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JEL Codes
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Permanent versus Transitory Income Shocks over the Business Cycle*

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September 28, 2018

Abstract

This paper investigates the role of subjective income expectations in shaping consumption dynamics of European economies in the last decade. We make two main contributions. We first exploit the joint availability of income expectations and realizations in a unique micro panel-dataset to identify the levels of transitory and permanent income shocks at the individual level. We then evaluate whether these calculated income shocks can help to explain contractions in aggregate consumption over the two most recent crisis. We find strong evidence that consumption behavior during the 2012-2013 crisis can be explained by the observed income shocks, but the same is not true of the 2008-2009 crisis.

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JEL classification: D12; E21.

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1 Introduction

In the last decade, most European countries experienced two episodes of severe economic recession: the 2008-2009 Global Financial Crisis and the 2012-2013 Sovereign Debt Crisis. The nature of the shocks over these periods, though, was very different. During the Global Financial Crisis, the prolonged decline of economic activity was mainly due to a fall in international trade, and was accompanied by a substantial drop in asset prices (Bottazzi, Wakefield, and Trucchi, 2017). During the Sovereign Debt Crisis, by contrast, the decline of GDP was mainly induced by the generalized worsening of financial conditions and the deterioration of business and household confidence (Busetti and Caivano, 2013; Del Giovane, Nobili, and Signoretti, 2013).

Households' consumption responses to the two crisis were also remarkably different. During the 2008-2009 Financial Crisis, the fall in aggregate consumption was much less severe than the accompanying decline in GDP. By contrast, in 2012-2013, declining GDP coincided with an even sharper drop and a more prolonged recovery of consumption. These dynamics of GDP and consumption were common to several European countries, although with different intensities. Why did consumption react to sharp changes in income so differently? According to the simplest version of the permanent income hypothesis - with quadratic preferences - only unanticipated changes in income that are perceived as permanent, i.e. changes in income expectations, should induce substantive changes in consumption. Expected and temporary changes to income, on the other hand, should not alter consumption significantly.

In this paper, we investigate how well income expectations explain the contraction in consumption during the two recent episodes of recession. We analyse the different role played by transitory and permanent shocks in explaining the dynamics of consumption during the last decade.

First, in a life-cycle framework, we map individual income expectations and realizations to individual permanent and transitory income shocks. We use a Dutch longitudinal survey over the period 2006 and 2016, which gathers unique information about income expectations along with its realizations at the household level, which is crucial for the identification of the income shocks. Second, we simulate households' consumption behavior in the face of these calculated income shocks. This approach allows us to study the direct effect of income expectations on consumption.

Our contribution to the literature is twofold. First, we identify individual-specific permanent and transitory income shocks; we reconstruct their time series over the last decade; and we illustrate their heterogeneity across cohorts and subgroups. Our methodology is closely related to Pistaferri (2001) and Attanasio, Kovacs, and Molnar (2017). The former paper uses the Italian Survey on Household Income and Wealth, which

collected information on income expectations in two specific waves (1989 and 1991). Because of this data restriction, Pistaferri (2001) can only provide a snapshot of transitory and permanent shocks, without being able to illustrate their time trend. Moreover, the biannual structure of the Survey does not allow to consider changes in income expectations occurring within the two year span. The paper by Attanasio, Kovacs, and Molnar (2017) combines two data sources - one for income realization (Consumer Expenditure Survey) and one for expectations (Michigan Survey) - to build up a synthetic cohort-panel.[1] Given the structure of the data, this analysis focuses on average cohort variables, while we are able to measure individual specific expectations. Moreover, their identification of transitory and permanent shocks hinges on strong assumptions about the distribution of income expectations[2] given that they quantify qualitative expectation data gathered from the Michigan Survey. Our identification method requires less restrictive assumptions and allows to construct longitudinal data on individual permanent and transitory shocks. Second, we add to the literature by assessing the impact of changes in income expectations on consumption, through the solution and simulation of a life-cycle model of individuals experiencing the shocks we observe in the data. To our knowledge, this is the first attempt to evaluate the effect of transitory and permanent shocks by simulating of a structural model.

We provide supporting evidence of the reliability of the data on income expectation, which is a crucial variable in our analysis. Income expectations turn out to be highly correlated with actual income and with other variables capturing expectations about labor market conditions (such as job status and the sources of future income change). Also, their variation turns out to be linked with the realizations of future income. Following the approach of Pistaferri (2001), we then combine these income expectations and data on realized income to identify the levels of permanent and transitory income shocks. A permanent income shock can be simply thought of as the change in subjective income expectations, while transitory income shock as the difference between realized income and subjective income expectation. We show that income expectations and the induced shocks to income were very different over the 2008-2009 and the 2012-2013 crises. Until around 2010, households were in general optimistic: their income expectations were systematically higher than their income realizations and they did not make substantial adjustments to their income expectations. After 2010, by contrast, households became more pessimistic and made significant downward revisions to their expectations, especially if the household head was of younger age.

[1] That is, rather than following individual households, they use repeated cross sections to follow cohorts over time.

[2] Namely that the distribution of expectation is known and that every respondent has an indifference interval around zero, which is symmetric and equal for everyone.

We make use of the household-level time-series of transitory and permanent income shocks between 2006 and 2016 to simulate our life-cycle model. The framework of our analysis is a single-asset, life-cycle model, in which we assume that exogenous household income is exposed to both permanent and transitory income shocks. Income and consumption trajectories of households in different cohorts might be very different, as they might have experienced very different income shocks between 2006 and 2016. Moreover, households in different cohorts are, by definition, at different stages of their life-cycle in the same period. As a result, their consumption reacts to similar income shocks rather differently. Our simulations show large variations in income shocks both between cohorts and over time. Income shocks turn out not to explain the consumption fall during the 2008-2009 crisis, as the income shock faced by households in this period was not substantial. On the contrary, our calculated measures for income shocks predict a large consumption drop for 2012 and 2013, which is similar in timing and magnitude to the slowdown experienced by the Dutch economy. In line with predictions from the permanent income hypothesis, negative permanent shocks experienced during the Sovereign Debt crisis are the main explanation for this consumption drop. The youngest cohorts faced the most dramatic consumption drop.

Trajectories of aggregate income and consumption in the Dutch economy remarkably mirror the trend observed in other European countries - and in the euro area overall. The results we obtain in a single-country setting are likely to be held more general and contribute to the understanding of the determinants of contractions in consumption during a recession period.

The rest of the paper is organized as follows. In Section 2, we illustrate the macroeconomic setting for our analysis. In Section 3, we review the methodology and the data used to identify income shocks together with descriptive results. The link between consumption and income shocks is addressed with a life cycle model in Section 4. Section 5 concludes.

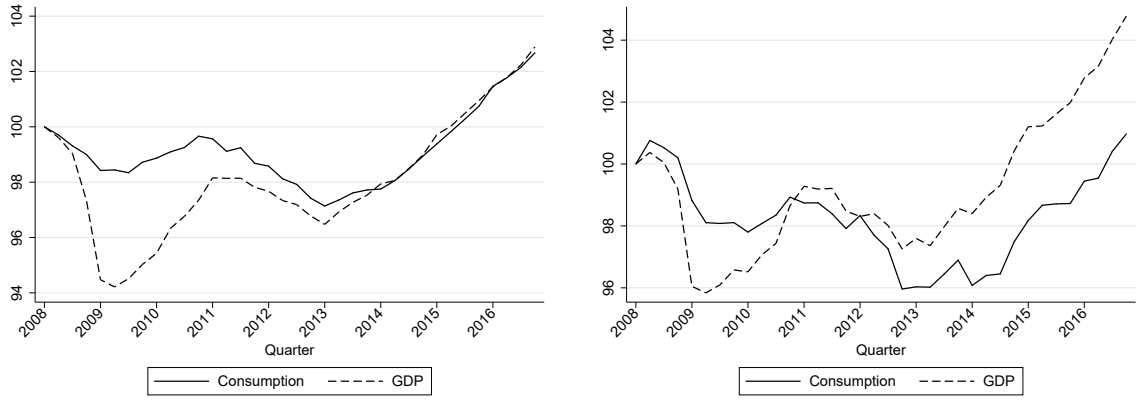
2 Crises in the Euro Area and in The Netherlands

Over the last decade, the euro area as a whole and the Netherlands experienced similar economic developments. In general, the dynamics of key macroeconomic variables in the Dutch economy mirrored the trends of the euro area, as shown in the Appendix in Figures A.1-A.4. Besides the determinants of GDP, patterns of business and household confidence, and labor market conditions were also akin in the euro area and in the Netherlands.

There were two substantial contractions in aggregate consumption in the euro area.

The first episode occurred during the Global Financial Crisis in 2008-2009, while the second one during the Sovereign Debt Crisis in 2012-2013. These two slowdowns followed one other in a rapid succession, but had different nature and took place within a different macroeconomic environment. As one can see in the left panel of Figure 1 below, the consumption drop during the Global Financial Crisis coincided with a much more severe reduction in GDP. As consumption decreased by less than 2%, GDP fall was closer to 6% between the first quarter of 2008 and the first quarter of 2009.[3] Consumption during the Sovereign Debt Crisis, by contrast, shrank by more than GDP. The decrease in consumption was about 1.5%, while the fall in GDP was 1% between the first quarter of 2012 and the first quarter of 2013.

Figure 1: GDP and main demand components: euro area and the Netherlands



Notes: Our calculations from Eurostat quarterly data (2nd November 2017); indices, 2008-Q1=100.

In line with the economic dynamics in the euro area, the Dutch economy also experienced a double fall in consumption between 2008 and 2013. Moreover, a smaller drop in income over the 2012-2013 crisis also coincided with a much larger consumption response, compared to the 2008-2009 crisis. As it is seen in the right panel of Figure 1, the consumption drop during the Global Financial Crisis coincided with a much more severe reduction in GDP. As consumption decreased by about 2%, GDP fall was more than 4% between the first quarter of 2008 and the first quarter of 2009. Consumption during the Sovereign Debt Crisis, by contrast, shrank by more than GDP. The decrease in consumption was about 2.3%, while the fall in GDP was less than 1% between the first quarter of 2012 and the first quarter of 2013.[4]

[3]Figure A.1 in the Appendix shows a more detailed version of Figure 1 with all the main demand components of GDP.

[4]The 2009 contraction in GDP was largely driven by a shrink in exports both in the euro area and in the Netherlands. International trade already started to drop at the end of 2007, which induced a fall of about 10-15% in exports by the beginning of 2009. This fact was documented in Caivano, Rodano, and Siviero (2010) and is visible from Figure A.1 and Figure A.2 in the Appendix. During the 2012-

The fact that a smaller drop in income between 2012 and 2013 coincided with a much larger consumption response, compared to what is observed between 2008 and 2009, suggests a potentially important role played by expectations.

The most important driver of actual consumption besides actual income is undoubtedly future income expectation. Households, based on their future income expectations, choose the level of their actual consumption in accordance with their consumption smoothing motive. In case income expectations change, households naturally reevaluate their optimal consumption plan. For instance, after an increase in their expected future income households feel wealthier and they might find it optimal to increase their current consumption immediately. This behavior is predicted by the simplest version of the permanent income hypothesis. According to the theory, only unanticipated changes in income that are perceived as permanent, i.e. changes in income expectations, should induce substantive changes in consumption. On the other hand, temporary changes to income, i.e. temporary discrepancies between income expectations and realizations, should not alter consumption significantly. As a consequence, observing income expectations and the changes in expectations during the Financial Crisis and the Sovereign Debt Crisis, is crucial if we aim to understand consumption dynamics in the last decade.

Even though data on expectations are very useful, there are not many countries where direct, quantitative data on subjective expectations are available. As we show later in this paper, the Netherlands is among those countries. The availability of data on expectations and the remarkable economic similarities between the euro area and the Netherlands over the two crises periods make the analysis of the Dutch case an important and relevant single-country case study.

3 Permanent and Transitory Shocks over the crisis: an Empirical Analysis

As documented in Section 2, the dynamics of GDP and consumption were very different during the Financial Crisis and the Sovereign Debt Crisis: the reaction of consumption on income changes were much more severe during the latter period. In this section, we investigate how well income expectations explain the contraction in consumption during the two recent episodes of recession. Households' income expectations and their perceptions of income shocks are naturally tied together, therefore we also analyze the roles played by transitory and permanent shocks in explaining the dynamics of consumption during the last decade.

2013 recession, by contrast, the slowdown in GDP was contemporaneous with a substantial recovery in export.

3.1 Identification of Permanent and Transitory Income Shocks

In order to identify the permanent and transitory components of income shock, we follow the approach developed by Pistaferri (2001) and exploited by Attanasio, Kovacs, and Molnar (2017). By using this method, we first show how expectations and different income shocks are functions of each other. We start by assuming the following, standard decomposition of the log of income as in Blundell, Pistaferri, and Preston (2008):

$$\begin{aligned} y_{it} &= \Pi^{'} Z_{it} + \alpha^{'} V_i + p_{it} + \varepsilon_{it} \\ \Pi^{'} Z_{it} &= \pi_0 + \pi_1 age_{it} + \pi_2 age_{it}^2 \end{aligned} \tag{1}$$

where y_{it} is the log of individual income i at time t; $\Pi^{'} Z_{it}$ is a deterministic time-varying component (second order polynomial of age), and $\alpha^{'} V_i$ is a deterministic time invariant component,which includes gender, education and individual fixed effects. p_{it} and ε_{it} are, respectively, the permanent and transitory components of income of individual i at time t. The transitory component (ε_{it}) is i.i.d, while the permanent component follows a Markov process:

$$p_{it} = p_{it-1} + \zeta_{it} \tag{2}$$

where ζ_{it} is the permanent income shock. Permanent and transitory shocks are assumed to be orthogonal, at all leads and lags. Combining equations (1) and (2) we obtain the following equation for change in income:

$$\Delta y_{it} = \Pi^{'} \Delta Z_{it} + \zeta_{it} + \Delta \varepsilon_{it} \tag{3}$$

Under the assumption of rational expectations, the two components of income shock can be defined as a function of income expectations and realizations, which is described in details in Appendix A.1. As a result, transitory and permanent income shocks can be respectively rewritten as:

$$\begin{aligned} \varepsilon_{it} = -E[\Delta y_{it+1} | \Omega_t] + (\gamma_0 + \gamma_1 age_{it+1}) = \\ y_{it} - E[y_{it+1} | \Omega_t] + (\gamma_0 + \gamma_1 age_{it+1}) \end{aligned} \tag{4}$$

and

$$\zeta_{it} = E[y_{it+1} | \Omega_t] - E[y_{it} | \Omega_{t-1}] - (\gamma_0 + \gamma_1 age_{it+1}) \tag{5}$$

where Ω_t is the set of information available to individual i at time t. Coefficients γ_0 and γ_1 are functions of the parameters π_1 and π_2, the coefficients on the second-order polynomial of age in equation (1).

In this way, one can give a straightforward interpretation of the temporary and

permanent income shocks based on income expectations and realizations. Apart from a predictable age affect, temporary income shock, ε_{it}, is identified by the gap between income realization and its subjective expectation; while permanent shock, ζ_{it}, is identified as the change in the subjective expectations of income. Therefore, this method allows us to identify temporary and permanent income shocks separately using data on observed and expected income only.

3.2 Data

We use data from the Dutch National Bank Household Survey (DHS), which is run on a longitudinal sample and representative of the Dutch-speaking population.[5] The data are collected annually by CentERdata on behalf of the Dutch National Bank through an online survey. Households without a computer and/or access to the internet are provided with a basic computer and an internet connection. All persons aged 16 or over are interviewed within each household. In our analysis we focus on the period between 2006 and 2016; and we restrict our sample to working respondents aged 21-65. The income variables, throughout the paper, are expressed in real terms, which we compute by using annual consumer price indices from Statistic Netherlands. After excluding respondents giving inconsistent distributions for income expectations and other outliers,[6] we end up with a sample of about 450 individuals per year.

Table 1: Descriptive statistics

	2006			2011			2015		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
age	578	47.5	10.8	412	51.0	10.6	415	48.2	11.2
No. of hous. members	578	2.7	1.4	412	2.5	1.3	415	2.7	1.4
No. of adults	578	1.8	0.4	412	1.8	0.5	415	1.8	0.5
work	578	0.7	0.5	412	0.7	0.5	415	0.8	0.4
retired	578	0.1	0.3	412	0.1	0.3	415	0.0	0.2
unemployed	578	0.0	0.2	412	0.0	0.2	415	0.0	0.2
no education	578	0.0	0.2	412	0.0	0.1	415	0.0	0.1
low education	578	0.3	0.4	412	0.2	0.4	415	0.2	0.4
middle education	578	0.4	0.5	412	0.4	0.5	415	0.4	0.5
vocational education	578	0.2	0.4	412	0.2	0.4	415	0.2	0.4
university education	578	0.1	0.3	412	0.1	0.3	415	0.2	0.4
observed income	578	30,616	10,966	412	33,474	11,562	415	33,025	12,631
expected income	578	31,407	11,620	412	32,507	11,379	415	30,000	11,298

Notes: Our calculations from DHS; real values (euros 2010).

Descriptive statistics of the final sample, for three representative waves, are reported

[5]See details on the sample selection procedure in Teppa and Vis (2012).

[6]For each year, we trimmed our sample at the top and bottom 5% of observed and expected income and of permanent and transitory shocks.

in Table 1. The average age of the respondents is about 50 and households are composed of less than three members of which about 2 are adults. Roughly 70% of respondents work and 10% are retired. There is also significant heterogeneity in terms of education: middle educated respondents and those having attended vocational schools represent about 40% and 20% of the sample, respectively.

The key feature of this dataset, which helps us identifying transitory and permanent income shocks separately, is the joint availability of observed and expected income. In what follows, we describe these two variables in details.

Income Realizations. The DNB Household Survey collects information on household income. Household heads and their spouses are asked the following question:

> "*What is the total net income for your household in [year]? The total net income for your household is the net income of all household members combined. Net income means the income after deduction of taxes and social security benefits.*"[7]

We use this measure of income realizations, since it is more closely related to the income measure used in questions eliciting income expectations, which are illustrated later in this section. Total net household income, however, can also be calculated by indirectly summing up different income sources. Examining the relative weight of capital and labor income is crucial to understand the dynamic of this variable and to interpret our findings. For this purpose, we first use survey questions, which collect information on capital income.[8] About 55% of respondents report zero income from financial assets, and financial revenues represent less than 4% of net income on average.[9] Less than 2% of respondents declare to earn income from housing wealth (real estate income/letting of rooms).

Second, we examine the correlation between total net income and labor income. Unfortunately, only gross labour income is available, which is obtained as the sum of earnings of all household's members. Figure A.5 plots the joint distribution of net total income and gross labour earnings, along with the regression line. The two variables turn out to be strongly correlated, with a regression line close to the 45 degree line.[10] These

[7]The Survey also collects information on the value of different income sources, at the individual level. We use information on self-reported household net income, since it is more closely related to the income measure used in questions eliciting income expectations. Descriptive statistics on alternative measures of income are available from the author on request.

[8]This information is available at the individual level. We combine information of all the household members to calculate the incidence of income from financial assets (interest/dividends /other) on total net household income.

[9]The average incidence for respondents with positive financial assets is less than 10%.

[10]The estimated regression is $y = -879 + 1.110x$, where the coefficient for x is significant at the 1%

additional information point out that family resources are mostly determined by labor income, while income from financial and real assets represents a minor component of net household income.

For further validation of our income measure from the survey, we finally compare the time trend of gross disposable income at the macro level as retrieved from National Accounts and at the micro level as obtained from the DHS. As shown in the Appendix in Figure A.6, both measures follow the same trend between 2006 and 2016: both of them display an increasing path between 2006 and 2009; a decreasing path between 2009 and 2013; while an again increasing path in the last part of our observation period. All in all, the aggregated micro data from the DHS well reproduces the dynamics observed at the macro level taken from the National Accounts.

Income Expectations. Information on expected income is gathered through two sets of questions. The first two questions elicit, respectively, the lower and upper bounds for expected income:

> "*We would like to know a little bit more about what you expect will happen to the net income of your household in the next 12 months. What do you expect to be the lowest (highest) total net yearly income your household may realize in the next 12 months?*"

The interval between the lower (l) and upper (h) bounds is then divided into equal intervals, given by

$$l + (h - l)x, \quad with \quad x = \frac{2}{10}, \frac{4}{10}, \frac{6}{10}, \frac{8}{10}$$

Respondents report, then, the probability attached to the possibility that future income will be lower than the threshold ($l + (h - l)x$). More precisely, for each threshold, they are asked

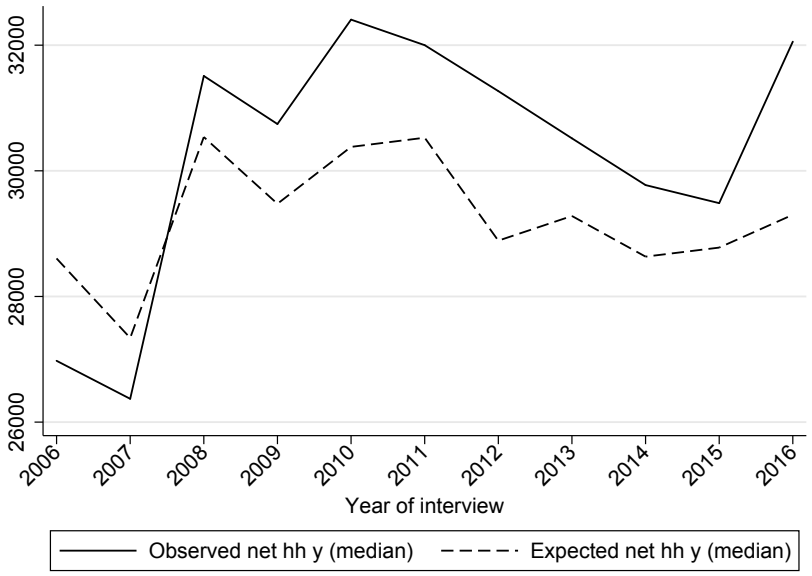
> "*What do you think is the probability (in percent) that the net yearly income of your household will be less than euro [threshold] in the next 12 months?*"

We exploit this information to compute the expected value of net household income.[11] Median values of expected real income over time are illustrated, along with observed real income, in Figure 2. The year on the horizontal axis is the year of interview, when information are elicited. Therefore, observed income refers to the previous calendar year, and the expectations to the year on the axis. Both realized and expected income increase before the crisis, until 2008. We then observe two episodes of fall in observed

level. The sign and magnitude of the two coefficients are due to the fact that labour income is gross, while total income is net.

[11] Heterogeneity in the way income expectations are elicited over time is discussed in Appendix A.2.

Figure 2: Observed and expected income



Notes: Real values (euros 2010). Weighted median. *Observed net hh y* is Observed net household income; *Expected net hh y* is Expected net household income.

and expected income. The first one - in 2008 - is a contraction by less than 1000 euros per year, with a similar magnitude for realized and expected income. Income reaches pre-shock levels in one year time. The second contraction in income was different from the previous one along several dimensions. On the one hand, the drop in expectations between 2011 and 2012 was more pronounced if compared to the cut in income, and it anticipated future income declines. On the other hand, the pessimism about future incomes remained stable over the period between 2012 and 2016: income started to increase after 2015, while expectations of income did not change significantly.

Reliability of expected income is crucial for the identification of income shocks, and for the interpretation of our results. For this reason, we provide evidence to support the informative value and the accuracy of expectations elicited by the DHS survey, which has never been done for this specific dataset. More precisely, we compare the distribution of income expectations and realizations; we exploit other questions in the questionnaire, related to future job status and income change, to test whether the answers of respondents are coherent within the survey; and we exploit the panel dimension of the dataset to compare individual expectations and ex-post income realizations (Manski, 2004).

We start examining the distribution of income expectations. Figure A.7 in the Appendix plots density function of income expectations and realizations for the pooled cross-section dataset. The distribution of expectations has a regular shape and shadows the one of income realization. This evidence is reassuring about informative response

to questions on expectations and about the reliability of expected income variable. The distribution of expectations is more left-skewed and presents a mass for very low annual income (close to 0), consistent with pessimistic expectations over the period.

Second, to gauge the accuracy of self-reported expectations, we test whether respondents give coherent answers to different questions eliciting expectations on future resources or job conditions. For this purpose, we exploit two additional indicators: self-reported probability of losing a job, and self-reported determinants of possible income changes in the next year.[12] To test the conditional correlation of those variables with expected income we perform two tests. First, we regress expected income on the probability of job loss (or job finding).[13] Second, we construct a set of dummies - one for each listed reason for expected income change - taking value 1 if the respondent chooses that potential determinant. We then regress the self-reported expected income change - calculated as the difference between expected and current income - on this set of dummies. We also control for a set of covariates.

Estimation results are reported in Table A.2. As shown in the first column, a higher probability of becoming unemployed is negatively correlated with expected income. Unemployed respondents report a lower expected income; the effect of a higher probability of finding a job has a positive effect, although not statistically significant.[14] Actual income turns out to be highly correlated with the expected one, with conditional correlation of 0.8 and significance of 1%. Results in the second column shows that expected change in household income is mainly associated with a job change. All in all, these results suggest that the income expectation variable is significantly correlated with expected job market conditions, supporting the internal coherence and the accuracy of questions eliciting expectations and the informative power of our measure for expected income.

Another way to evaluate the accuracy of elicited expectations is to follow respondents over time and compare income realizations with elicited income expectations, as suggested by Manski (2004). We exploit the longitudinal component of the data and we regress income realization on expectations elicited one period ahead. Results are shown

[12]The survey question is: "*As a consequence of what changes (listed below) do you expect the total net yearly income of your household to change in the next 12 months?" Alternatives are (more than one answer possible): a member of the household who currently has a job, will stop working / a member of the household who is currently out of work, will start working / a member of the household will change jobs / a member of the household will get a promotion / social security (welfare) benefits (if any) that the household now receives will significantly go up/ social security (welfare) benefits (if any) that the household now receives will significantly go down/ other changes / I don't expect any significant changes in the next 12 months / none of the above.*

[13]Expectations about job loss are elicited for workers only; expected probability of finding a job in the next 12 months is available for non-workers only.

[14]Possibly also because the small number of unemployed respondents entails a low variability of this measure.

in Table A.3. As it is seen in the first column, unconditional correlation is higher than 0.8. Even if the inclusion of other controls reduces its magnitude, the correlation stays as high as 0.5 in all the specifications. As shown in columns 4 and 5, the correlation between expectations and future income realizations is lower for households, which are more uncertain about their future income (proxied by the square root of income expectations). Income realizations in $t+1$ are also highly affected by income in t (columns 2-5). These findings suggests that income expectations have a high predictive power for actual income realization.

An important aspect to be discussed is the time period our collected survey information refers to. First of all, we consider a time period of one year, since both questions on observed and expected income refer to a 12 months period. Identification of transitory shocks requires computing the difference $y_{it} - E[y_{it+1}|\Omega_t]$ as it was shown in equation 4). Since the DHS questionnaire measures y_{it} as observed household income earned in the previous calendar year, expected income should be ideally elicited on January 1st (and referring to the coming calendar year). The gap between the date of the interview and the beginning of the year is, thus, a source of time discrepancy. In our sample, this issue is mitigated by the fact that more than two thirds of interviews are collected between weeks 10 and 18 and only 8% of respondents reply after week 30. In our baseline measure of income shock, we implicitly assume that no shock has occurred within this time span (January 1st and time of the interview), but we also measure income shocks i) including only respondents with a time discrepancy lower than 18 weeks and ii) using a 'corrected' measure of observed income, which is meant to be consistent with expected income by measuring observed income realizations during the 12 months preceding the interview.[15] Figure A.8 shows that the distribution of observed income (referred to the previous year) and the distribution of 'corrected' household income (referring to the 12 months before the month of the interview) are broadly comparable.

3.3 The Behavior of Income Shocks

We calculate permanent and transitory shock following the strategy outlined in Section 3.1. We start with estimating the deterministic component of income dynamics through

[15]For instance, if the survey is run during week 10 of year 2010, we construct 'corrected' income as a weighted average of observed income in 2010 and 2009, where the weight for the first component is given by the incidence of income 2010 in the calculation of income in the previous 12 months (i.e. 10 weeks out of 52). In this case, $y_{corr} = (10 * y_{2010} + (52 - 10) * y_{2009})/52$.

the following equation:[16]

$$y_{it} = \pi_0 + \pi_1 age_{it} + \pi_2 age_{it}^2 + u_{it}$$

Estimates are shown in Table 2 (the bottom panel reports values for parameters γ_0 and γ_1 in equations (4) and (5)).[17][18] The estimated positive coefficient for age and the negative one for age squared point to an inverse U-shape profile of the deterministic time-variant component of log income, as depicted in Figure A.9, that peaks at the age of 47.

Table 2: Estimates of the deterministic component of ln(income)

	Est. Coeff.	St. error
Age	0.0507 ***	(0.0036)
Age sq.	-0.0005 ***	(0.0000)
Constant	9.0771 ***	(0.08084)
N	11,870	
γ_0	.0512	
γ_1	-0.0010	

Notes: $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. Real values (euros 2010).

Having estimated the predictable age affect of income, we can now compute transitory and permanent shocks as in equations (4) and (5), respectively. The evolution of their median values is illustrated in Figure 3. The solid line shows the median of permanent income shocks, while the dashed line is the median of transitory income shocks. Up to 2010, transitory income shocks were negative. Based on equation (4), negative transitory shocks indicate that income expectations were systematically higher than income realizations, i.e. households were in general optimistic. After 2010, the sign of transitory shocks changed to positive, showing that income expectations were below their realizations, i.e. households were in general pessimistic.[19] On the other hand, permanent income shocks showed a very different pattern. Up to 2010 permanent income shocks were relatively small, close to zero. Based on equation (5), close to zero

[16]To this purpose, we consider log net households' income in real terms and restrict the sample to household heads and their partners.

[17]They are derived according to the formulas $\hat{\gamma}_0 = (\hat{\pi}_1 - \hat{\pi}_2)$ and $\hat{\gamma}_1 = 2\hat{\pi}_2$ introduced in Section 3. To avoid possible biases related to the two recessions, we enlarge the time span and we include in the sample all the household heads interviewed from 1997 to 2016.

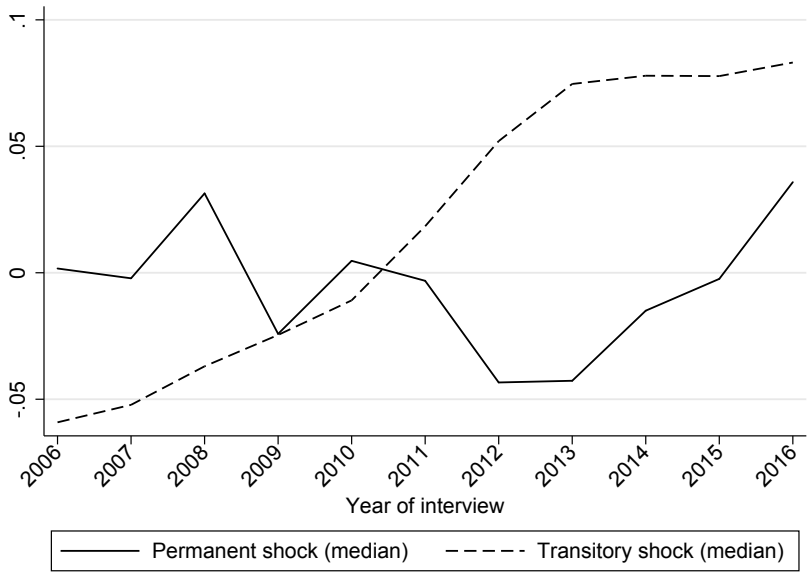
[18]Note that the impact of time invariant variables, notably education, is captured by π_0.

[19]In the same vein, thought with a less clear picture, in Figure A.10 we report the evolution of the mean transitory and permanent shocks. The pattern is robust to the normalization with respect to total income in previous year (Figure A.11).

permanent income shock indicates that households, over this period, made no significant changes in their income expectations. Between 2010 and 2015, permanent income shocks were on average larger and negative: meaning that households constantly revised their income expectations downwards. The upward revision of expectations only started in the last year of our sample, in 2016, where the permanent income shock became positive.

Consider now how these two different income shocks behaved over the two crises. During the Global Financial Crisis, households were exposed to a big negative transitory shock, which only became positive after 2011. At the same time they faced a one-period negative permanent income shock in 2009. Our surprising finding is that this permanent income shock does not mirror the severity of the 2008-2009 financial crisis.[20] During the Sovereign Debt crisis, in turn, households were exposed to a large positive transitory shock. At the same time they faced a prolonged period of time with large, negative permanent income shocks.

Figure 3: Permanent and transitory shocks: Median



Notes: Real values (euros 2010). Weighted median.

To provide a broader picture of shock dynamics, we plot the distribution of transitory and permanent income shocks at three points in time: before the crisis (2006-07), during the Global Financial Crisis (2009) and at the onset of the Sovereign Debt Crisis (2012).

[20]Figure A.12 shows that the paths of transitory shock based on either observed income or 'corrected' income are very similar, supporting our assumption that time discrepancies do not play a big role in this context. Permanent shocks hinge on a measure of change in expectation, e.g. $E[y_{it+1}|\Omega_t] - E[y_{it}|\Omega_{t-1}]$ (see equation 5). Time discrepancy, in this case, refers to the moment when expectations are retrieved, in two sequent waves. This discrepancy is less than one week in one third of cases, while it is lower than our weeks in the large majority of interviews (almost 60%).

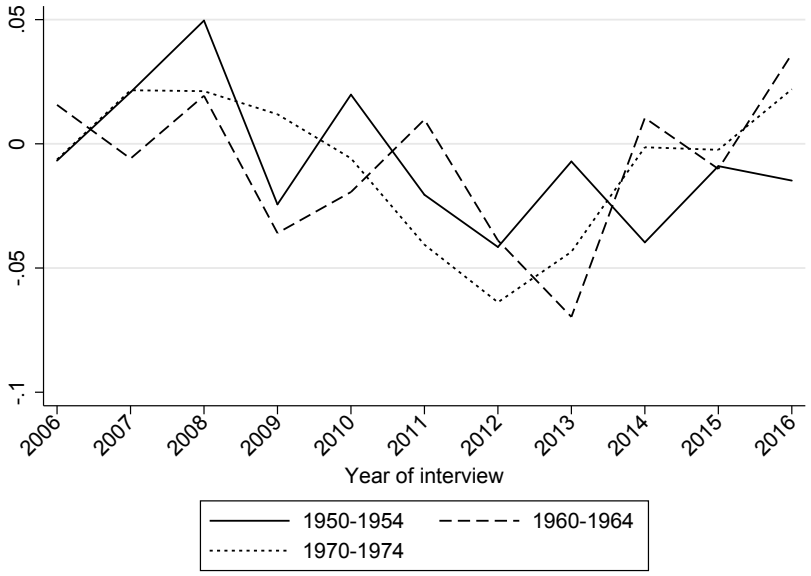
Figure A.13 shows two consecutive shifts to the right of the distribution of the transitory shock, after the first and second shock, respectively. The mass of below zero transitory income shocks constantly decreases, which means that households become more and more pessimistic over our period of interest. Figure A.14 shows a similar graph for permanent income shocks. As we can see, the mass of below zero permanent income shocks progressively increases. It captures the increasing number of households who revise their income expectations downwards. The evolution of shocks we see from the income shock distributions reinforces our earlier conclusions from Figure 3.

So far, we focused on aggregate income shocks, while using them potentially masks a large degree of heterogeneity across households for a number of reasons. In what follows, we take a look at heterogeneity induced by households' financial position and age.

One way to gauge the extent of households' heterogeneity is to examine median values of permanent and transitory shock across income quartiles. As shown in the Appendix, in Figure A.15, the level of the transitory income shocks are very similar across households in different income quartiles. By contrast, the level of the permanent income shocks are different across households in different income quartiles. There are two important things to notice. First, up until 2010, households in the two lowest income quartiles are, on average, hit by positive permanent income shocks, while households in the top two income quartiles are mainly hit by negative permanent income shocks. Second, after 2010, households in each income quartiles face mostly negative permanent income shocks. Moreover, during the Sovereign Debt Crisis, the most affluent households are hit by the most negative permanent income shocks.[21] In general, most affluent households made the largest negative adjustments in their future income expectations.

[21]Results are robust when we take a look at the permanent and transitory shock as a fraction of the income in $t-1$, see Figure A.16.

Figure 4: Permanent shocks by cohort (weighted median)

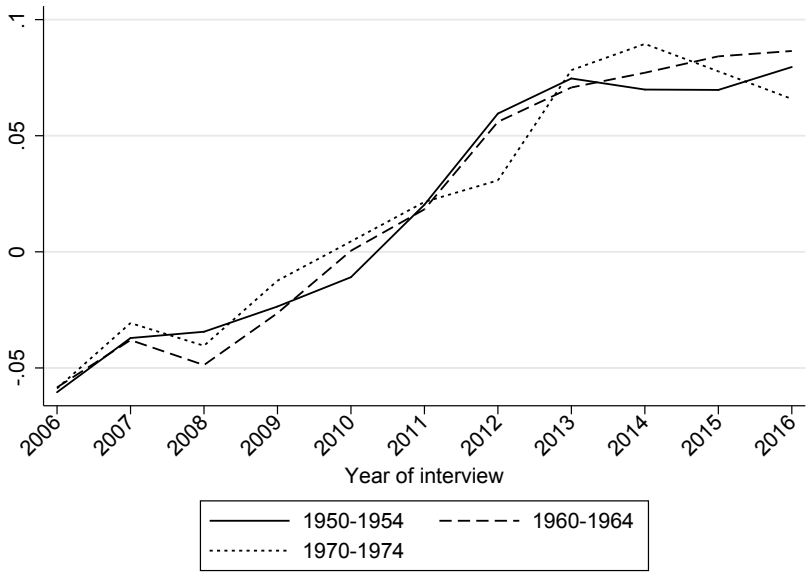


Notes: Sample size for each cohort: > 55 observations. Real values (euros 2010).

Another way to gauge the extent of households' heterogeneity is by taking a look at them by age. In Figure 4 and Figure 5, we plot the median values of permanent and transitory income shocks for three different cohorts. Cohorts are defined by households' date of birth. Cohort 1950-1954, for example, includes households born between 1950 and 1954. In each graph, the solid, dashed and dotted lines refer to the average income shocks of cohort 1950-1954, cohort 1960-1964, and cohort 1970-1974, in this order. Figure 4 highlights two important facts. First, income expectations were not revised significantly by any of the cohorts until 2011. Second, that the downward revision in income expectations over the Sovereign Debt Crisis is mainly driven by younger cohorts (see also Table A.4, which shows the evolution of the shocks for all the cohorts).

Figure 5 shows that transitory income shocks are qualitatively and quantitatively very similar for different cohorts over the observed period. Similarly to our observation in Figure 3 earlier, households, irrespective of the cohort they belong to, constantly become less and less optimistic about their future income. Until about 2010, when transitory income shocks become positive, households are in general optimistic: their future expected income is above their realised income. After 2010 then, households get more pessimistic: their future expected income is constantly below their realised income.

Figure 5: Transitory shocks by cohort (weighted median)



Notes: Sample size for each cohort: > 55 observations. Real values (euros 2010).

Permanent and transitory shocks can not only be characterized by their means or medians, but also by looking at their dispersions summarized by variances. In the pooled cross-section the variances of permanent and transitory shocks are 0.050 and 0.035 respectively. In particular the variance of transitory shocks ranges from 0.027 for households born between 1940-1944 to 0.037 for those born after 1975. For the same cohorts, the variance of the permanent shocks ranges from 0.026 to 0.055.

4 A Life-Cycle Model of Consumption Behavior

In this Section, our goal is to assess how important different income shocks are in the evolution of consumption between 2006 and 2016 by using simulations. As we found in Section 3, households in different cohorts experienced rather different income shocks over this period, we mainly focus on cohort-level behavior in order to understand aggregate consumption dynamics. Households in different cohorts are, by definition, at different stages of their life-cycle in the same period and therefore their consumption could react to similar income shocks rather differently.

We first build a life-cycle model with different cohorts of households, and with both permanent and transitory income shocks. We then use the time-series of the income shocks, calculated in Section 3.3 from the Dutch household data, to simulate households' consumption behavior. Our goal is to reveal the contribution of each cohort to the dynamics of aggregate income and consumption over the Global Financial Crisis and

the Sovereign Debt Crisis.

4.1 Model Structure

We build a single-asset model of life-cycle consumption and savings behavior with permanent and transitory income uncertainty. Households live for T periods as adults, of which W periods are spent as workers and the rest as retirees. They maximize their present discounted lifetime utility, which only depends on their non-durable consumption. Households only have access to a one-period bond, which helps them reallocate resources between periods. There is no credit market in the model. We formulate household i's value function in period t in a recursive form as follows:

$$V_{i,t}(X_{i,t}, P_{i,t}) = \max_{\{C_{i,t}\}} U(C_{i,t}) + \beta \mathbb{E}_t V_{i,t+1}(X_{i,t+1}, P_{i,t+1}), \tag{6}$$

subject to

$$X_{i,t+1} = R^X(X_{i,t} - C_{i,t}) + Y_{i,t+1} \tag{7}$$

where β is the subjective discount factor measuring patience. $C_{i,t}$ is non-durable consumption, $Y_{i,t}$ is labor income, and $P_{i,t}$ is the permanent part of the labor income, to be defined later in this section. $X_{i,t}$ is the cash-on-hand, defined as the sum of savings and labor income in period t.

Utility Function

The period utility function is a CRRA (Constant Relative Risk Aversion) function in nondurable consumption.

$$U(C_{i,t}) = \frac{C_{i,t}^{1-\rho}}{1-\rho} \tag{8}$$

where $\rho \geq 0$ is a curvature parameter, which equals to the relative risk aversion parameter and to the inverse of the elasticity of intertemporal substitution.

Sources of Uncertainty.

In the model, the only uncertainty faced by households is their idiosyncratic labor income. Following the income process described by equations (1) and (2), here we also assume that (log) labor income is exogenously described by a combination of deterministic and random components at any time before retirement. In addition, we assume that income shocks are similar within cohort while they might be different between cohorts.

The (log) labor income, $y^c_{i,t}$, for household i belonging to cohort c at time t is defined as:

$$y^c_{i,t} = G_t + p^c_{i,t} + \varepsilon^c_{i,t} \tag{9}$$

with G_t being a deterministic function of age only; $p^c_{i,t}$ is the permanent income component, and $\varepsilon^c_{i,t}$ is the transitory income shock for the same household. Furthermore, the permanent income component follows a martingale process of the form:

$$p^c_{i,t} = p^c_{i,t-1} + \zeta^c_{i,t} \tag{10}$$

where $\zeta^c_{i,t}$ is the shock on the permanent income. We assume that both of the innovations on log income can be decomposed into a cohort-specific and a household-specific part. Therefore, we write them as follows

$$\varepsilon^c_{i,t} = \varepsilon^c_t + \varepsilon_{i,t} \tag{11}$$

$$\zeta^c_{i,t} = \zeta^c_t + \zeta_{i,t} \tag{12}$$

where ε^c_t and ζ^c_t are the cohort-specific income shocks. $\varepsilon_{i,t}$ and $\zeta_{i,t}$ are household-specific income shocks, which are assumed to be normally distributed, serially uncorrelated, and independent.[22]

$$\varepsilon_{i,t} \sim N(-0.5\sigma^2_\varepsilon, \sigma^2_\varepsilon) \tag{13}$$

$$\zeta_{i,t} \sim N(-0.5\sigma^2_\zeta, \sigma^2_\zeta) \tag{14}$$

Labor income at any time after retirement is a constant, a, fraction of the last working year's permanent labor income. One can think of this as a pension that is wholly provided by the employer and/or the state.

4.2 Solution and Simulation

This life-cycle problem cannot be solved analytically, so we apply numerical techniques. Given the finite nature of the problem, a solution exists and can be obtained by approximating optimal policy functions by backward induction. We use the backward induction technique over the normalized value function of the households to obtain the optimal policy functions.[23] Expectations in the model refer to uncertain incomes, while

[22]The assumption of log-normality of the income shocks with given parameters is a simplification. In this case the mean values of the level of the income shocks equal 1.

[23]Following Carroll (1992), variables are normalised by permanent income for ease of computation. In Appendix A.3, we show the detailed derivation of the standardized model.

they are evaluated using the Gauss-Hermite approximation. Since the innovations of income are log-normally distributed random variables in each period, we are able to use a two-dimensional Gauss-Hermite quadrature to approximate the expectations as follows

$$\begin{aligned}\mathbb{E}_t V_{t+1}(x_{t+1}) &= \int V_{t+1}\Big(x_{t+1}(Z,N)\Big)\,\mathrm{d}F(Z)\mathrm{d}F(N) \\ &= \int_{-\infty}^{\infty} \frac{1}{\pi} V_{t+1}\Big(x_{t+1}\big(\sqrt{2}\sigma_Z Z, \sqrt{2}\sigma_N N\big)\Big) e^{-(Z^2+N^2)} \\ &\approx \sum_{i \bigotimes j \bigotimes k} \frac{1}{\pi} w_i^{GH} w_j^{GH} V_{t+1}\Big(x_{t+1}\big(\sqrt{2}\sigma_Z Z_i^{GH}, \sqrt{2}\sigma_N N_j^{GH}\big)\Big)\end{aligned} \tag{15}$$

where Z_i^{GH} and N_j^{GH} are the Gauss-Hermite nodes, while w_i^{GH} and w_j^{GH} are the corresponding weights.

Cohorts.

In order to take into account that different groups of households might have experienced different income shocks, we define cohorts and simulate their behavior separately. Given that our focus period is between 2006 and 2016, we define ten cohorts based on their age in 2006. We use 5-year age intervals between ages 20 and 65.

Simulation.

When simulating the model, we use the information we extracted from the Dutch household survey data: the deterministic component of the income, the level of the cohort-specific permanent and transitory income shocks by year, and the variance of the household-specific income shocks by year. The deterministic component of income (G_t) is approximated by a second-order polynomial of age, and the parameter estimates are shown in Table 2. The cohort-specific transitory and permanent income shocks (ε_t^c, ζ_t^c), and the variance of the household-specific income shocks (σ_ε^2, σ_ζ^2) are calculated in Section 3.3 and the results are reported in Table A.4. The parameter values we use for the simulation are also listed in Table 3.

For each simulation, we draw realizations for the two unknown, household-specific income shocks ($\varepsilon_{i,t}$, $\zeta_{i,t}$) according to equations (13)-(14). We assume that each household starts its life with zero wealth, and it only receives labor income. Altogether we run 100,000 simulations, 10,000 households in each cohort. When aggregating variables, we use cohort weights, which are representative weights for the Dutch population.

4.3 Simulation Results

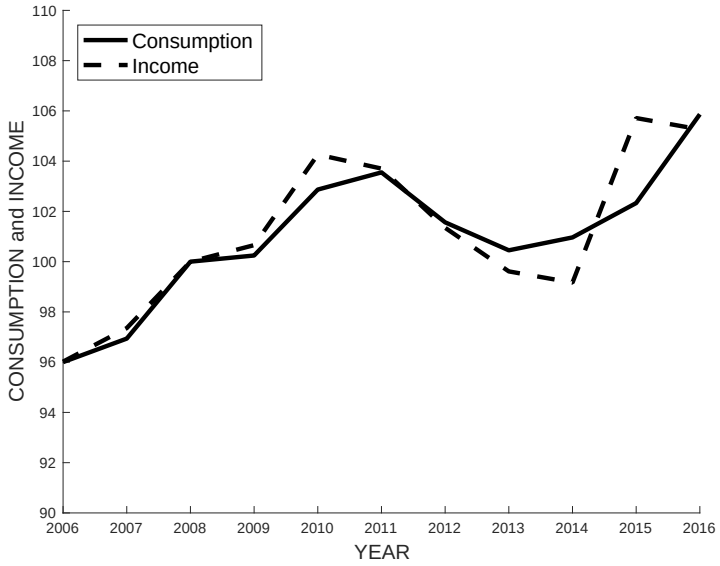
In Figure 6, we see the simulation results for the aggregate income and consumption profiles between 2006 and 2016. For the ease of comparison to Figure 1, which shows

Table 3: Parameters for the benchmark model

Parameter		Value	Source
T	*Number of years as adult*	60	
W	*Number of years as worker*	45	
β	*Discount factor*	0.95	
ρ	*Risk aversion parameter*	1.5	Blundell, Browning, and Meghir (1994)
Constant	*Age-spec income, constant*	8.782	Own calculations, DHS
Age	*Age-spe income, linear trend*	0.064	Own calculations, DHS
$Age^2/10$	*Age-spec income, quadratic trend*	-0.001	Own calculations, DHS
a	*Replacement rate*	0.75	Own calculations, DHS
σ^2_ζ	*Var.permanent income shock*	[0.026, 0.055]	Own calculations, DHS
σ^2_ε	*Var.transitory income shock*	[0.027, 0.037]	Own calculations, DHS
R^X	*Liquid asset return*	1.02	Gourinchas and Parker (2002)

the observed evolution of aggregate variables in the Netherlands, we create indices of our simulated variables, taking 2008 as the base year (=100) both for income and consumption.

Figure 6: Simulated Income and Consumption Profiles



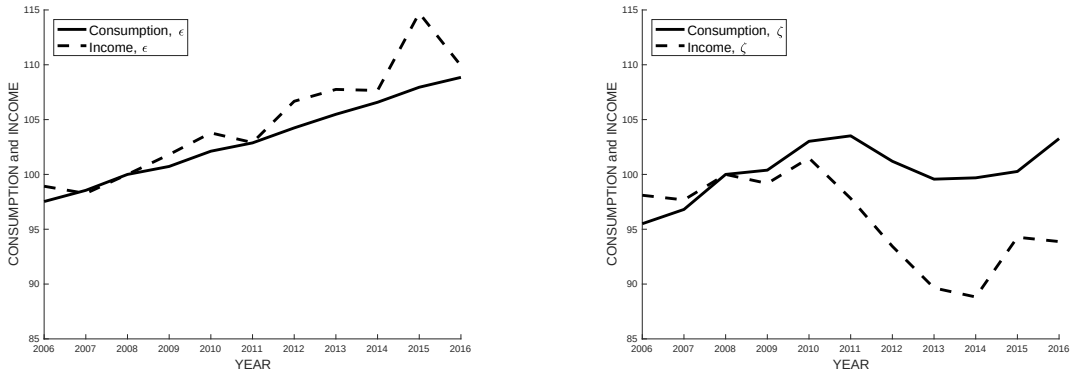
There are two important things to notice in this figure. On the one hand, our income shock measures - based on income expectations and realizations - does not help us replicating the 2008-2009 crisis, consumption doesn't change significantly over this period in the simulated model. The reason behind is simple: the observed income shocks don't lead to a decline in income over 2008-2009. It is also visible in Figure 3, which shows the median income shocks over time.

On the other hand, the use of our income shock measures generates a significant

downturn in the simulated economy for 2012-2013, mimicking the actual pattern observed in the Dutch case, as shown in Figure 1. The combination of transitory and permanent income shocks leads to a sizable drop in income, which, in turn, triggers a large shrink in consumption as well. In the simulated economy, as seen in Figure 6, income falls by 3.9% between 2011 and 2013, while consumption drops by 2.9%. In the Netherlands, as seen in Figure 1 income was 2% lower in 2013 than in 2011, while consumption was 3.2% lower in 2013 than in 2011.

In order to reveal the importance of the permanent and transitory income shocks separately in explaining the behavior of the economy, next we disentangle these two shocks in our simulations. Simulations help us compare counterfactuals, which are otherwise unobservable. We first assume that households only face cohort-specific transitory income shocks, but no cohort-specific permanent income shocks, i.e. $\varepsilon_t^c \neq 0$, $\zeta_t^c = 0$. We then assume the other extreme case, where households only face cohort-specific permanent income shocks, but no cohort-specific transitory income shocks, i.e. $\varepsilon_t^c = 0$, $\zeta_t^c \neq 0$. The left panel of Figure 7 shows how the economy would evolve if households only expe-

Figure 7: Simulated Income and Consumption Profiles under Transitory (left) and Permanent (right) Shocks



rienced the observed transitory income shocks. Under this scenario, average household income constantly increases and consumption follows. Given the transitory nature of the income shocks, changes in income don't induce significant changes in consumption. Having information on transitory income shocks, on their own, only could not help us understand the dynamics of the economy over the observed period, between 2006 and 2016. Our simulated model doesn't predict crisis either around 2008-2009 or around 2012-2013.

The right panel of Figure 7 shows how the economy would evolve if households only experienced the observed permanent income shocks. Under this scenario, average household income constantly increases and consumption follows closely. Given the permanent

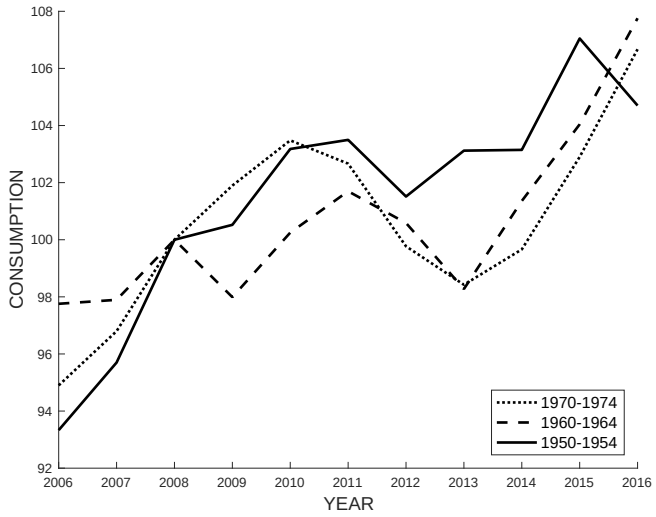
nature of the income shocks, changes in income induce significant changes in consumption. The most abrupt change in income and consumption happens between 2011 and 2013, when income drops by more than 6%, while consumption drops by around 4%. Having information on permanent income shocks, on their own, could not help us explain the dynamics of the economy over our period of interest: the implied drop in aggregate income and consumption over the Sovereign Debt Crisis is way larger than what is observed in the Dutch economy.

These simulation results are in line with the permanent income hypothesis: as we have seen, consumption tracks income more closely when the income shocks are permanent rather than temporary. As Figure 7 shows, households' consumption responds strongly to income changes induced by permanent income shocks, while it is much less sensitive to income changes induced by transitory income shocks. Note here, that households' consumption response to transitory income shocks crucially depends on the age of the household. As households get older, any transitory income shock looks more like a permanent one from their perspective - i.e. they have to smooth the same shock over a shorter horizon. As a result, households belonging to older cohorts should react more to any transitory income shock, compared to households belonging to younger cohorts. Households' consumption response to permanent income shocks also crucially depends on the age of the household. Younger cohorts have longer time horizon ahead of them, therefore a permanent income drop affects their lifetime income more than it does older households'. As a result, households belonging to younger cohorts should react more to any permanent income shock, compared to households belonging to older cohorts.

Cohorts do only differ in the way they respond to the same income shocks, but in fact, they also faced rather different income shocks over our period of interest. For this reason, it is worthwhile taking a look at cohort-level differences in income shocks and the implied consumption behavior. In Figure 8, we plot the consumption evolution for three different simulated cohorts: for households born between 1950-1954, 1960-1964, and 1970-1974. We choose these particular cohorts in order to be able to compare their consumption paths to the shocks they face, reported in Figure 4 and Figure 5 in Section 3.3.

Two points are worth noting in Figure 8. First, the crisis in 2008-2009 only had an effect on one cohort's consumption, the consumption of cohort 1960-64. Second, the 2012-2013 crisis affected the consumption behavior of all the three cohorts. The youngest cohort faced the most dramatic consumption drop, while the oldest cohort only experienced a slight decrease in its consumption during the crisis. The difference between cohorts' reaction is not surprising. As described earlier, even the simplest version of the permanent income hypothesis model predicts that younger cohorts' consumption react

Figure 8: Simulated Consumption Profiles for Different Cohorts



less to transitory income shocks and react more to permanent income shocks, compared to those of older cohorts.

In the simulation exercise above we do not aim to match data moments with simulated counterparts. We are simply interested in whether income shocks, which are identified by subjective expectations and realizations of income, alone, are able to generate the crisis periods around 2008-2009 and 2012-2013. According to our results, income shocks are only relevant in explaining the most recent recession, while they don't help us understand the 2008-2009 crisis. These observations lead us to conclude that the two crisis, the one in 2008-2009 and the other in 2012-2013, are very different in nature. Households' income expectations do not change significantly during the Global Financial Crisis, while these expectations got much worse during the Sovereign Debt Crisis. In particular, the 2012-2013 crisis hit the younger cohorts the most, as they suffered from the largest income drop on average.

5 Conclusions

Expectations are key factors in determining individual decisions and are central to economic models of behavior. In particular, consumption theories - like the permanent income hypothesis and the life cycle model - embody the idea that individuals or households are forward looking decision makers. Measuring expectations and, in turn, identifying income shocks, is, however, difficult because individuals may have information not observed by the econometrician (Jappelli and Pistaferri, 2010). A growing body of economic literature exploits on probabilistic expectations data, an approach fully supported

by Manski (2004), although reliability of elicited expectations in household surveys has been a subject of some controversy among behavioral and social scientists, as discussed by Dominitz and Manski (1997).

This paper contributes to this literature by investigating the role of subjective income expectations in shaping consumption dynamics over the last decade. Moreover, it documents the reliability of the elicited expectations variable, showing that income expectations are linked with both expectations about labour market conditions and future income realizations.

We exploit a unique, micro panel-dataset of Dutch households to identify the levels of transitory and permanent income shocks, following the approach developed by Pistaferri (2001) and later exploited by Attanasio, Kovacs, and Molnar (2017). We find large variations of the shocks both between cohorts and over time. Up until 2010, households were in general optimistic, income expectations were systematically higher than income realizations. During the Sovereign Debt Crisis, instead, households became more pessimistic and made significant downward revisions to their expectations, especially if the household head was of younger age. Our analysis adds to the results by Pistaferri (2001), who only observes a snapshot of transitory and permanent shocks, by illustrating how people change their expectations in face of idiosyncratic and aggregate events over a decade period. The main advantage of our method is that the identification of the permanent and transitory shock does not require strong assumptions, as in Attanasio, Kovacs, and Molnar (2017), about the distribution of income expectations.

We use the time series of the estimated transitory and permanent income shocks in a life-cycle model in order to shed light on the impact of different income shocks on the evolution of consumption. Our simulations show that income shocks turn out to be relevant in explaining the Sovereign Debt Crisis, while they do not contribute to our understanding of the 2008-2009 crisis. The two episodes of economic downturn are, therefore, very different in nature: income shocks are much more important drivers of the Sovereign Debt Crisis.

Our results contribute to assess the effect of households' income expectations on aggregate consumption dynamics. Despite the fact that the distinction between transitory and permanent shocks is a well established result in theoretical consumption models, the lack of suitable data can explain the shortage of empirical works trying to quantify their impact. Our work tries to fill this gap. Using the unique, Dutch micro-dataset, we combine data on income expectations and realizations to calculate income shocks. We then investigate the determinants of consumption drop during the last decade. Given the similarities in the dynamics of aggregate variables between the Dutch economy and the euro area, our findings might help our general understanding of the determinants of

contractions in consumption during a recession period.

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A Appendix

A.1 Identification of Income Shocks

We assume the following standard decomposition of the log of income process (Pistaferri, 2001; Blundell, Pistaferri, and Preston, 2008):

$$y_{it} = \Pi^{'} Z_{it} + \alpha^{'} V_i + p_{it} + \varepsilon_{it} \tag{A.1}$$

where Z_{it} is a deterministic time variant component of income and $\alpha^{'} V_i$ is a deterministic time invariant one (e.g. it includes gender, education and individual fixed effect). p_{it} and ε_{it} are, respectively, the permanent and transitory component of income of individual i at time t. The transitory component (ε_{it}) is independently distributed σ^2_{ε}, while the permanent component is a Markov process:

$$p_{it} = p_{it-1} + \zeta_{it} \tag{A.2}$$

where ζ_{it} is the permanent shock and it is assumed to be i.i.d. with constant variance σ^2_{ζ}. It is orthogonal to the transitory shock, at all lags and leads.
Combining equations (A.1) and (A.2) we obtain the following equation for the change in income:

$$\Delta y_{it} = \Pi^{'} \Delta Z_{it} + \zeta_{it} + \Delta \varepsilon_{it} \tag{A.3}$$

Under the assumption that the deterministic component of the evolution of income is a second order polynomial of age. i.e. $\Pi^{'} Z_{it} = \pi_0 + \pi_1 age_{it} + \pi_2 age^2_{it}$, equation (A.3) can be rewritten as:

$$\Delta y_{it} = (\gamma_0 + \gamma_1 age_{it}) + \zeta_{it} + \Delta \varepsilon_{it} \tag{A.4}$$

where $\gamma_0 = (\pi_1 - \pi_2)$ and $\gamma_1 = 2\pi_2$.

Rewriting equation (A.4) and exploiting the assumption of rational expectations, we can derive the following expression for the transitory shock:

$$\begin{aligned} \varepsilon_{it} = -E[\Delta y_{it+1} | \Omega_t] + (\gamma_0 + \gamma_1 age_{it+1}) = \\ y_{it} - E[y_{it+1} | \Omega_t] + (\gamma_0 + \gamma_1 age_{it+1}) \end{aligned} \tag{A.5}$$

Substituting this expression in equation (A.4), we identify the permanent income shock as:

$$\zeta = E[y_{it+1} | \Omega_t] - E[y_{it} | \Omega_{t-1}] - (\gamma_0 + \gamma_1 age_{it+1}) \tag{A.6}$$

where Ω_t is the set of information available to individual i at time t, and coefficients γ_0 and γ_1 are function of parameters π_1 and π_2. We can interpret the temporary shock

ε_{it} as the gap between income realization and its expected value, given the information available at time t. The permanent shock p_{it} is measured by the revision in income expectations with respect to the previous period $(t-1)$.

A.2 Data: Monthly and Annual Values of Expected Income

Wording of questions in the DNB Household Survey are, unfortunately, not homogeneous across waves. To our purpose, a relevant variation concerns questions eliciting income expectations. While after 2007, they explicitly refer to '*annual*' income, the time frame they refer to is more ambiguous for years 2003-2007. The exact wording of questions since 2008 is: '*We would like to know a little bit more about what you expect will happen to the net income of your household in the next 12 months. What do you expect to be the lowest total net yearly income your household may realize in the next 12 months? What do you expect to be the highest total net yearly income your household may realize in the next 12 months?*'.

In waves 2003-2007, the questions are: '*We would like to know a little bit more about what you expect will happen to the net income of your household in the next 12 months. What do you expect to be the lowest total net monthly income your household may realize in the next 12 months? What do you expect to be the highest total net income your household may realize in the next 12 months?*'. The first question refers to a time span of 12 months; the second and third refer to monthly income when eliciting the lower bound of the distribution and to any time frame when asking about the upper bound, respectively. In this sense, responses to those questions could be expressed either in annual or monthly terms.

To tackle this issue, we derive information on the relevant time frame for responses in period 2002-2007 by exploiting responses in waves when the reference to annual income is unambiguous. This approach is in the same spirit of imputation methods to tackle missing value described by Little and Rubin (2002), and exploit the panel structure of the sample to derive additional information for the period 2002-2007. We proceed by steps, as described hereafter.

1. For each respondent, we calculate expectations referring to the lower and the upper bounds of annual income, i.e. year 1998-2002 and 2008-2015, to compute their average expected values for this period. This individual specific 'average lower/upper bound for annual income' may depend on observable variables (family composition, education, etc.) and unobservables (ability of household members, optimism/pessimism of the respondent, information available to the respondent but not to the econometrician, etc).

2. We, then, estimate the lower/upper bound for expected income in each specific year. We use as regressors the individual specific mean of expectations described in 1., aimed to capture individual specific information and expectations, along with other individual and family characteristics, aimed to capture both heterogeneity of expected income over the life-cycle and time-specific events which may affect expectations. More precisely, we use the pooled sample for periods 1998-2002 and 2008-2015 and we regress the logarithm of expected income on the 'average lower/upper bound for annual income', observed net household income, age, the number of workers in the couple, whether the respondent is working, and two dummies derived from a qualitative question about expectations and capturing, respectively, whether the respondent does not expect any significant change in income or whether she expect an income increase.[24] Estimate results are shown in Table A.1. The lower (upper) bound is positively associated with the log mean lower (upper) bound and the log of observed income.

3. We use the estimated 'typical lower/upper bound for expected income' to identify respondents who report the upper and lower bound of expected *monthly* income in waves 2002-2007. More precisely, we assume that the upper/lower bound refer to monthly income when the reported value is lower than 20% of predicted annual values.

[24]More precisely, we exploit the following question: "*As a consequence of what changes (listed below) do you expect the total net yearly income of your household to change in the next 12 months? (More than one answer possible). a) A member of the household who currently has a job, will stop working, b) a member of the household who is currently out of work, will start working, c) a member of the household will change jobs, d) a member of the household will get a promotion e) social security (welfare) benefits (if any) that the household now receives will significantly go up f) social security (welfare) benefits (if any) that the household now receives will significantly go down/ other changes g) I don't expect any significant changes in the next 12 months h) none of the above.*

Table A.1: Estimates of (log of) lower/upper bound of expected income

	Lower bound	Upper bound
Ln(mean lower bound)	1.064***	
	(0.012)	
Ln(mean upper bound)		0.944***
		(0.011)
Ln(income observed)	0.241***	0.249***
	(0.012)	(0.011)
Age	0.005***	0.004***
	(0.001)	(0.001)
No. workers in couple	-0.115***	-0.103***
	(0.030)	(0.027)
Working	0.010	0.041
	(0.029)	(0.026)
No significant changes in income expected	0.071***	0.068***
	(0.026)	(0.023)
Positive reasons for change in income	0.108**	0.109**
	(0.052)	(0.047)
Year 1998	0.143***	0.119**
	(0.055)	(0.050)
Year 1999	0.138**	0.066
	(0.059)	(0.053)
Year 2000	0.213***	0.202***
	(0.082)	(0.075)
Year 2001	0.047	0.042
	(0.058)	(0.053)
Year 2002	0.007	-0.029
	(0.057)	(0.052)
Year 2009	-0.140***	-0.161***
	(0.051)	(0.046)
Year 2010	-0.141***	-0.107**
	(0.050)	(0.045)
Year 2011	-0.054	-0.059
	(0.051)	(0.046)
Year 2012	-0.215***	-0.167***
	(0.050)	(0.045)
Year 2013	-0.201***	-0.223***
	(0.050)	(0.046)
Year 2014	-0.287***	-0.245***
	(0.048)	(0.044)
Year 2015	-0.049	-0.078*
	(0.049)	(0.044)
Year 2016	-0.068	-0.040
	(0.050)	(0.046)
Constant	-3.482***	-2.294***
	(0.153)	(0.141)
Observations	22033	22046

Notes: $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$. Coefficients, standard error in parenthesis. Real values (euros 2010).

A.3 Standardization of the Model

The number of state variables of in the problem can be reduced from two ($X_{i,t}$, $P_{i,t}$) to one $\left(\frac{X_{i,t}}{P_{i,t}}\right)$. At terminal age $t = T$ the value function becomes

$$V_{i,T}(X_{i,T}, P_{i,T}) = \frac{C_{i,T}^{1-\rho}}{1-\rho},$$

With standardized variables, using notation $x_{i,T} = \frac{X_{i,T}}{P_{i,T}}$ and $c_{i,T} = \frac{C_{i,T}}{P_{i,T}}$, the value function can be written as

$$V_{i,T}(x_{i,T}) \;=\; U(c_{i,T}) = U\left(\frac{C_{i,T}}{P_{i,T}}\right) = \frac{\left(\frac{C_{i,T}}{P_{i,T}}\right)^{1-\rho}}{1-\rho}$$

Hence the value function with standardized variables can be rewritten as

$$V_{i,T}(x_{i,T}) \;=\; \frac{1}{(P_{i,T})^{1-\rho}}\left[\frac{C_{i,T}^{1-\rho}}{1-\rho}\right]$$

Therefore the relationship between the original and standardized value functions is:

$$V_{i,T}(X_{i,T}, P_{i,T}) = P_{i,T}^{1-\rho} V_{i,T}(x_{i,T})$$

Now considering the value function at age $t = T - 1$:

$$\begin{aligned} V_{i,T-1}(X_{i,T-1}, P_{i,T-1}) &= \max_{C_{i,T-1}} \{U(C_{i,T-1}) + E_{i,T-1}\beta V_{i,T}(X_{i,T}, P_{i,T})\} \\ &= (P_{i,T-1})^{1-\rho} \max_{c_{i,T-1}} \left\{ U(c_{i,T-1}) + E_{i,T-1}\left[\beta\left(\frac{P_{i,T}}{P_{i,T-1}}\right)^{1-\rho} V_{i,T}(x_{i,T})\right]\right\} \end{aligned}$$

And similarly to the previous result, the simple relationship we get is

$$V_{i,T-1}(X_{i,T-1}, P_{i,T-1}) \;=\; P_{i,T-1}^{1-\rho} V_{i,T-1}(x_{i,T-1})$$

It can be shown that this relationship holds at a generic time t, hence the value function and the standardized value function at any point in time only differ by a scale factor. It is equivalent to maximize either function.

A.4 Tables and Figures

Table A.2: Correlation between different measures of income expectations

Dep. var.	Expected hh income	Expected change in hh income
	(1)	(2)
Prob. unempl*work	-21.560***	
	(4.101)	
Prob. finding job*unempl.	5.970	
	(11.790)	
Unemployed	-3203.842***	
	(587.851)	
Hh income	0.832***	
	(0.009)	
Who has a job, will stop		-30066.664
		(35620.656)
Who is out of work, will start		-9025.901
		(46391.410)
Will get a promotion		-29836.115
		(52228.800)
Welfare benefits will go up		-10495.329
		(103266.049)
Welfare benefits will go down		-18828.277
		(44173.080)
Other changes		-14552.987
		(27460.559)
Change job		169346.680***
		(37217.875)
None of the above		20478.029
		(47550.368)
Don't know/no answer		-25293.397
		(119431.906)
Constant	638.469	-39903.980
	(2012.374)	(170920.318)
Other controls	Yes	Yes
Obs.	3,795	7,637

Notes: Dependent variables are: expected income in t+1 (column 1) and difference between expected income in t+1 and observed income in t (column 2). Other control variables are: age, age squared, no. members, no. children, education and year dummies. Mean expected household income in the sample (first column) is 33,099. Average expected change in household income (second column) is 16,500. Column 2 reports the answer to the question: "As a consequence of what changes do you expect the total net income of your household to change in the next 12 months?"; reference category is "No significant changes".

Table A.3: Predictive power of expectations

Dep. var.	**Income in** $t+1$				
	(1)	(2)	(3)	(4)	(5)
Expected income	0.845***	0.495***	0.492***	0.555***	0.554***
	(0.015)	(0.029)	(0.030)	(0.032)	(0.032)
Sq. root income expect. (/1000)				1664.675***	1392.796***
				(373.271)	(348.811)
Exp. income* sq. root				-0.043***	-0.041***
				(0.010)	(0.009)
Hh income		0.382***	0.339***	0.366***	0.327***
		(0.029)	(0.029)	(0.029)	(0.029)
Age			125.668		91.286
			(120.176)		(119.858)
Age sq.			-1.799		-1.424
			(1.265)		(1.260)
No. hh members			1979.578***		1914.858***
			(362.350)		(353.345)
No. children			-2187.382***		-2106.688***
			(448.523)		(435.684)
Educ. low			-512.854		-631.860
			(738.694)		(694.029)
Educ. middle			770.360		537.710
			(726.287)		(685.101)
Educ. vocat.			450.252		269.021
			(711.214)		(680.909)
Educ. college			1700.891**		1692.210**
			(793.034)		(759.614)
Constant	6042.205***	4644.903***	-362.667	3052.981***	-876.262
	(471.413)	(421.881)	(2888.669)	(472.374)	(2871.621)
Year dummies	Yes	Yes	Yes	Yes	Yes
Obs.	2606	2606	2606	2606	2606

Notes: OLS estimate. Errors clustered at the household level.

Table A.4: Permanent and transitory shocks, by cohort (weighted median values)

Permanent shock

Year	Coh 3	Coh 4	Coh 5	Coh 6	Coh 7	Coh 8	Coh 9	Coh 10
2006	-0.012	0.015	-0.007	0.002	0.016	-0.012	-0.006	0.025
2007	0.010	0.009	0.021	-0.002	-0.006	-0.035	0.022	-0.025
2008	0.034	-0.006	0.050	-0.015	0.019	0.038	0.021	0.086
2009	-0.125	-0.020	-0.024	-0.055	-0.036	-0.019	0.012	-0.009
2010		0.001	0.020	-0.005	-0.019	0.029	-0.006	0.025
2011		0.002	-0.021	-0.032	0.010	0.001	-0.041	0.013
2012		-0.031	-0.042	-0.014	-0.039	-0.116	-0.064	-0.066
2013		-0.080	-0.007	-0.037	-0.070	-0.054	-0.043	-0.047
2014		-0.088	-0.040	-0.005	0.010	0.016	-0.001	-0.025
2015			-0.009	-0.029	-0.010	0.058	-0.002	0.008
2016			-0.015	0.048	0.036	0.042	0.022	0.049

Variance of permanent shock variance (pooled data)

$\sigma^2_\zeta = 0.050$

Temporary shock

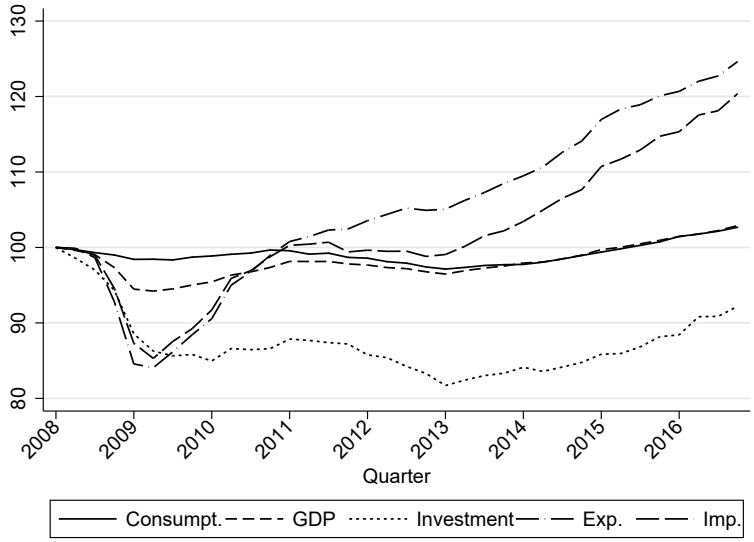
Year	Coh 3	Coh 4	Coh 5	Coh 6	Coh 7	Coh 8	Coh 9	Coh 10
2006	-0.048	-0.060	-0.060	-0.064	-0.058	-0.064	-0.059	-0.046
2007	-0.064	-0.062	-0.037	-0.067	-0.038	-0.038	-0.031	-0.040
2008	-0.027	-0.039	-0.034	-0.029	-0.049	-0.022	-0.040	-0.053
2009	0.075	-0.026	-0.024	-0.017	-0.026	0.031	-0.012	-0.055
2010		-0.015	-0.011	-0.032	0.000	0.006	0.004	-0.019
2011		0.008	0.020	0.016	0.018	0.029	0.021	0.005
2012		0.054	0.060	0.042	0.056	0.055	0.031	0.050
2013		0.097	0.075	0.062	0.071	0.072	0.078	0.083
2014		0.106	0.070	0.074	0.077	0.070	0.090	0.089
2015			0.070	0.080	0.084	0.084	0.078	0.078
2016			0.080	0.078	0.086	0.090	0.066	0.088

Variance of temporary shock variance (pooled data)

$\sigma^2_\varepsilon = 0.035$

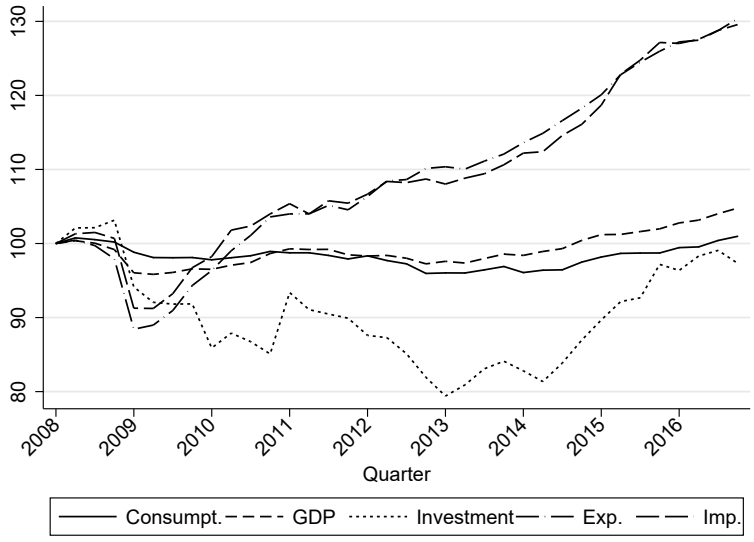
Notes: Coh 1: year of birth lower than 1935; Coh 2: year of birth 1935-39; Coh 3: year of birth 1940-44; Coh 4: year of birth 1945-49; Coh 5: year of birth 1950-54; Coh 6: year of birth 1955-59; Coh 7: year of birth 1960-64; Coh 8: year of birth 1965-69; Coh 9: year of birth 1970-74; Coh 10: year of birth 1975+. Sample size for each cell is > 55 observations. Real values (euros 2010).

Figure A.1: GDP and main demand components: Euro Area



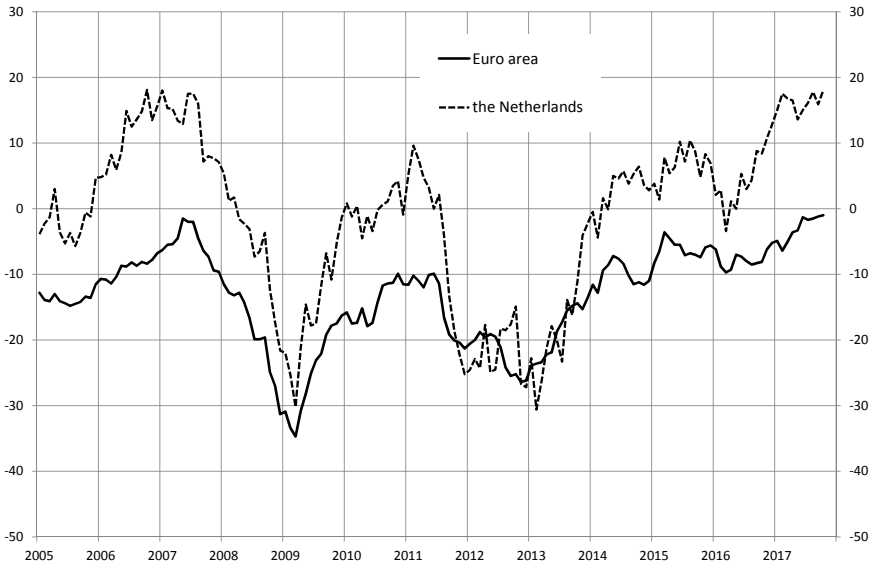
Notes: Our calculations from Eurostat quarterly data (2nd November 2017); indices, 2008-Q1=100

Figure A.2: GDP and main demand components: the Netherlands



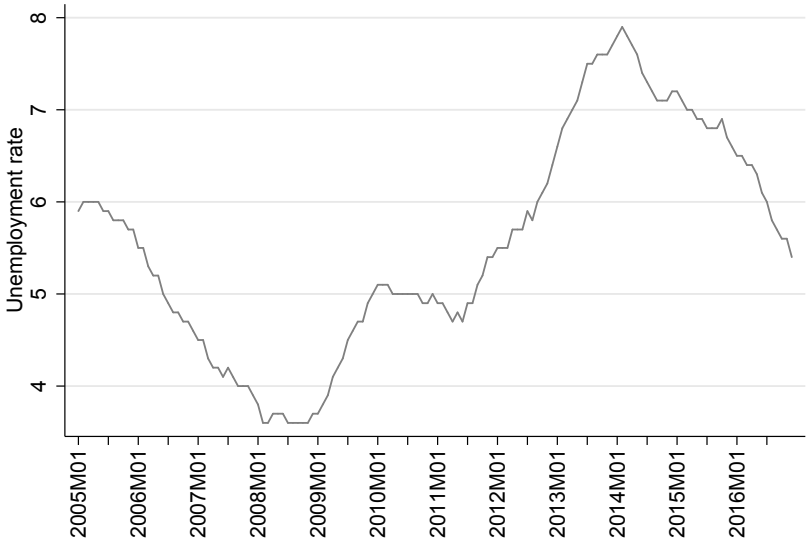
Notes: Our calculations from Eurostat quarterly data (2nd November 2017); indices, 2008-Q1=100

Figure A.3: Consumer confidence index in the euro area and the Netherlands



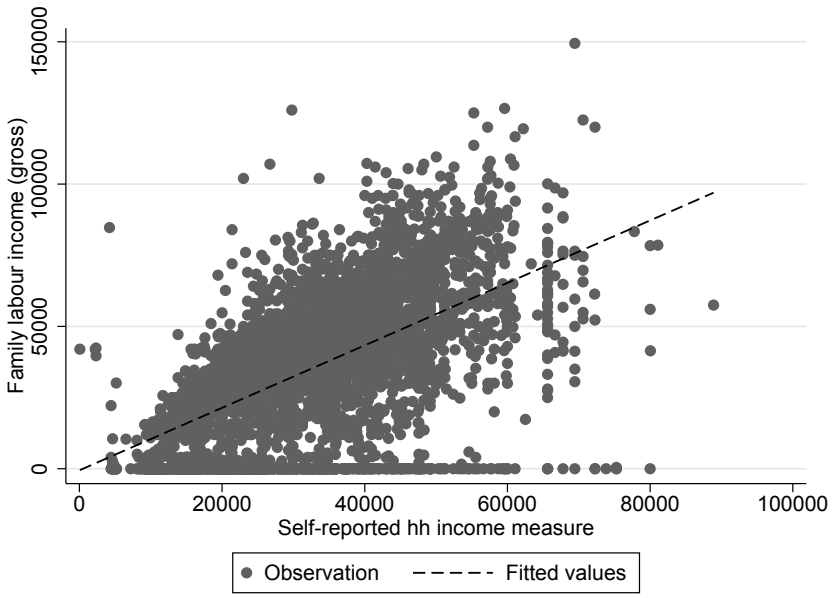
Notes: Consumer confidence (European Commission), monthly data.

Figure A.4: Unemployment rate in the Netherlands



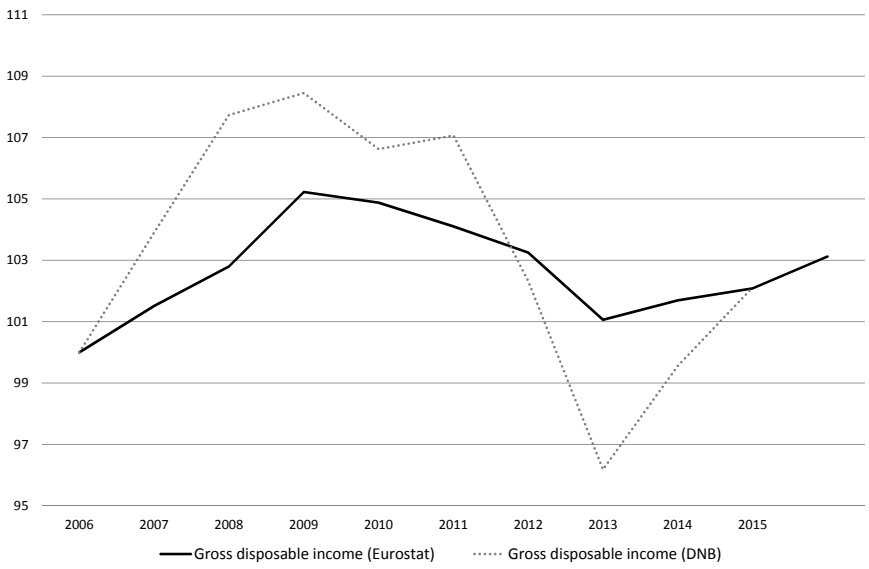
Source: Eurostat.

Figure A.5: Correlation between self-reported net household income and salary



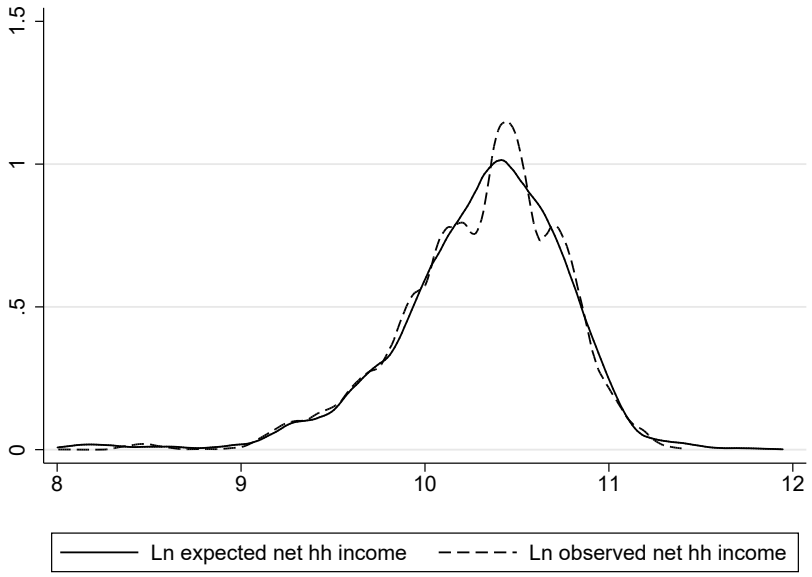
Notes: One observation per household-year. The estimated regression line is $y = -879 + 1.11x$; the coefficient on x is significant at the 1% level.

Figure A.6: Gross disposable income: micro and macro data (2006=100)



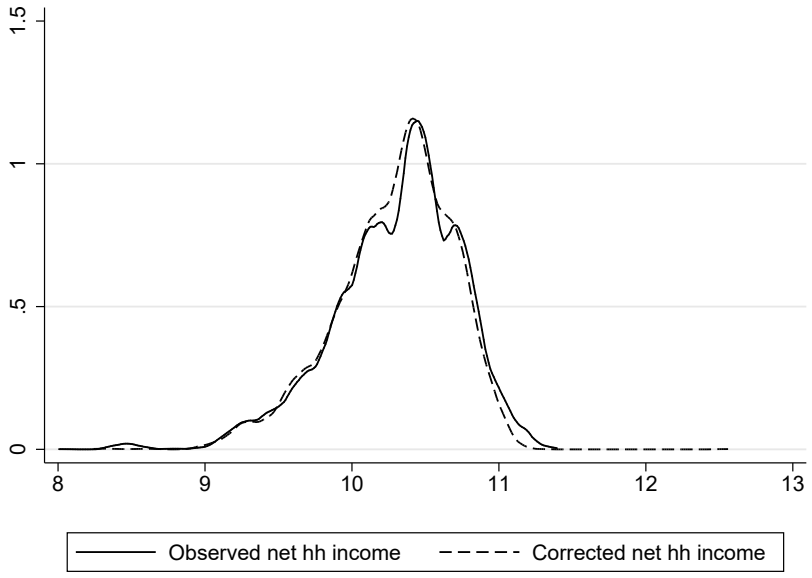
Notes: Real values (euros 2010). Moving averages of two terms. Data for DHS refers to t-1, where t is the year of the interview.

Figure A.7: Distribution of logarithm of observed and expected income



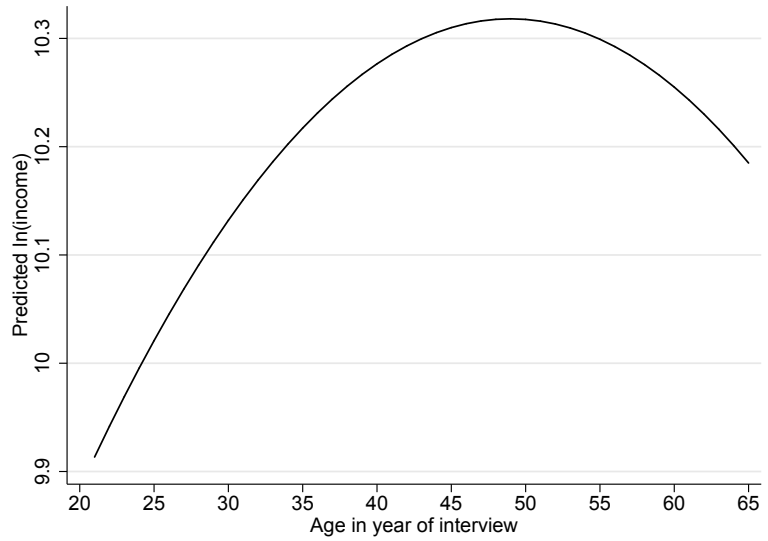
Notes: Pooled cross-section.

Figure A.8: Distribution of logarithm of observed and corrected income



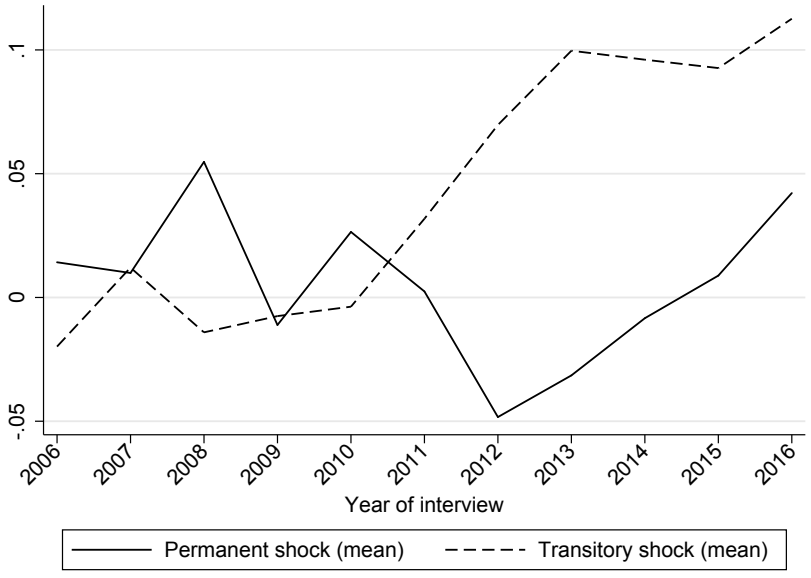
Notes: Pooled cross-section.

Figure A.9: Estimates of the deterministic component of ln(income)



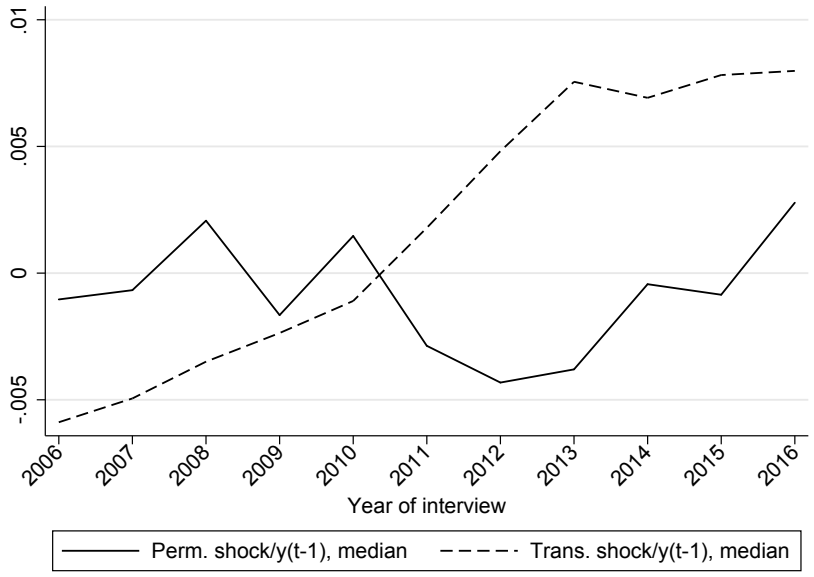
Notes: Our calculations from DHS Household survey.

Figure A.10: Permanent and transitory shocks: average



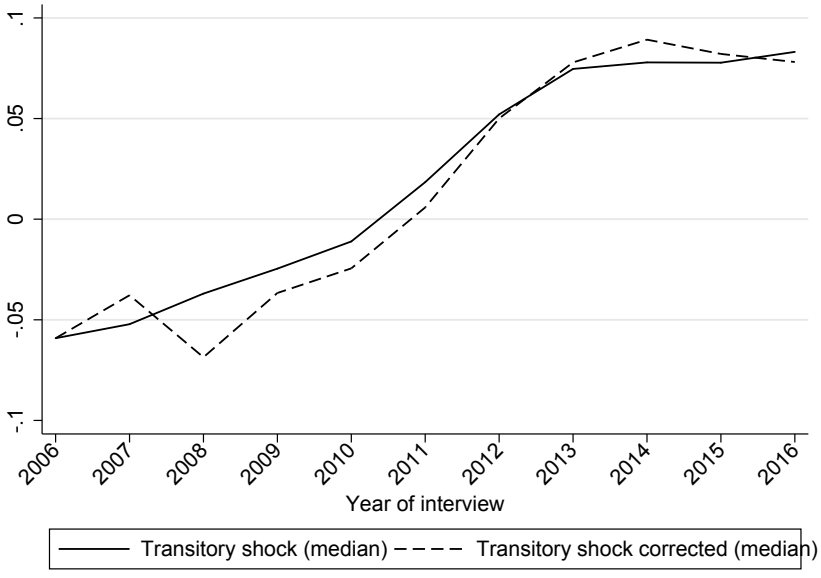
Notes: Real values (euros 2010). Weighted mean.

Figure A.11: Permanent and transitory shocks/ income in $t-1$



Notes: Real values (euros 2010). Weighted mean.

Figure A.12: Transitory shock: based on calendar year and past 12 months



Notes: Corrected shock: Observed income is the average of the last 12 months and not referred to calendar year. As for permanent shocks, the difference between the week of the interview is larger than 12 weeks for only 15% of the sample; it is less than 4 weeks for 50% of the sample. Weighted median.

Figure A.13: Transitory shocks: Distribution over time

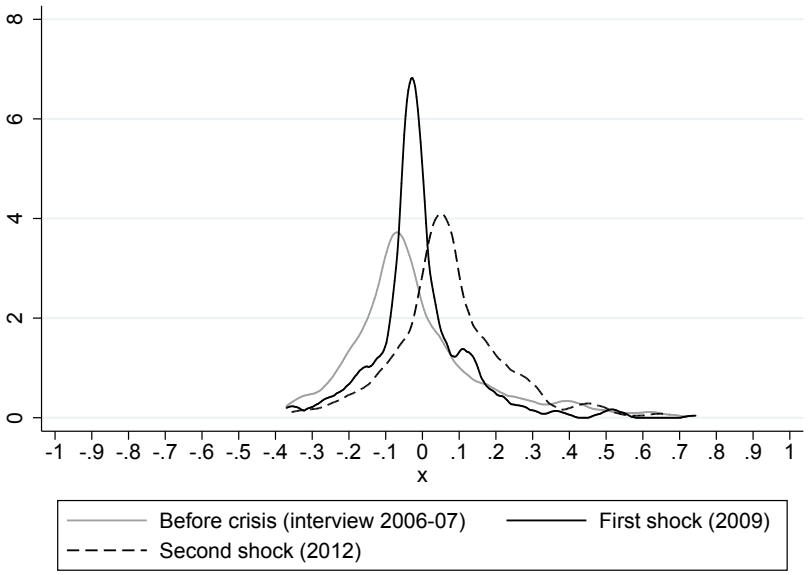


Figure A.14: Permanent shocks: Distribution over time

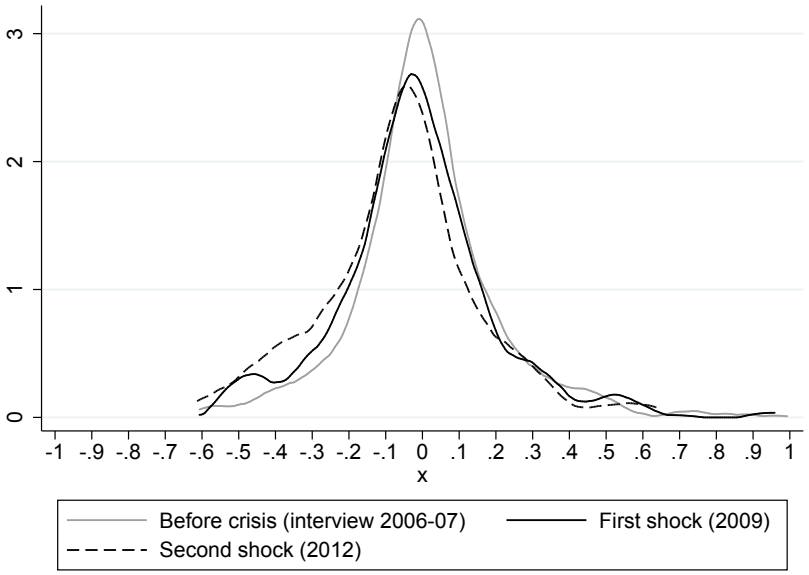
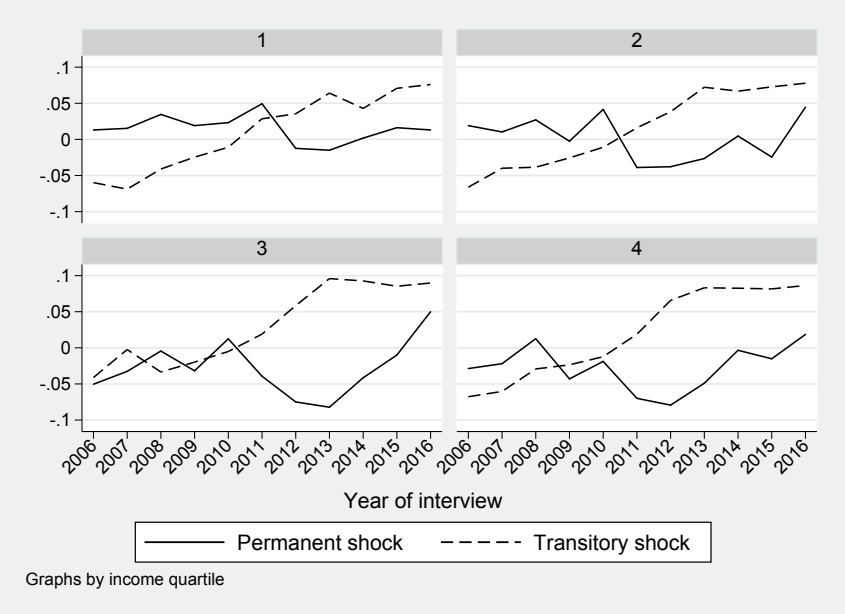
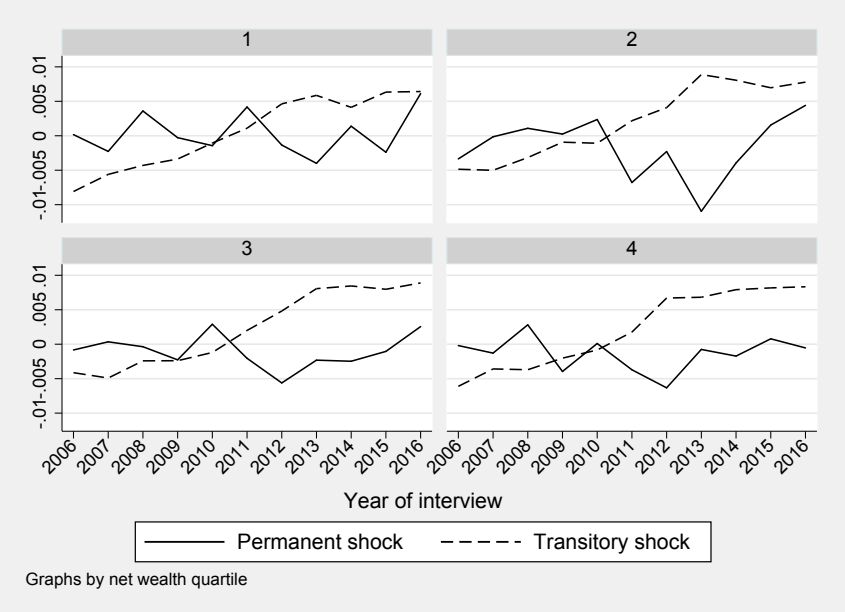


Figure A.15: Permanent and transitory shocks: Distribution across income quartiles in t-1



Notes: Weighted median.

Figure A.16: Permanent and transitory shocks/ income in $t-1$: Distribution across income quartiles



Notes: Weighted median.