional dummies. Under the null of rational expectations $\beta_1 = 0$ and $\beta_2 = 0$. To estimate this model we need to observe the same individual at least for three consequent waves. We need information on the number of family members, employment status and income recipients at time t-1 and t and information on actual income realization at time t+1. No model that explains the alternative to the null hypothesis is specified.

Forecast errors are defined in two alternative ways: i) as the difference between the self-reported income realizations, calculated as the midpoints of the reported intervals at time $t+1$ and the subjective mean of next year's family income level at time t (Model A); and ii) as a binary variable taking 1 whether income expectation is less than the minimum of the income category containing the self-reported actual realization (Model B).

For our purposes the main limitation of our panel remains its short time dimension, that is 8 years. 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 by

Chamberlain (1984), the increase of the cross section dimension does 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 account for macroeconomic shocks we have included controls in both steps of the estimation procedure[7]. In particular we allow for the presence of time and geographical dummies.

The choice between excluded variables and controls is someway arbitrary and controls cannot be used to test the null. Hence, we allow for different specifications.

As underlined above, we have information on the subjective maximum and minimum expected income and on the subjective cumulative distribution function of next year's net family income, calculated at the thresholds. That makes it possible to estimate the entire distribution of income expectations without making assumptions on the shape of the loss function. Hence, the rejection of the null in our orthogonality test is never imputable to false assumptions on the loss function. The only assumption that our analysis requires is on the distribution function whose parameters have to be estimated. To understand whether this choice have an effect on our estimates, we allow for two alternative distribution functions, the beta and the piecewise uniform.

4.2 Second stage: the Euler equation

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

$$\Delta \log c_{t+1} = \widehat{fe}_{t+1}\omega_1 + Z_t\omega_2 + \eta_{t+1} \tag{20}$$

where the dependent is the log of consumption change, $\widehat{fe_{t+1}}$ is the predicted forecast error as obtained from eq. (19), Z_t contains the same set of variables as in first step and $+\ \eta_{t+1}$ is an error term. The matrix Z_t contains the conditional variance term to allow

[7] A macroeconomic shock occurring in the observed years and potentially affecting the Dutch household consumption behavior is the final constitution of the European Monetary Union (EMU) and the consequent adoption of a single currency. Jappelli and Pistaferri (2011) study whether financial integration and liberalization brought about by the introduction of the euro has affected the sensitivity of consumption with respect to income shocks in Italy. The authors do not find a significant effect on consumption smoothing.

for the fact that if utility exhibits decreasing absolute 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. 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 will generate spurious evidence of excess sensitivity. The same reasoning applies to our behavioral model.

The Z_t also includes 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 dataset does not collect subjective expectations about next year's real interest rate but it is possible to proxy it by using expected inflation. This approximation is exact if financial market is perfect. In this case there is only one interest rate and subjective expected real interest rates differ only because of 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 underlined 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 and geographical dummies.

Another 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 nonseparability may bring us to spurious evidence of excess sensitivity. Therefore, among the controls at the second step we have explicitly included variables describing variations in the number of family members, members that are looking for a job and income recipients.

5 Results

In this section we present the empirical evidence concerning the model presented in section 2. As already underlined, to perform our test we need observations that stay in the panel for, at least, three consecutive years.

To deal with the noise contained in the measured income and savings, and hence in measured consumption, and with the extreme values contained in the subjective expectations, we have run the STATA 9.1's robust estimator(*rreg*) using default parameters for model A. Such estimator is robust with respect to outliers either in the space of the regressors and in the space of residuals[8].

For model A, the null hypothesis of rational expectations is rejected with both OLS and the robust estimator. We use the robust estimates as our linear prediction of the systematic error component to use in the second step. For model B, we have performed the standard *logit* estimator in first steps.

The assumption of rational expectations implies that our instruments are weakly exogenous so long as we use instruments that were in the agents' information sets. In order to show that our results are not due to a particular set of instruments we use two alternative specifications. In the first specification the matrix X_t consists in a large set of variables containing information on the household head and household characteristics. The second specification differs from the first in the fact that income expectation remains the only component of X_t in eq. (19) and income and income squared are dropped from Z_t at both steps. The reason for eliminating all these variables 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.

The reported P-values in first step equations suggest the rejection of the hypothesis of rational expectations at any conventional significance level. Results for the estimation of the corresponding second stage Euler equations show that predictable forecast errors help explain consumption change, which is evidence in favor of our behavioral model.

[Table 5 About Here]

Let us look at the reported first stages. Table 5 reports results obtained regressing the both definitions of forecast error on a large set of excluded variables X_t and a set of controls Z_t, using a beta distribution function for inferring the mean of income expectation and the variance of expected income. The set of controls is compounded by the same variables we allow at the second stage. The matrix X_t include variables on the household structure and

[8]The *rreg* procedure first performs an initial screening based on Cook's distance > 1 to eliminate gross outliers prior to calculating starting values and then performs Huber iterations followed by biweight iterations with tuning constant of 7 (Li, 1985). A more detailed description of *rreg* and some Monte Carlo evaluations are provided by Hamilton (1991).

variables describing the head of the household. The reported F and Chi squared tests are based on the set of excluded variables but not on the controls.

There is a significant negative coefficient on expected income with all specifications, 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. Furthermore, for the model A, we find significant coefficients on the variance of expected income, income, income squared, education, self-employed, good health, employed on a temporary basis, working in public institution and temporal and regional dummies. For model B, only Δn_fam, working in public institution and time dummies.

Considering the specification with fewer instruments, P-values of first step equations continue to suggest the rejection of the hypothesis of rational expectations (Table 6). The coefficients on income expectation, subjective inflation, subjective variance of expected income, working in public institution, time and regional dummies are significant at 1 %. The choice between excluded variables and controls is someway arbitrary, so we have calculated the F test on different sub-samples of the excluded variables. For instance, we have considered the hypothesis that the stated expectation were the only excluded variable 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. Results continue to support the rejection of the null.

[Table 6 About Here]

Second step estimates reported in Tables 5 and 6 support our behavioral model. Predictable errors in forecasting income $\widehat{fe}$ explain consumption variation, confirming that irrational pessimistic/optimistic consumers upward/downward revise their consumption decision as income realizes. The omission of all components of X_t except income expectation in the first step gives smaller estimated coefficients on predictable forecast errors but still significant at 5% level in one case out of two. The estimated significant coefficients on predictable forecast errors range between 0.045 and 0.074. These estimated parameters suggest that systematic errors explain on average 4.3 % of the variation in consumption with our sample. The coefficients on the other variables included at the second stage are never statistically significant for any specification of forecast errors and instruments. Non-separability of consumption and leisure do not seem to be important in the consumption decision, as variations in the number of job seekers, $\Delta jobseek$, and members, Δn_fam, in a household are never significant. Also precautionary savings and interest rates appear not to be important in determining consumption changes. To show that our results are not driven by the choice of the subjective expectations distribution function, we reported in Table 7 second steps results referring to the same models described above for the case of a piecewise linear distribution function.

[Table 7 About Here]

The estimated coefficient of predictable forecast error is positive and statistically significant at the 5 percent level, with values from 0.052 to 0.081 . It is smaller when we consider the specification with only one excluded variable.

5.1 Robustness analysis

As shown in Figure 1, we observe significant shifts to upper classes in the reported income categories between 1999 and 2000, while, the distribution of answers is stable along the other years. The magnitude of this change is huge, as the mean of household's income level jumps from €25,310 in 1999 to €42,193 in 2000 (Figure 2). As pointed out by Kapteyn et al. (2009), a possible explanation for this anomalous change in the distribution of answers on income categories may be that in 2000 the technology used for the interviewing of respondents was thoroughly modernized. In order to understand whether and how this anomalous shock influences our findings, we drop all observations of year 1999, with which the change from 1999 to 2000 is associated, and replicate all regressions. We perform this for all forecast errors and instruments specifications, and distribution functions. Results, reported in Tables 8 and 9, confirm our previous findings, showing again an estimated coefficient of predictable forecast error positive and significant at 1 or 5 % in 6 out of 8 cases with significant values between 0.05 and 0.082.

[Figure 1 About Here]

[Figure 2 About Here]

[Table 8 About Here]

[Table 9 About Here]

Results are still in line with our hypothesis when we eliminate the subjective income variance from both steps of all specifications, with or without observations of 1999 and using both distributions for inferring the subjective mean of income expectations. For the ease of exposition, all these results have not been reported[9].

As a further robustness check, we separate households with positive versus negative income growth to have some information on possible asymmetry. Table 11 show model A's results where second step equation 20 is modified as follows. We create two dummy variables. The first dummy takes 1 whether income of the household increases (*pos*), while the second takes 1 whether income of the household decreases (*neg*). We consider two specifications. Column (1) reports results from a specification where, other than $\widehat{fe}$, also the dummy (*pos*) and the interaction term between $\widehat{fe}$ and the dummy (*pos*) are included. Column (2) reports similar results using the dummy (*neg*). While the parameter on $\widehat{fe}$ remain statistically significant in 5 out of 6 regressions, the interaction terms are never statistically significant, suggesting that there is not a significant association between, on one side, predictable forecast error and, on the other side, magnitude and sign of income shocks.

[Table 11 About Here]

Finally, we check whether our results are driven from not properly taking into account the non-separability of consumption and leisure. To do this, we restrict estimations on those individuals with stable i) number of family members, ii) family employment status iii) number of family members recipient of income. Results, which are reported in columns (3-5) of Table 11, show that the parameter on fe is still statistically significant, suggesting that previous estimates were not biased from the above mentioned potential source of spurious correlation.

6 Irrationality and excess sensitivity

In this section we investigate the relative importance of irrationality, liquidity constraints, and precautionary saving in explaining excess sensitivity.

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 predictable forecast errors is rarely mentioned, let alone explored. From Hall's article (Hall, 1978) on, all the effort in testing the Euler

[9]These results are available from the authors upon request.

equation and excess sensitivity of consumption to predictable income changes have concentrated on liquidity constraints[10] and precautionary saving, although, as pointed out by Carroll (1992), it is very hard to distinguish empirically between precautionary saving and liquidity constraints as households may increase saving today if they expect to be liquidity constrained in the future[11].

Here, we are not interested in discerning between the two classical sources of excess sensitivity. We aim at demonstrating the importance of irrationality as an alternative sources of excess sensitivity. We estimate the following Euler equation, modified to allow for irrationality.

$$\Delta\log c_{t+1} = \phi_1 \Delta D_{t+1} + \rho^{-1}(E(r_{t+1}|\Omega_t) - \delta) +$$
$$\frac{\rho}{2} var_t(\Delta\log c_{t+1} - \rho^{-1}(r_{t+1})) +$$
$$\phi_2 E\Delta\log(y_{t+1}|\Omega_t) + \phi_3 E[y_{t+1} - E_t^{su}(y_{t+1})] + \varepsilon_{t+1}, \quad (21)$$

where i is an household index, $c_{i,t+1}$ is our estimate of consumption, $D_{i,t+1}$ is a matrix that includes our controls for households' preferences, nonseparability 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, $E\Delta\log(y_{i,t+1}|\Omega_t)$, and predicted forecast error, $E[y_{t+1} - E_t^{su}(y_{t+1})|\Omega_t)]$, are added to the Euler equation in order to test the orthogonality condition, i.e. that $\phi_2 = 0$ and $\phi_3 = 0$. We choose a log specification for income growth and instrument it with the same set of variables we use to instrument the forecast error.

[Table 10 About Here]

Table 10 shows the estimated coefficients of predictable forecast errors, predictable changes in income, subjective variance and expected rate of inflation. We consider the model A, where forecast errors are given by comparing income expectations and realizations of families, with the specification with a larger set of excluded variables defined in the previous

[10] For instance, see Hall and Miskin (1982), Runkle (1991), Garcia et al. (1997) and Jappelli et al. (1998). More recently, Johnson and Li (2010) distinguish between a household with low liquid assets (liquidity-constrained household) and a household without ready access to credit (borrowing-constrained household)and find that only the consumption growth of households that are both liquidity and borrowing constrained is excessively sensitive to lagged income.

[11] See also Jappelli and Pistaferri (2010) for an extended and updated review on empirical approaches and evidence on the sensitivity of consumption to predicted income changes, including works combining realizations and expectations of income or consumption in surveys in which data on subjective expectations are available.

section. Expectations and subjective variances have been calculated using the beta distribution.

The first column shows that when the excess sensitivity test is performed the coefficients on the predictable forecast error remain large and significant. This suggests that irrationality is still a possible explanation for excess sensitivity of consumption, even when other explanations are considered. The second column presents results for the equation without considering predictable changes in income. The estimated coefficient for the forecast error is significant and similar to the one reported in column 1. This is evidence of the fact that irrationality is an explanation that stands on its own. Hence, the coefficient on predictable forecast errors seems not to be biased much if precautionary savings and liquidity constraints are not properly taken into account. The third column shows the results of the excess sensitivity test under the rational expectations hypothesis. A higher and statistically significant coefficient of the predictable changes in income could be interpreted as evidence of the fact that not taking into account irrationality may bias upward the coefficient of the predictable changes in income. However, this parameter remains statistically insignificant. Hence, with this dataset, not taking into account irrationality does not give biased evidence in favor of liquidity constraints. All other variables including the subjective variance of income show insignificant parameters. A similar investigation using data where there exists statistically significant evidence of excess sensitivity of consumption to predicted income growth would help to better understand the relative importance of irrationality/myopia explanation on one side and liquidity constraints and precautionary saving on the other side.

One final remark on sample composition should be done. Because of the way we have built up consumption, starting from those who declared to have put money aside in the last 12 months, we could have induced some form of selection in the sample. In particular, as consumption has been calculated only for those with positive savings, the sample could have been selected against liquidity constrained families. Hence reported evidence from Table 10 could be biased in favor of our model. In particular, estimated coefficients of the predictable changes in income and of the subjective variance, among the others, could be biased and not statistically significant.

To avoid the selection problem we have decided to include in the sample also the respondents that declared that they have not been able to put money aside during last 12 months. For those respondents saving has been considered equal to 0. Results remain in line with those obtained previously (Table 10)[12]. Estimated coefficients on predictable forecast error are a little smaller but significant in all specifications. Moreover, and more importantly for the sample selection issue, also the coefficients on predictable income growth continue not to be significant. Estimated coefficients for the subjective variance term are still nonsignificant, confirming that our results are not induced by sample selection.

7 Conclusions

We have presented evidence that suggests that 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. We have tested and rejected the null of rational expectations.

This adds to the literature on testing rational expectations with self reported expectations, because we have demonstrated a connection between predictable forecast errors and actual economic behavior. It is often argued that earlier contributions do not supply evidence to support the claim that the elicited expectations really correspond to those affecting the agent's behavior. Our result that it is possible to partially explain agents consumption decisions using predictable forecast errors should therefore be of interest.

Moreover, we find that irrationality is an important and autonomous source of the excess sensitivity of consumption, even when precautionary savings and liquidity constraints are considered.

[12] We have also replicated estimations reported in the previous section including those observations declaring not to be able to put money aside and have found similar results.

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Table 1: Number of households by panel type and year

year	RE	%	HI	%	Total
1993	1,760	*0.66*	899	*0.34*	2,659
1994	2,174	*0.72*	852	*0.28*	3,026
1995	2,084	*0.75*	697	*0.25*	2,781
1996	2,006	*0.79*	533	*0.21*	2,539
1997	1,921	*0.85*	339	*0.15*	2,260
1998	1,687	*0.95*	88	*0.05*	1,775
1999	1,506	*0.96*	67	*0.04*	1,573
2000	1,737	*0.97*	45	*0.03*	1,782
2001	2,094	*0.98*	44	*0.02*	2,138
2002	1,953	*0.98*	36	*0.02*	1,989
2003	1,914	*0.99*	29	*0.01*	1,943
2004	1,842	*0.98*	29	*0.02*	1,871
2005	1,973	*0.99*	20	*0.01*	1,993
2006	1,912	*0.99*	18	*0.01*	1,930

Notes: Column RE reports summary statistics for the panel representative of the Dutch population. Column HI reports summary statistics for the panel representative of the top 10 percent of the income distribution of the Dutch population.

Table 2: Response rates on the income expectations variables

Year	1995	1996	1997	1998	1999	2000	2001	2002	Pooled
household	4854	4250	3447	2392	2250	1055	2075	2139	22462
Y_{max}, Y_{min}	2335	2035	2847	1966	1863	1037	2043	2095	16221
%	*0.48*	*0.48*	*0.83*	*0.82*	*0.83*	*0.98*	*0.98*	*0.98*	*0.72*
$Y_{max} - Y_{min} < 5$	323	293	339	239	245	135	338	365	2277
%	*0.07*	*0.07*	*0.10*	*0.10*	*0.11*	*0.13*	*0.16*	*0.17*	*0.10*
Probab.	2010	1741	2195	1483	1372	899	1709	1732	13141
%	*0.41*	*0.41*	*0.64*	*0.62*	*0.61*	*0.85*	*0.82*	*0.81*	*0.59*
No monoton.	307	295	311	212	202	184	352	388	2251
%	*0.06*	*0.07*	*0.09*	*0.09*	*0.09*	*0.17*	*0.17*	*0.18*	*0.10*
Final	1703	1446	1884	1271	1170	715	1357	1344	10890
%	*0.35*	*0.34*	*0.55*	*0.53*	*0.52*	*0.68*	*0.65*	*0.63*	*0.48*

Notes: Number of respondents at the questions on lowest and highest possible income, cumulative subjective probability distribution and response rates.

Table 3: Number of respondents at the questions on realized family income and savings, and response rates

Year	Household	Income	%	Savings	%
1995	4055	3675	*0.91*	2672	*0.66*
1996	3384	3091	*0.91*	2215	*0.65*
1997	2660	2417	*0.91*	1661	*0.62*
1998	1365	1264	*0.93*	867	*0.64*
1999	1368	1300	*0.95*	937	*0.68*
2000	1934	1349	*0.70*	1002	*0.52*
2001	2663	2097	*0.79*	1624	*0.61*
2002	2358	1993	*0.85*	1560	*0.66*
Total	19787	17186	*0.87*	12538	*0.63*

Table 4: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
forecast Error(I)	0.45	0.68	-3.02	6.96	426
forecast Error(II)	0.52	0.5	0	1	426
expected Income (I)	24760.9	14069.39	547.04	90232.44	426
expected Income (II)	24716.07	14033.63	546.62	89438	426
consumption	25330.08	14048.91	320.28	144010.27	426
savings	4418.51	5256.46	680.5	51050.5	426
Income(categ.)	4.12	0.89	1	6	426
Income	34485.2	17235.56	4538	84033.5	426
expected inflation	2.79	2.17	0	15	426
variance of income	87.25	395.89	0	6956.31	426
Pre vocational	0.17	0.38	0	1	426
Pre university	0.1	0.3	0	1	426
Apprentice	0.18	0.38	0	1	426
Vocat. college	0.36	0.48	0	1	426
University	0.17	0.38	0	1	426
gender	0.89	0.32	0	1	426
jobseeker	0.01	0.12	0	1	425
n. family members	2.57	1.27	1	7	426
n. recipients	1.38	0.70	0	5	426
good health	0.86	0.35	0	1	426
employee	0.75	0.43	0	1	426
self-employed	0.01	0.1	0	1	426
student	0.14	0.35	0	1	426
retired	0	0.05	0	1	426
temporary	0.01	0.12	0	1	426
experience	29.06	12.64	0	56	426
age	49.3	11.33	25	70	426
type of employer:public	0.35	0.48	0	1	426
type of employer:non-public	0.5	0.5	0	1	426

Notes: Forecast error (I) is defined as the difference between realizations and expectations divided by actual income at time t. Forecast error (II) is a binary variable taking 1 whether income expectation is less than the minimum of the income category containing the self-reported actual realization. Expected income (I) is the estimation of next year's income obtained assuming a beta distribution. Expected income (II) is the estimation of next year's income obtained assuming a piecewise linear distribution. Consumption is obtained by subtracting savings to income. Savings is calculated as the midpoints of the reported intervals. Income is calculated as the midpoints of the reported intervals (Income categ.). Variance of income is the estimated variance of expected income divided by current actual income.

Table 5: Estimation results assuming a beta distribution. More instruments

First stage	(1)	(2)	(3)	(4)
$E_t^{su} y_{t+1}$	-.0000221*	(-21.50)	-.0000762*	(-11.59)
$E_t^{su} \pi_{t+1}$	-.00313	(-0.95)	-.00981	(-0.45)
$\Delta jobseek$	.0835	(0.96)	.0793	(0.13)
Δn_fam	-.0392	(-0.84)	-.538***	(-1.79)
$\Delta recipient$	-.00812	(-0.47)	-.0149	(-0.15)
$\frac{Var_t^{su}(y_{t+1})}{y_t}$	-.0000687**	(-2.35)	-.000115	(-0.64)
instit	.0296	(1.20)	.21	(1.43)
public	.0705*	(2.58)	.351**	(2.18)
y_t	.0000147*	(5.56)	.000017	(1.31)
y_t^2	-5.74e-11**	(-2.02)	3.38e-11	(0.28)
Primary	-.379**	(-2.36)	-.168	(-0.19)
Pre vocational	-.137***	(-1.73)	.0563	(0.12)
Pre university	-.0605	(-0.73)	.00992	(0.02)
Apprentice	-.115	(-1.45)	-.0678	(-0.15)
Vocat. college	-.076	(-0.99)	-.0247	(-0.06)
University	-.0575	(-0.71)	-.0991	(-0.22)
gender	-.0295	(-0.79)	.301	(1.44)
good health	.0787**	(2.53)	.204	(1.10)
poor health	.0588	(0.34)	1.08	(0.78)
employee	.0507	(1.25)	-.197	(-0.82)
self-employed	.141***	(1.90)	.0712	(0.17)
student	.00429	(0.09)	-.405	(-1.31)
retired	-.0387	(-0.28)	-1.07	(-1.25)
temporary	.257**	(2.39)	.0329	(0.06)
experience	-.00223	(-0.72)	.00757	(0.42)
age	-.000145	(-0.01)	-.0234	(-0.41)
age^2	.0000252	(0.26)	.000228	(0.40)
R-squared	0.522			
	F-test : F(18, 848) = 28.20	$Pr > F$: .000	Chi^2(18) = 147.05	Pr> Chi^2: .000
Obs	884		1514	
Second stage	(1)	(2)	(3)	(4)
$\widehat{fe}$	.0489*	(2.63)	.0742*	(3.93)
y_t	-6.31e-07	(-0.70)	-6.96e-07	(-0.94)
y_t^2	1.28e-11	(1.33)	1.08e-11	(1.64)
$E_t^{su} \pi_{t+1}$	-.000191	(-0.10)	-.0000826	(-0.04)
$Var_t^{su}(y_{t+1})$	5.14e-11	(0.02)	5.17e-11	(0.02)
Δn_fam	.00496	(0.16)	.00582	(0.15)
$\Delta jobseek$	-.0797	(-1.20)	-.0772	(-1.16)
$\Delta recipient$	.0000654	(0.01)	.000647	(0.09)
public	.0121	(1.44)	.0113	(1.31)
instit	-.00989	(-1.04)	-.0119	(-1.23)
Reps	10000		10000	
Obs	559		562	

Notes: Columns (1-2) report results when forecast error is defined as the difference between realizations and expectations divided by actual income at time t; cols (3-4) report results when forecast error is defined as a binary variable taking 1 whether income expectation is less than the minimum of the income category containing the self-reported actual realization. *FirstStage.* $E_t^{su} y_{t+1}$ is the income expectation calculated assuming a beta distribution function. $E_t^{su}(\pi_{t+1})$ inflation expectation (point expectation). $\frac{Var_t^{su}(y_{t+1})}{y_t}$ is the ratio of variance of expected income and actual income. *Gender* is an indicator variable that takes value 1 if respondent is male. *Temporary* is an indicator that takes value 1 if employed on a temporary basis. *Experience* is years of work since the first occupation. Δn_fam controls for the variation in family composition. $\Delta jobseek$ controls for the variation in the number of family members who declare to be looking for a job. $\Delta recipient$ controls for the variation in the number of income recipients in the family. Primary, Pre vocational, Pre university, Apprentice, Vocat. college and University are dummies indicating the educational level. *Public* is an indicator for employed by the government. *Instit* is an indicator for employed by another public institution. Controls not allowed to perform F-test and Chi squared test. *Secondstage.* The dependent variable is the consumption change. $\widehat{fe}$ is predicted forecast error. In both steps, year 1996, no education and northern region are the dummies excluded to avoid perfect collinearity. Reported second stage standard errors result from 10,000 bootstrap replications of the entire two steps estimation procedure.

Table 6: Estimation results assuming a beta distribution. Income expectation as the only instrument

First stage	(1)	(2)	(3)	(4)
$E^{su}(y_{t+1})$	-.0000144*	(-17.76)	-.0000542*	(-11.91)
$E_t^{su}\pi_{t+1}$	-.00792**	(-2.27)	-.0402**	(-2.08)
$\frac{Var_t^{su}(y_{t+1})}{y_t}$	-.000125*	(-5.09)	-.00016	(-1.08)
$\Delta jobseek$	.00995	(0.14)	-.59	(-1.56)
Δn_fam	-.0364	(-0.77)	-.42***	(-1.72)
$\Delta recipient$	-.00846	(-0.51)	.0962	(1.19)
instit	.0564**	(2.41)	.188	(1.62)
public	.0927*	(3.67)	.293**	(2.35)
1997	-.176*	(-5.16)	-.712*	(-3.98)
1998	-.181*	(-5.29)	-.249	(-1.33)
1999	.735*	(17.81)	.751*	(4.47)
2000	.267*	(5.01)	2.38*	(8.71)
2001	.22*	(6.24)	2.33*	(12.42)
west	.0819*	(2.77)	.32**	(2.19)
east	.0751**	(2.28)	.126	(0.77)
south	.0837*	(2.68)	.372**	(2.42)
R-squared	0.423			
	F(1, 1283) = 315.37	$Pr > F$: .000	Chi^2(1) = 141.86	Pr> Chi^2: .000
Obs	1300		2207	

Second stage	(1)	(2)	(3)	(4)
$\widehat{FE}$	.0263	(1.60)	.0455**	(2.32)
$E_t^{su}\pi_{t+1}$	-.000677	(-0.53)	-.000523	(-0.41)
$Var_t^{su}(y_{t+1})$	1.12e-10	(0.13)	1.98e-11	(0.04)
Δn_fam	.0127	(0.54)	.0157	(0.69)
$\Delta jobseek$	-.0692	(-1.50)	-.0658	(-1.44)
$\Delta recipient$	-.00236	(-0.55)	-.0028	(-0.65)
public	.00258	(0.39)	.00255	(0.38)
instit	-.00823	(-1.13)	-.00893	(-1.21)
1997	.00589	(0.63)	.00645	(0.68)
1998	.00117	(0.12)	-.00086	(-0.09)
1999	-.0238	(-1.39)	-.00885	(-0.58)
2000	.00174	(0.09)	-.0131	(-0.66)
2001	.00669	(0.68)	-.00877	(-0.67)
west	.00806	(1.04)	.00795	(1.03)
east	.00472	(0.59)	.00587	(0.74)
south	.00178	(0.22)	.00176	(0.23)
Reps	10000		10000	
Obs	824		828	

Notes: Columns (1-2) report results when forecast error is defined as the difference between realizations and expectations; cols (3-4) report results when forecast error is defined as a binary variable taking 1 whether income expectation is less than the minimum of the income category containing the self-reported actual realization. *FirstStage.* $E_t^{su}y_{t+1}$ is the income expectation calculated assuming a beta distribution function. $E_t^{su}(\pi_{t+1})$ inflation expectation (point expectation). $\frac{Var_t^{su}(y_{t+1})}{y_t}$ is the ratio of variance of expected income and actual income. Δn_fam controls for the variation in family composition. $\Delta jobseek$ controls for the variation in the number of family members who declare to be looking for a job. $\Delta recipient$ controls for the variation in the number of income recipients in the family. Primary, Pre vocational, Pre university, Apprentice, Vocat. college and University are dummies indicating the educational level. *Public* is an indicator for employed by the government. *Instit* is an indicator for employed by another public institution. Controls not allowed to perform prediction and the F-test. *Secondstage.* The dependent variable is the consumption change. $\widehat{fe}$ is predicted forecast error. In both steps, year 1996, no education and northern region are the dummies excluded to avoid perfect collinearity. Reported second stage standard errors result from 10,000 bootstrap replications of the entire two steps estimation procedure.

Table 7: Estimation results assuming a piecewise linear distribution.

More instruments				
Second stage	(1)	(2)	(3)	(4)
$\widehat{fe}$	.0554*	(3.05)	.0813*	(4.28)
y_t	-6.09E-07	(-0.63)	-5.72e-07	(-0.77)
y_t^2	1.34E-11	(1.30)	1.03E-11	(1.54)
$E_t^{su}\pi_{t+1}$	-0.000667	(-0.37)	-0.000375	(-0.20)
$Var_t^{su}(y_{t+1})$	-1.34E-10	(-0.04)	-1.46E-10	(-0.05)
Δn_fam	0.00933	(0.30)	0.0103	(0.19)
$\Delta jobseek$	-0.0801	(-1.22)	-0.0776	(-1.10)
$\Delta recipient$	0.00072	(0.10)	0.00171	(0.24)
Reps	10000		10000	
Obs	551		552	
Fewer instruments				
Second stage	(1)	(2)	(3)	(4)
$\widehat{fe}$	.0335***	(1.94)	.0522*	(2.70)
$E_t^{su}\pi_{t+1}$	-0.000743	(-0.51)	-0.000803	(-0.54)
$Var_t^{su}(y_{t+1})$	5.41E-10	(0.40)	1.28E-10	(0.10)
Δn_fam	0.0135	(0.47)	0.0182	(0.45)
$\Delta jobseek$	-0.0701	(-1.47)	-0.0685	(-1.47)
$\Delta recipient$	-0.000381	(-0.08)	-0.00084	(-0.17)
Reps	10000		10000	
Obs	778		781	

Notes: First stages are not reported. Columns (1-2) report second stage results where forecast error, in first stage, is defined as the difference between realizations and expectations; cols (3-4) report results where forecast error, in first stage, is defined as a binary variable taking 1 whether income expectation is less than the minimum of the income category containing the self-reported actual realization. The dependent variable is the consumption change. $\widehat{fe}$ is predicted forecast error. $E_t^{su}(\pi_{t+1})$ inflation expectation (point expectation). $\frac{Var_t^{su}(y_{t+1})}{y_t}$ is the ratio of variance of expected income and actual income. Δn_fam controls for the variation in family composition. $\Delta jobseek$ controls for the variation in the number of family members who declare to be looking for a job. $\Delta recipient$ controls for the variation in the number of income recipients in the family. In both steps, year 1996, no education and northern region are the dummies excluded to avoid perfect collinearity. Standard errors result from 10,000 bootstrap replications of the entire two steps estimation procedure.

Table 8: Estimation results assuming a beta distribution. Year 1999 excluded

More instruments				
Second stage	(1)	(2)	(3)	(4)
$\widehat{fe}$	.0584*	(2.68)	.0828*	(4.10)
y_t	-4.69E-07	(-0.47)	-2.01E-07	(-0.25)
y_t^2	1.17E-11	(1.1)	6.25E-12	(0.89)
$E_t^{su}\pi_{t+1}$	-0.000546	(-0.28)	-0.000335	(-0.17)
$Var_t^{su}(y_{t+1})$	9.01E-11	(0.04)	-1.24E-11	(-0.01)
Δn_fam	0.0111	(0.23)	0.00901	(0.13)
$\Delta jobseek$	-0.0816	(-1.21)	-0.0783	(-1.04)
$\Delta recipient$	-0.0000365	(-0.01)	0.000017	(0.00)
Reps	10000		10000	
Obs	481		479	
Fewer instruments				
Second stage	(1)	(2)	(3)	(4)
$\widehat{fe}$	0.0311	(1.62)	.0493**	(2.41)
$E_t^{su}\pi_{t+1}$	-0.00104	(-0.65)	-0.00106	(-0.66)
$Var_t^{su}(y_{t+1})$	1.07E-10	(0.12)	7.54E-12	(0.01)
Δn_fam	0.014	(0.44)	0.0186	(0.41)
$\Delta jobseek$	-0.0658	(-1.42)	-0.0657	(-1.40)
$\Delta recipient$	-0.0013	(-0.25)	-0.00229	(-0.44)
Reps	10000		10000	
Obs	676		678	

Notes: First stages are not reported. Columns (1-2) report second stage results where forecast error, in first stage, is defined as the difference between realizations and expectations; cols (3-4) report results where forecast error, in first stage, is defined as a binary variable taking 1 whether income expectation is less than the minimum of the income category containing the self-reported actual realization. The dependent variable is the consumption change. $\widehat{fe}$ is predicted forecast error. $E_t^{su}(\pi_{t+1})$ inflation expectation (point expectation). $\frac{Var_t^{su}(y_{t+1})}{y_t}$ is the ratio of variance of expected income and actual income. Δn_fam controls for the variation in family composition. $\Delta jobseek$ controls for the variation in the number of family members who declare to be looking for a job. $\Delta recipient$ controls for the variation in the number of income recipients in the family. In both steps - other than year 1999 -, year 1996, no education and northern region are the dummies excluded to avoid perfect collinearity. Standard errors result from 10,000 bootstrap replications of the entire two steps estimation procedure.

Table 9: Estimation results assuming a piecewise linear distribution. Year 1999 excluded

More instruments				
Second stage	(1)	(2)	(3)	(4)
$\widehat{fe}$	.0576*	(2.99)	.0794*	(4.22)
y_t	-5.01E-07	(-0.51)	-2.70E-07	(-0.35)
y_t^2	1.20E-11	(1.15)	6.91E-12	-0.99
$E_t^{su}\pi_{t+1}$	-0.000873	(-0.47)	-0.000676	(-0.36)
$Var_t^{su}(y_{t+1})$	9.92E-11	(0.04)	-1.31E-10	(-0.05)
Δn_fam	0.0129	(0.35)	0.0124	(0.19)
$\Delta jobseek$	-0.0783	(-1.19)	-0.0782	(-1.06)
$\Delta recipient$	-0.000658	(-0.09)	-0.000776	(-0.11)
Reps	10000		10000	
Obs	501		498	
Fewer instruments				
Second stage	(1)	(2)	(3)	(4)
$\widehat{fe}$	.0311***	(1.72)	.0518*	(2.67)
$E_t^{su}\pi_{t+1}$	-0.00133	(-0.83)	-0.00138	(-0.86)
$Var_t^{su}(y_{t+1})$	1.14E-10	(0.12)	2.28E-11	(0.03)
Δn_fam	0.0161	(0.51)	0.0201	(0.46)
$\Delta jobseek$	-0.066	(-1.41)	-0.0649	(-1.37)
$\Delta recipient$	-0.00148	(-0.29)	-0.00264	(-0.52)
Reps	10000		10000	
Obs	704		706	

Notes: First stages are not reported. Columns (1-2) report second stage results where forecast error, in first stage, is defined as the difference between realizations and expectations; cols (3-4) report results where forecast error, in first stage, is defined as a binary variable taking 1 whether income expectation is less than the minimum of the income category containing the self-reported actual realization. The dependent variable is the consumption change. $\widehat{fe}$ is predicted forecast error. $E_t^{su}(\pi_{t+1})$ inflation expectation (point expectation). $\frac{Var_t^{su}(y_{t+1})}{y_t}$ is the ratio of variance of expected income and actual income. Δn_fam controls for the variation in family composition. $\Delta jobseek$ controls for the variation in the number of family members who declare to be looking for a job. $\Delta recipient$ controls for the variation in the number of income recipients in the family. In both steps- other than year 1999 -, year 1996, no education and northern region are the dummies excluded to avoid perfect collinearity. Standard errors result from 10,000 bootstrap replications of the entire two steps estimation procedure.

Table 10: Irrationality and excess sensitivity. Expectations calculated assuming a beta distribution function. More instruments

	Without families saving zero			With families saving zero		
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{fe}_t$	0.060048	0.055689		0.029034	0.032419	
	(2.76)	(2.71)		(1.97)	(2.25)	
$ln(\widehat{\frac{y_{t+1}}{y_t}})$	0.026989		-0.030568	-0.01601		-0.042625
	(0.51)		(-0.63)	(-0.53)		(-1.40)
$E_t^{su}\pi_{t+1}$	-0.0001495	-0.0003649	-0.0003306	-0.0006197	-0.0005003	-0.0008722
	(-0.08)	(-0.20)	(-0.17)	(-0.84)	(-0.71)	(-1.18)
$Var_t^{su}(y_{t+1})$	-1.36E-10	-1.12E-10	-9.13E-10	4.01E-10	3.83E-10	3.33E-10
	(-0.04)	(-0.03)	(-0.28)	(0.33)	(0.33)	(0.3)

Notes: Forecast errors are defined as the difference between the self reported income realizations, calculated as the midpoints of the reported intervals, at time $t+1$ and the subjective mean of next year's family income level at time t calculated assuming a beta distribution function. Forecast errors and predictable income growth instrumented with the larger set of instruments. Models (1)-(3): families that reported not to have put money aside last 12 months are dropped. Models (4)-(6): families that reported not to have put money aside last 12 months are included. T-statistics from bootstrapped standard errors with 1,000 replications are shown in parentheses. Regression in col. (1) is performed over 529 observations, while regression reported in col. (4) uses 719 observations.

Table 11: Robustness analysis

More instruments					
dummy income gr. (pos)	-.0037004				
	(-0.28)				
dummy income gr. (neg)		-.047166			
		(-1.63)			
$\widehat{fe}$	.0584*	.057*	.0619*	.0600*	.0513**
	(3.61)	(3.73)	(3.37)	(3.68)	(2.18)
Interaction with (pos)	-.020				
	(-0.85)				
Interaction with (neg)		.065623			
		(1.09)			
yt	-6.91e-07	-6.50e-07	-1.12e-06	-7.13e-07	8.00e-07
	(-0.83)	(-0.76)	(-0.97)	(-0.68)	(0.53)
y_t^2	1.36e-11	1.44e-11	1.95e-11	1.45e-11	1.58e-12
	(1.50)	(1.52)	(1.43)	(1.17)	(0.09)
$\mathrm{E}_t^{su}\pi_{t+1}$	-.0002475	-.0001159	-.0004079	-.0000659	-.0018759
	(-0.15)	(-0.06)	(-0.17)	(-0.03)	(-0.55)
$\mathrm{Var}_t^{su}(y_{t+1})$	-9.68e-11	-1.30e-10	-3.42e-10	-1.82e-11	-1.06e-09
	(-0.22)	(-0.28)	(-0.52)	(-0.03)	(-0.86)
Δn_fam	.0064955	.015933		.0024885	.023337
	(0.44)	(0.99)		(0.14)	(0.88)
$\Delta jobseek$	-.089174*	-.075389**	-.080443**		-.11548**
	(-3.02)	(-2.37)	(-2.11)		(-2.19)
$\Delta recipient$	.0002469	.0016262	.0044674	.0069289	
	(0.04)	(0.27)	(0.57)	(0.96)	
Obs	529	529	364	390	198
Fewer Instruments	(1)	(2)	(3)	(4)	(5)
dummy income gr. (pos)	-.023443**				
	(-2.04)				
dummy income gr. (neg)		.018188			
		(1.19)			
$\widehat{fe}$	.027447***	.02713**	.042566**	.040276**	.021561
	(1.89)	(2.06)	(2.46)	(2.46)	(0.88)
Interaction with (pos)	.0056109				
	(0.27)				
Interaction with (neg)		-.029746			
		(-0.80)			
$\mathrm{E}_t^{su}\pi_{t+1}$	-.0008435	-.0007178	-.0010662	-.0008725	-.0009022
	(-0.60)	(-0.50)	(-0.53)	(-0.46)	(-0.31)
$\mathrm{Var}_t^{su}(y_{t+1})$	8.89e-11	-2.34e-11	6.47e-10	6.92e-10	-1.02e-09
	(0.46)	(-0.11)	(1.28)	(1.41)	(-0.85)
Δn_fam	.0102	.013829		.0089384	.029795
	(0.82)	(1.11)		(0.59)	(1.35)
$\Delta jobseek$	-.071589*	-.071454*	-.071279*		-.073071***
	(-3.21)	(-3.19)	(-2.69)		(-1.85)
$\Delta recipient$	-.0021805	-.0005353	.0012441	.0033368	
	(-0.49)	(-0.12)	(0.21)	(0.57)	
Obs	748	748	521	556	295

Notes: First stages are not reported. Forecast error, in first stage, is defined as the difference between realizations and expectations. The dependent variable is the consumption change. *dummy income gr. (pos)* is a dummy that takes 1 whether individuals reported their income belonging to a higher income category at time t+1 than they reported at time t and 0 otherwise. *dummy income gr. (neg)* is a dummy that takes 1 whether individuals reported their actual income belonging to a lower income category at time t+1 than they reported at time t and 0 otherwise. $\widehat{fe}$ is predicted forecast error. *Interaction with (pos)* is the interaction between $\widehat{fe}$ and (pos). *Interaction with (neg)* is the term of interaction between $\widehat{fe}$ and (neg). $E_t^{su}(\pi_{t+1})$ inflation expectation (point expectation). $\frac{Var_t^{su}(y_{t+1})}{y_t}$ is the ratio of variance of expected income and actual income. Δn_fam controls for the variation in family composition. $\Delta jobseek$ controls for the variation in the number of family members who declare to be looking for a job. $\Delta recipient$ controls for the variation in the number of income recipients in the family. In both steps, year 1996, no education and northern region are the dummies excluded to avoid perfect collinearity. Standard errors are those obtained from using the STATA 11's rreg estimator .

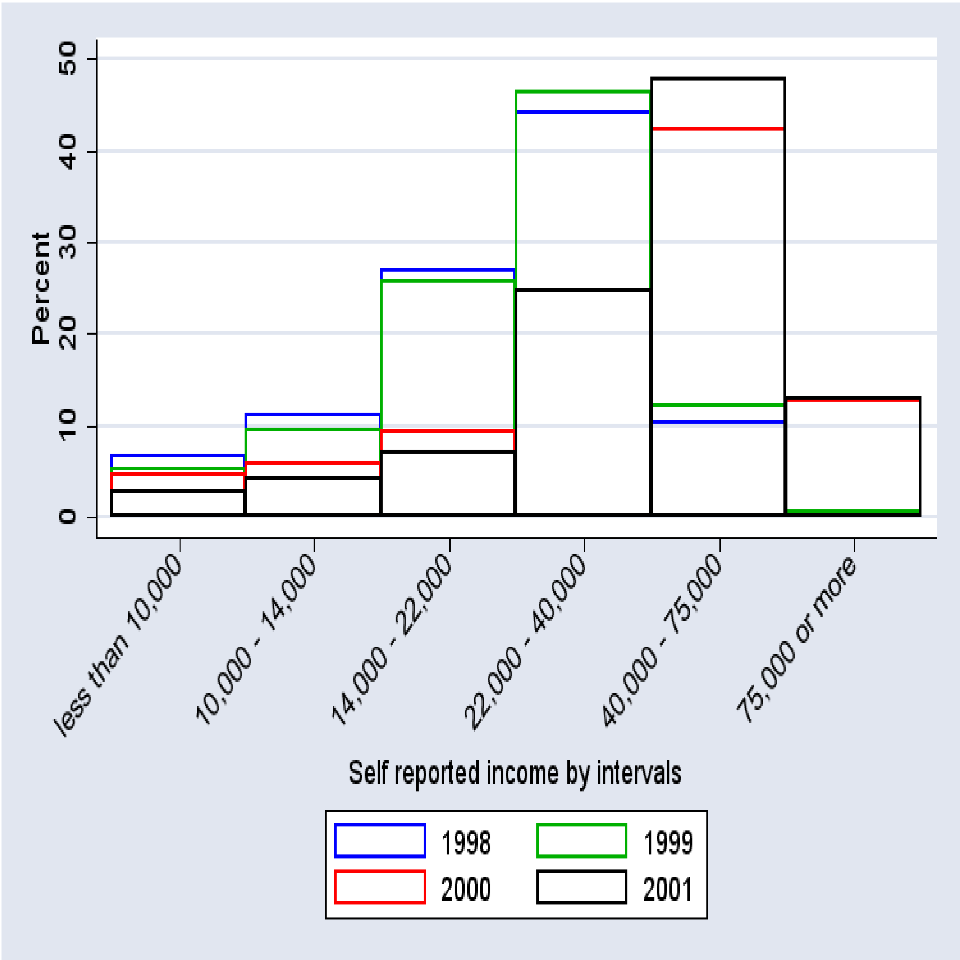

Figure 1: Income distribution by years

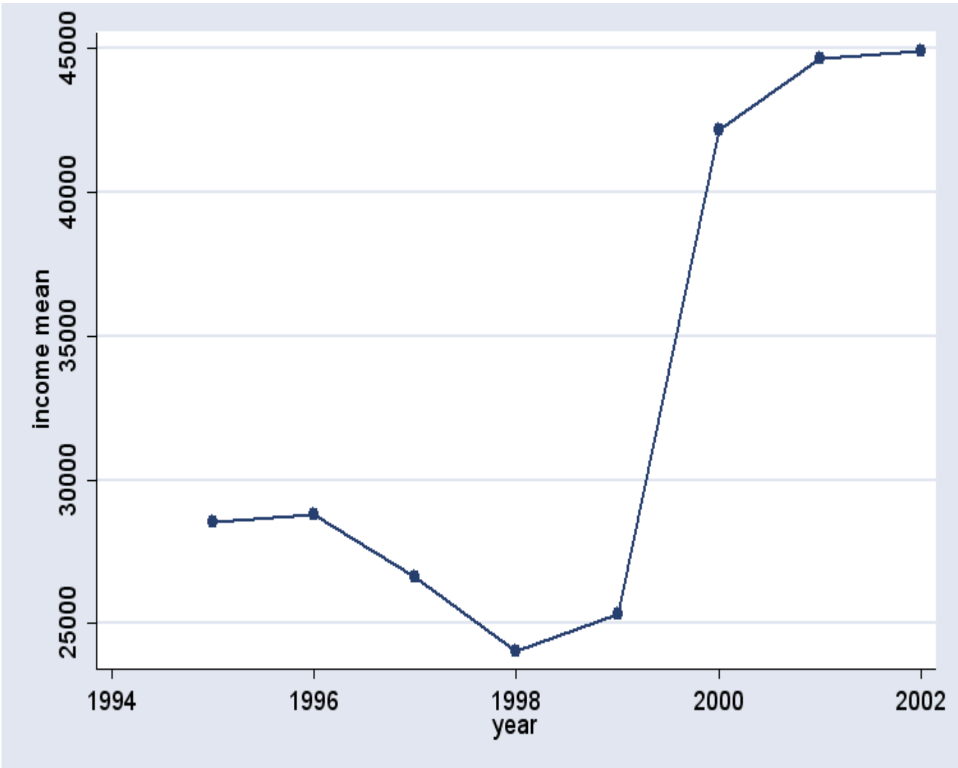

Figure 2: Sample income mean by years