EUROSÜSTEEM

Consumption Sensitivities in Estonia: Income Shocks of Different Persistence

Merike Kukk, Dmitry Kulikov, Karsten Staehr

Working Paper Series

3/2012

The Working Paper is available on the Eesti Pank web site at:
www.bankofestonia.ee/pub/en/dokumendid/publikatsioonid/seeriad/uuringud/

For information about subscription call: +372 668 0998; Fax: +372 668 0954
e-mail: publications@eestipank.ee

ISBN 978-9949-493-05-0
Eesti Pank. Working Paper Series, ISSN 1406-7161

Consumption Sensitivities in Estonia: Income Shocks of Different Persistence*

Merike Kukk, Dmitry Kulikov and Karsten Staehr**

Abstract

The Permanent Income Hypothesis (PIH) entails that consumption reacts more strongly to persistent than to temporary income shocks. This prediction is tested using data from the Estonian Household Budget Surveys for 2002–2007. The dataset contains questions which make it possible to distinguish between persistent and temporary income shocks based on the households' own assessment. The estimations confirm that the marginal propensities to consume out of the two income shocks differ, households are forward-looking and seek to smooth consumption. Moreover, the estimated propensities of persistent shocks are of reasonable magnitudes, consistent with the PIH. Further analysis reveals, however, features that are in breach of the PIH. The consumption estimations are affected by lagged temporary income shocks. When income shocks are decomposed into positive and negative values, there is evidence of excess sensitivity to positive temporary shocks.

JEL Code: D12, E21, R22

Keywords: consumption, Permanent Income Hypothesis, income persistence, consumption smoothing, rule-of-thumb consumption

Corresponding author's e-mail addresses: karsten.staehr@eestipank.ee, karsten.staehr@tseba.ttu.ee

The views expressed are those of the authors and do not necessarily represent the official views of Eesti Pank.

* The authors would like to thank Arvo Valtin from Statistics Estonia for help on many data issues and seminar participants at Eesti Pank for useful comments. All errors remain the responsibility of the authors.

** Merike Kukk is a Researcher at the Tallinn University of Technology, Dmitry Kulikov is a Senior Economist at Eesti Pank and Karsten Staehr is a Professor at the Tallinn University of Technology and a Research Supervisor at Eesti Pank.

Non-technical summary

The consumption dynamics of households is important for microeconomic welfare analysis as well as macroeconomic policy study. It is therefore vital to obtain detailed knowledge of the consumption behaviour of households, including the reaction of household consumption to income changes. Using the Permanent Income Hypothesis (PIH) as the theoretical starting point, this paper analyses how households in Estonia reacted to income shocks of different persistence.

The main innovation of the analysis is the use of the Estonian Household Budget Survey (HBS) which allows a decomposition of income shocks into high-persistence regular shocks and low-persistence temporary shocks based on information from the interview of the individual household. This eliminates the need for restrictive statistical decomposition, which typically utilises PIH assumptions regarding the co-movements of consumption and income.

The data sample consists of 2351 households interviewed twice during the period 2002–2007, i.e. a period of rapid economic growth and increasing household income in Estonia. The regular income shock is derived directly from the answers of the households. The temporary income shock is derived from temporary income defined as the difference between the current and regular income. In order to assess the properties of the self-reported income measures, different empirical methods are used to produce approximate estimates of their persistence. The analyses show that Estonian households diligently assess the persistence of the two income measures; shocks to regular income are very persistent, while shocks to temporary income exhibit little persistence.

The starting point for the consumption estimations is a model with regular income shocks and contemporaneous temporary income shocks. The results of this parsimonious specification are generally supportive of the PIH. The sensitivity of consumption to regular income shocks is significantly higher than the sensitivity to temporary shocks. Moreover, the sensitivity of regular income shocks is consistent with the estimated degree of persistence of this variable. The estimations are robust to different consumption measures, to different degrees of persistence of the income processes and the inclusion of additional control variables.

The PIH posits that households are forward-looking, which entails that contemporaneous consumption does not react to *lagged* temporary income shocks. The estimations reveal, however, that consumption reacts to the lagged temporary income shock when this variable is included in the estimations. This implies that changes in the Estonian household consumption dur-

ing the boom years of 2002–2007 cannot be fully explained by forward-looking behaviour as hypothesised by the PIH. The coefficient of the lagged temporary shock is negative and, in numerical terms, close to the coefficient of the contemporaneous temporary income shock.

One explanation of the finding that consumption reacts to changes in temporary income is the presence of proportional or *rule-of-thumb* consumption, which entails a backward-looking behaviour according to which changes in consumption simply react to income changes. The computations suggest that substantially less than half of the results show behaviour consistent with the PIH, while substantially more than half of overall consumption can be attributed to rule-of-thumb behaviour. The calculations, however, are based on restrictive assumptions and subject to substantial uncertainty.

When positive and negative income shocks are included separately, the reaction of consumption to regular income shocks is symmetric, but the reaction to temporary income shocks is highly asymmetric. Households appear to smooth consumption in case of negative temporary income shocks, but not in case of positive temporary income shocks. The latter finding is not consistent with the PIH and cannot easily be explained by theories incorporating liquidity constraints.

The study contributes to the empirical literature on consumption behaviour by analysing consumption smoothing in a fast-growing emerging-market economy and by making use of self-reported information on the persistence of income shocks. In spite of the unique sample and shock identification, the results are broadly in line with findings in earlier studies. Households react differently to income shocks of different persistence as predicted by the PIH, but they also react to lagged income changes which is not predicted by the PIH. The findings using the rule-of-thumb model are in accordance with previous studies, although the fraction of household consumption derived from rule-of-thumb behaviour is relatively large.

Estonia experienced very rapid economic development during the sample years 2002–2007; incomes grew at a fast rate and financing possibilities developed rapidly. In spite of the extraordinary economic changes experienced in Estonia, households appear to have formed expectations and made consumption decisions in ways comparable to experiences from countries with a more stable economic environment. As data are not available from the deep recession experienced by Estonia in 2008–2009, it is not readily examined whether the same pattern continued during the downturn or whether the findings reflect factors that are unique for the upturn.

Contents

[A]lthough the agent may be able to discriminate between a transitory and a permanent shock, the econometrician is not. As a result, econometric identification of separate income shock components is difficult in the extreme."

Pistaferri (2001, p. 465)

1. Introduction

This paper studies the response of consumption to income shocks of different persistence using data from a panel of Estonian households for the period 2002–2007. The dataset permits a distinction between income shocks that are judged by households to be persistent and income shocks that are likely to be to be short-lived. Unlike most previous studies, the decomposition of income shocks relies on the households' own assessment and is therefore free of theory-based restrictions that are otherwise needed to identify income shocks of different persistence.

The insight that the reaction of consumption to income shocks depends on their persistence follows from the Permanent Income Hypothesis (PIH) developed by Friedman (1957). According to the theory, households respond one-to-one to income shocks that are expected to have a permanent impact, while the consumption response to transitory income shocks is negligible: they are smoothed through saving and dissaving. Since Friedman (1957), numerous studies have sought to provide estimates of consumption sensitivities to different income shocks in order to gain a better understanding of the factors that affect consumption.

It is challenging to devise empirical tests of the PIH, including tests entailing the estimation of the response of consumption to income shocks of different persistence. The main reason is that when an income innovation of a household is observed, the amount of ancillary information on the persistence of the income change is usually limited. Three different ways to decompose income shocks into components of different persistence have been devised in the literature.

One approach is to use quasi-experimental data in which specific episodes of income changes can be classified according to their expected impact on the income path of the households. Another approach relies on model-based or statistical decomposition of observed income shocks into permanent and transitory components. Such econometric identification requires either very long time series or additional restrictive assumptions about the co-movement of

consumption and income, cf. also the citation above by Pistaferri (2001). Finally, it might be possible to deduct the degree of income shock persistence directly from information provided by the individual household. The use of self-reported assessments on the degree of persistence of income shocks is very rare in the literature as the information is typically not available in household surveys.

This paper uses the latter approach as the Estonian Household Budget Survey (HBS) uniquely permits a decomposition of the income stream of the individual household into two distinct categories: one that the household expects to have a long-lasting impact on its income, and one that the household expects to be of a transient nature. Using supplementary statistical evidence, we argue that Estonian households indeed split their income streams according to this classification as the dynamics of the two income categories are markedly different. It enables us to study the consumption response of Estonian households to income shocks of different persistence and to test whether the behaviour is consistent with the PIH.

The paper also offers a detailed view on the microeconomic underpinnings of the household consumption behaviour in an environment characterised by a high degree of macroeconomic volatility and uncertainty. A panel of Estonian households used in this study has experienced a rapid increase in the living standards throughout the period of 2002 to 2007, against the backdrop of high inflation and booming real estate prices, coming to an abrupt end in the second half of 2007. This macroeconomic environment offers an outstanding setting for testing the implications of the PIH founded on a forward-looking optimising behaviour of rational agents.

The rest of the paper is organised as follows: Section 2 provides a brief overview of the theoretical and empirical literature on consumption sensitivity to income changes. Section 3 shows the implications of the PIH when the income stream consists of components that are characterised by different impact on the household's long-run income. Section 4 introduces the Estonian HBS data and examines the nature of income innovations that are identified using the ancillary survey information. Section 5 gives the results of three empirical tests of the PIH using identified income shocks. Finally, Section 6 summarises the empirical findings.

2. Consumption response to income shocks: a brief literature overview

The main *theoretical* insight of the PIH as developed in Friedman (1957) is that the reaction of consumption to income shocks depends on their impact

on expected future income. Further elaborations and analytical solutions of the PIH emerged in Hall (1978), Flavin (1981) and Hall and Mishkin (1982). The PIH postulates that households smooth their consumption profile over time, an outcome that follows from the standard framework, where a representative household maximises its expected lifetime utility given the future income stream. The optimal outcome ties the level of consumption in each time period to the discounted stream of all future expected resources available to the household.[1]

The PIH implies that the consumption of the individual household is not directly tied to its current income, but instead to the informational update that the current income brings about the future income stream. After receiving new information about the change in its permanent income, the household fully adapts its consumption profile to the new circumstances. On the other hand, when new information entails a one-period shift in the income stream with a limited effect on lifetime earnings, the household absorbs this income innovation through saving or dissaving, without changing its consumption level. These two scenarios are commonly known as permanent vs. transitory income shocks.

The *empirical* strategy for testing the PIH is therefore based on the ways of classifying unexpected income fluctuations into different categories according to their anticipated impact on the household's permanent income.[2] The latter is not observed in empirical data and remains largely a theoretical construct. Japelli and Pistaferri (2010a) provide a comprehensive overview of empirical literature using a menu of approaches to classify observed income changes into permanent and transitory shocks and test the implications of the PIH.

In *quasi-experimental* data the reaction of households to specific episodes of income changes is used to disentangle the effect of permanent and transitory shocks. In some episodes the observed income changes are regarded transient, such as temporary unemployment, one-off tax refunds or weather shocks, while in other episodes they are viewed as long-lasting, such as major health problems. A drawback of quasi-experiments is that they tend to focus on one specific income change, whereas households are likely to be subject to several shocks at the same time and their reactions to a particular episode may be affected by other income innovations of a potentially different kind.

[1] The consumption level predicted by the PIH is sometimes defined as permanent income, although Friedman appears to have produced several alternative definitions (Chao (2003)).

[2] Another large strand of the empirical literature on the PIH is known under the banner of "excess sensitivity tests". It tests sensitivity of changes in current consumption to past information which should be zero under the assumption of rational expectation. Japelli and Pistaferri (2010a) offer a recent overview of this literature.

A model-based *econometric decomposition* of the observed income variations into permanent and transitory components was pioneered in the seminal paper of Hall and Mishkin (1982). They derive from the PIH a set of variance-covariance restrictions between changes of consumption and income across different time periods and furthermore impose the assumption that the household's income stream consists of two parts: a difference-stationary component with innovations that persist indefinitely and a covariance-stationary component whose innovations dissipate over time. Hall and Mishkin (1982) use data from the US Panel Study of Income Dynamics (PSID) and a derived set of restrictions to estimate the response of household consumption to these two types of innovations. They find partial support for the PIH when 80% of the households consume a constant share of their permanent income, while the remaining 20% follow the *rule-of-thumb* proportional consumption model.

Quah (1990) uses the same model-based decomposition of the income process to derive implications for the *aggregate* income and consumption time series. In particular, he relies on the spectral density properties of income changes under the assumption of one difference-stationary component and one covariance-stationary component to argue that smoothness of the observed aggregate consumption series is not inconsistent with considerably more volatile aggregate income, as previously claimed in *Deaton's paradox* by Deaton (1987).

The model-based decomposition of income shocks, and its implied links with consumption changes have also been used by Blundell et al. (2008) to study the evolution of income and consumption inequality using the PSID and the Consumer Expenditure Survey (CEX) for the period 1978–1992. They document the sensitivity of consumption to permanent and transitory income shocks across different education and age cohort groups, and find that the estimated response coefficients of the permanent shock vary from 0.6 to 1, while those of the transitory shock remain statistically indistinguishable from zero.

Applying a similar methodology, Japelli and Pistaferri (2010b) use the Bank of Italy Survey of Household Income and Wealth (SHIW) for the period 1987–2006 to examine the benefits of the financial integration within the EMU in terms of potential improvements of households' ability to smooth their consumption in the face of unanticipated income fluctuations. They find that household consumption responses are not statistically different in the pre-EMU and post-EMU sub-samples, with the estimated consumption sensitivity in the range of 0.7 to 1.0 with respect to the permanent income shock, and from 0 to 0.3 with respect to the transitory one.

We have found only one paper that uses *self-reported identification* of the persistence of income shocks, namely Pistaferri (2001). The households surveyed in the Italian SHIW for 1989–1991 reported their income in the survey year and their expectation of income in the following year. Based on this subjective information *and* additional assumptions on the development of household income across the life-cycle, income shocks can be decomposed into temporary and persistent shocks. Pistaferri (2001) found no excess sensitivity to transitory income shocks, while the estimated sensitivity of permanent shocks was 0.57.[3]

3. Theoretical framework

The Permanent Income Hypothesis follows directly from the solution of the intertemporal maximisation problem of a household which receives an exogenous stream of income in the current and future periods. We consider a simple model in discrete time with an infinite time horizon.

The consumption of household *i* in period *t* is denoted C_{it} and its exogenous income is Y_{it}. The household chooses a consumption path in order to maximise the discounted expected utility given a discount rate which is equal to the constant real interest rate *r*. With a quadratic period utility function, the optimal consumption level in period *t* is then a share $r/(1+r)$ of the discounted current and future income as expected by the household in period *t* (Flavin (1981)):

$$C_{it} = \frac{r}{1+r}\sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^{j} \mathrm{E}_{it} Y_{it+j} \tag{1}$$

The term $\mathrm{E}_{it} Y_{it+j}$ denotes household *i*'s expected income in period $t+j$ conditional on information available in period *t*. The solution in eq. (1) entails that the household smoothes consumption across all periods. Consumption only changes between periods if new information regarding the future income stream of the household becomes available. If there is a revision of expectations between two time periods, consumption responds in the following way:

$$\Delta C_{it} = \frac{r}{1+r}\sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^{j} \left[\mathrm{E}_{it} Y_{it+j} - \mathrm{E}_{it-1} Y_{it+j}\right] \tag{2}$$

[3] Jappelli and Pistaferri (2000) also use subjective income expectations, but test for excess sensitivity to *predicted* income innovations.

The *change* in the consumption of household *i* from period $t-1$ to period *t*, ΔC_{it}, is proportional to the *change* in the discounted sum of income in all future periods (including the current period). The impact on consumption of income changes is thus directly linked to their impact on expected future income. Income innovations or income shocks may have very different persistence. Shocks with high persistence have a large impact on the expected future income and, hence, on consumption. On the other hand, shocks with low persistence have a limited impact on expected future income and, hence, on consumption.

It is customary to consider income streams taking the form of AR(1) processes where the autoregressive coefficient captures the degree of persistence. It is furthermore customary to assume that the total income can be decomposed into only two AR(1) processes with different autoregressive coefficients.[4] This division into two components follows the framework used for the income process with permanent and transitory components pioneered by Friedman (Chao (2003)).

$$\begin{aligned} Y_{it} &= Y_{it}^{H} + Y_{it}^{L} \\ Y_{it}^{H} &= \rho^{H} Y_{it-1}^{H} + \xi_{it}^{H} \\ Y_{it}^{L} &= \rho^{L} Y_{it-1}^{L} + \xi_{it}^{L} \end{aligned} \tag{3}$$

The income of household *i* in period *t*, Y_{it}, is the sum of the high-persistence component Y_{it}^{H} and the low-persistence component Y_{it}^{L}. The high-persistence component Y_{it}^{H} has the autoregressive coefficient $\rho^{H} \in [0,1]$ and a white noise shock ξ_{it}^{H}. In the case of a widely used assumption that $\rho = 1$, the high-persistence component follows a martingale implying that income shocks never die out. The low-persistence component Y_{it}^{L} has the autoregressive coefficient $\rho^{L} \in [0,1]$ and a white noise shock ξ_{it}^{L}. In case of the widely used assumption that $\rho^{L} = 0$, income shocks die out immediately. The labelling of the two different income components makes it natural to assume that $\rho^{H} > \rho^{L}$.

Expressing eq. (2) with the two income shocks defined in eq. (3) leads to the following equation:

$$\Delta C_{it} = \frac{r}{1+r}\frac{1+r}{1+r-\rho^{H}}\xi_{it}^{H} + \frac{r}{1+r}\frac{1+r}{1+r-\rho^{L}}\xi_{it}^{L} \tag{4}$$

[4] In the literature the two components of the income process are often labelled as permanent and transitory. However, as these income components are not truly permanent and transitory as in the PIH framework, we use the labels shocks of high persistence and shocks of low persistence to avoid confusion with truly permanent and transitory shocks.

Eq. (4) implies that the magnitude of the response of consumption to income shocks depends on their persistence (ρ^H and ρ^L, respectively) and the real interest rate *r*. As it is assumed that $\rho^H > \rho^L$, the PIH predicts that consumption changes should be more sensitive to the high-persistence shock ξ_{it}^H than to the low-persistence shock ξ_{it}^L. To gain an idea of the quantitative importance of the size of the persistence coefficient, Table 1 shows some examples of the consumption sensitivity to income shocks of different persistence computed from eq. (4).

Table 1: Theoretical coefficients for income shocks of different persistence

Persistence coefficient	1.0	0.95	0.9	0.8	0.6	0.4	0.2	0
Theoretical consumption response to income shock	1.0	0.444	0.286	0.167	0.091	0.063	0.048	0.038

Note: Authors' calculations using the assumption that the annual real interest rate is 4%.

It follows from Table 1 that the consumption sensitivity according to the PIH decreases fast when persistence falls below 1 as the sum of discounted future earnings is very different depending on whether the discount factor is 1 or smaller. Already when the persistence coefficient is 0.9 the theoretical consumption sensitivity is less than 0.3. If the persistence coefficient is 0, the consumption response to the income shock is $r/(1+r)$, i.e. the response is negligible with reasonable values of the real interest rate. Similarly, a shock with an autoregressive coefficient equal to 0.20 dies out very fast, implying that it has a very modest effect on lifetime earnings and consumption response does not differ remarkably from the impact of a stochastic shock (4.8% and 3.8%, respectively).

4. Dataset and identification of income shocks

4.1. The Estonian Household Budget Survey

The empirical consumption response models in Section 5 make use of the household-level information on consumption and income contained in the Estonian Household Budget Survey (HBS). This survey has been conducted annually from 2002 to 2007 by Statistics Estonia, using a unified statistical

methodology, which is outlined below and described in detail in ES (2012).[5] The rolling panel part of the Estonian HBS, used for empirical consumption modelling in this paper, consists of several thousand pairs of household observations on durable and non-durable consumption, different types of income, and various ancillary characteristics. The cross-sectional part of the Estonian HBS has previously been used by Kulikov et al. (2009) in an exploratory study of Estonian households' saving behaviour.

Each annual wave of the Estonian HBS in 2002–2007 comprises a representative cross-section of the Estonian households. The primary annual sample design is based on regional stratification, making it possible to obtain an adequate coverage of some sparsely populated Estonian regions. In addition, the annual survey sample is a rolling panel: the first half of it consists of households newly drawn from the population registry, while the second half is made up by re-interviewing the previous year's first half. The data collection takes place in a sequence of twelve consecutive rounds, each corresponding to one calendar month and covering 1/12 of the full annual sample. As a result of this survey design, the available time dimension of our panel is limited to two observations per household, spaced apart by exactly one calendar year. Due to the sample attrition and changes in response rates across different survey waves, the number of re-interviewed and newly drawn households displays some variations from year to year.

The Estonian HBS contains a detailed breakdown of the monthly income and consumption figures of each household. The after-tax household income is composed of wage income, business-related income, property income, transfers and other income sub-categories. The total spending on household consumption is the sum of spending on twelve individual consumption expenditure groups; cf. the COICOP/HICP categories (Eurostat (2012a)).

The empirical consumption models in this paper use two distinct monthly household income totals available in the survey: the *current* monthly after-tax household income containing the sum of five income sub-categories described above, and the self-reported *regular* after-tax income. The former reflects a slew of all possible idiosyncratic income variations afflicting the household in a particular calendar month, while the latter can be viewed as an estimate of the average monthly household income over a longer time period.[6]

---

[5] The survey was discontinued in 2008–2009 due to funding constraints and re-started again in 2010 using a different sampling methodology. More information on the survey, including the list of official publications and methodology notes on both the pre-2008 and post-2009 samples, can be found on the homepage of Statistics Estonia: www.stat.ee/households.

[6] The question about regular income contained in the survey was the following: "What is the regular amount of money at the disposal of your household during one month, taking into

The two separate household income totals contained in the survey give an opportunity to disentangle long-term income changes from its short-term fluctuations using the households' own perceptions. The methodology used to identify household income shocks will be covered in detail in Subsection 4.2.

On the consumption side, this paper takes advantage of two household consumption figures provided by the survey: the full monthly household consumption that covers all twelve COICOP/HICP sub-groups, and the non-durable monthly household consumption containing the sum of expenditures on food, non-alcoholic and alcoholic beverages, tobacco, clothing and footwear, housing (excluding regular maintenance and repair), transport services and fuel, newspapers, books and magazines, pet food, hotels and eating-out. Most of our results in Section 5 are based on the non-durable consumption measure, which is standard practice in the empirical consumption literature.[7] We also undertake robustness checks of the main findings using the total monthly household consumption figures.

In line with our theoretical setup and the empirical literature in the field, we convert all nominal income and consumption variables contained in the survey to real values. To this end, the monthly HICP price index spanning the period 2002–2007 is used as a deflator (Eurostat (2012b), variable name: *prc_hicp_midx*, index 2005 = 1).[8] To avoid that outliers affect results unduly, we follow the convention in empirical consumption studies and express the consumption and income variables in logarithms.

Table 2 shows summary statistics of the main consumption and income variables. Here and henceforth we use the following subscripts: i indexes an individual household in the panel; separate observations of each individual household are in turn indexed by t, where in this paper $t \in \{1, 2\}$ because the Estonian HBS is limited to two observations per household. In this notation, t is a notional time subscript; a link to the calendar time of the interview, as a way of capturing seasonal and business-cycle effects, is achieved by in-

consideration all kinds of income?" This question was asked after the household had stated its current monthly income and consumption amounts.

[7] The dynamics of durable consumption is in general different from the non-durable one; cf. Bertola and Caballero (1990). Since durable consumption goods deliver a stream of services lasting for many time periods, the correct way to account for it is to impute these service streams using some empirical procedure. We do not pursue this route, opting instead for a simpler way of separating the two kinds of consumption expenditures in our empirical models.

[8] We also experimented with household-specific price indices as suggested in Attanasio and Weber (1995). The resulting change in our empirical consumption models was, however, marginal and the main conclusions remained the same. To facilitate comparison with most other studies in the field, the economy-wide consumer price index is used to deflate the nominal variables.

cluding a set of annual dummies in our empirical consumption models in Section 5.

Table 2: Main variables in the dataset, household-specific data

Variable	Definition	Mean	St. dev.
$\log C_{it}^{tot}$	Logarithm of real monthly total consumption expenditures, in EEK	8.952	0.680
$\log C_{it}^{nd}$	Logarithm of real monthly non-durable consumption expenditures, in EEK[a]	8.494	0.595
$\log Y_{it}$	Logarithm of real monthly after-tax income in EEK	9.151	0.636
$\log Y_{it}^{reg}$	Logarithm of real regular monthly after-tax income in EEK	9.018	0.558
$\log Y_{it}^{temp}$	Logarithm of real temporary monthly after-tax income; $\log Y_{it}^{temp} \equiv \log Y_{it} - \log Y_{it}^{reg}$	0.133	0.361

Notes: During the sample period, the kroon (isocode EEK) was the currency in Estonia; the exchange rate was fixed at 15.65 EEK per 1 EUR.

[a] *Expenditures on non-durable consumption include expenditures on food, alcohol, clothes and footwear, non-durable housing expenses, public transport and fuels, journals and magazines, pet food, eating out, travel and tourism expenses.*

Beyond the variables directly stemming from the Estonian HBS, the last row of Table 2 also includes a measure of the *temporary income* of the household. This variable is the difference between the household's current income and its regular income in a particular month. Equivalently, $\log Y_{it}^{temp}$ is defined as $\log Y_{it}^{temp} \equiv \log Y_{it}^{cur} - \log Y_{it}^{reg}$.

Apart from income and consumption data, the Estonian HBS contains a wealth of information about different household characteristics, including socio-demographic attributes (age of the household head, family size), variables for consumption characteristics (dummies for above-average or below-average level) and indicators of economic affluence (participation in the labour market, property ownership flags, liquidity position). A brief summary of these ancillary variables, which are used as control variables in the empirical models in Section 5 of this paper, is given in Table A.1 in Appendix A.

There are 30127 observations in the pooled HBS dataset across the survey waves from 2002 to 2007. This number includes a total of 8797 households (17594 pooled observations) which have been interviewed twice in a rolling panel fashion across two consecutive survey waves, and which comprise the original panel portion of the dataset subject to further sample reductions.

By far the biggest cause of sample reduction is empty income and expenditure records because of missing values in the relevant parts of the survey.

The second biggest reason for reducing the number of observations is the difference of household head characteristics between the two household observations in the panel.[9] Furthermore, all households classified as self-employed are excluded from the final analysis: this happens when a share of their business-related income in the total monthly income exceeds the cut-off threshold of 20%. The income of self-employed households is deemed to be too volatile and subject to potentially large measurement errors.[10] Following the same argument a few observations with property income exceeding 20% of total income are also excluded.[11] Finally, all observations where the household head is classified as "inactive" on the labour market in any of the two time periods are removed from the final analysis.[12] After all sample reductions, the final panel contains observations on 2351 individual household units, each one observed at two distinct time periods separated by one calendar year, for a total of 4702 panel observations.

4.2. Identification of income shocks in the Estonian HBS

A unique feature of the Estonian HBS, that sets it apart from many other micro-econometric datasets in the empirical consumption literature, is the availability of two different household-specific income measures: the current monthly household income, $\log Y_{it}^{cur}$, and the self-reported regular monthly income, $\log Y_{it}^{reg}$. We make use of these two variables to compute empirical measures of the high- and low-persistence income shocks, as postulated by our theoretical framework in Section 3.

The empirical strategy used in Section 5 to test the PIH relies on identification of two income shocks of different persistence, which feed into the in-

[9] This difference can be caused by a recording error, a genuine switch of the household head, defined in the survey as a household member that contributes the biggest share of the current household income, or by a particular survey design feature, whereby the interviewer revisits dwelling units, triggering an error when a household changes its residence after the first sampling. Details on the exact filtering procedure used to carry out the comparison of household head characteristics across the pairs of panel observations are available on request from the authors.

[10] Hurst et al. (2010) refer to income underreporting of self-employed households in U.S. household surveys. Krueger and Perri (2010) document substantial differences in the observed labour income volatility between self-employed and non-self-employed household in the PSID and SHIW datasets.

[11] This income category includes rents from owned land and real estate, interest income on deposits and investments, and the intellectual property income. For the rest of the observations, property income comprises on average less than 0.2% of households total income and therefore should not markedly affect the estimations.

[12] This partly addresses issues related to the possible non-separability of consumption and leisure in the utility of the representative household, see Attanasio and Weber (2010).

come measures and affect consumption of forward-looking households in different ways; cf. eqs. (3) and (4). As discussed in Subsection 4.1 two different income variables are available for the computation of the shocks: regular income, $\log Y_{it}^{reg}$, which presumably is relatively persistent, and temporary income, $\log Y_{it}^{temp}$, which is likely to exhibit little persistence. We posit that the regular and temporary income shocks can be computed using the two available household-specific income variables in the following way:

$$\begin{aligned} \log Y_{it}^{reg} &= \alpha^{reg} + \rho^{reg} \log Y_{it-1}^{reg} + \nu_{it}^{reg} \\ \log Y_{it}^{temp} &= \alpha^{temp} + \rho^{temp} \log Y_{it-1}^{temp} + \nu_{it}^{temp} \end{aligned} \tag{5}$$

The index *i* identifies a particular household, while the time index *t* indicates whether the specific variable refers to the first or the second interview round. The terms α^{reg} and α^{temp} are constants, ρ^{reg} and ρ^{temp} are autoregressive coefficients and ν_{it}^{reg} and ν_{it}^{temp} are the shocks or innovations of the corresponding income processes.

As discussed in Subsection 4.1, the regular income variable conveys a perception of households' average income over a certain time span, possibly taking into account income expectations in the near-term future. The precise formulation of the question, however, leaves many open ends; different respondents are likely to have different time horizons in view when reporting their regular income. This makes it difficult to attain a clear picture of the persistence of the regular income measure implied by the survey responses.

At the same time, temporary income is defined as a residual of the current income left from subtracting the regular income component; by construction it is likely to represent a highly idiosyncratic part of the household income. However, because this income measure is a linear combination of the current income $\log Y_{it}^{cur}$ and the regular income $\log Y_{it}^{reg}$, its persistence remains hitherto unknown: it is linked to the underlying persistence of the current and regular income variables.

In order to ascertain the empirical properties of regular and temporary household income, and to compute the corresponding innovations for subsequent use in Section 5, we estimate the coefficients of the equations in (5) using two alternative econometric techniques. First, we employ pooled OLS estimation to obtain estimates of the two persistence coefficients ρ^{reg} and ρ^{temp}. As noted, the time dimension of our panel is limited to two observations per households, making it impossible to fully control for the household

heterogeneity by employing the fixed effects estimator.[13] We make use of additional control variables to examine the issue in some detail.

Second, acknowledging the risk of biased results from the pooled OLS estimator, we depart from household-specific data and use time-series methods on aggregated data series. More specifically, we average out household heterogeneity in our dataset by taking means of $\log Y_{it}^{reg}$ and $\log Y_{it}^{temp}$ across all households interviewed in each survey month over the full sample period from 2002 to 2007, obtaining two time-series with 72 monthly observations each. OLS estimator is then used to infer ρ^{reg} and ρ^{temp} from the averaged data.

Columns (1) and (2) in Table 3 show the estimated coefficients of the two income processes in (5) using pooled OLS estimator on our panel of Estonian households. There are indeed substantial differences in the persistence of two income variables: the estimate of ρ^{reg} in Column (1) is 0.81, while the estimate of ρ^{temp} in Column (2) is 0.25. Figure B.1 in Appendix B displays estimates of the two coefficients based on estimations undertaken for each month across the sample period. Although the confidence intervals of the rolling estimates are wider because of smaller samples, on average they remain close to their full sample levels.

As mentioned previously, the results in Columns (1) and (2) of Table 3 are susceptible to unobserved household heterogeneity. While unable to fully take this heterogeneity into account by using the fixed effects estimator, we seek to examine the extent of the problem by adding control variables to our baseline regression in Table 3. The results are shown in Tables C.1 and C.2 in Appendix C. The estimate of ρ^{reg} is somewhat sensitive to the set of controls, but it remains in the interval of 0.7-0.8 across various specifications in Table C.1. The estimate of ρ^{temp} remains broadly unchanged around the value of 0.25 for all model specifications in Table C.2.

[13] Arellano and Bond (1991) document the effects of ignoring household-specific effects in models with lagged dependent variables. The full use of their techniques would require at least three observations per household in our panel.

Table 3: Coefficient estimates of regular and temporary income streams

	(1)	(2)	(3)	(4)
	Regular income	**Temporary income**	**Regular income**	**Temporary income**
$\hat{\rho}^{reg}$	0.815*** (0.015)	..	0.818*** (0.072)	..
$\hat{\alpha}^{reg}$	1.768*** (0.132)	..	1.645** (0.647)	..
$\hat{\rho}^{temp}$	..	0.253*** (0.038)	..	–0.026 (0.125)
$\hat{\alpha}^{temp}$	..	0.087*** (0.009)	..	0.139*** (0.021)
R^2	0.634	0.065	0.678	0.001
No. of obs.	2351	2351	71	71

*Notes: OLS estimation. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively.*

Columns (3) and (4) in Table 3 present estimates of ρ^{reg} and ρ^{temp} obtained from the aggregated $\log Y_{it}^{reg}$ and $\log Y_{it}^{temp}$ series. The two series are displayed in Figure B.2 in Appendix B, showing the overall dynamics of the two household income streams across the sample period from 2002 to 2007. The regular income appears to be closely following the real gross domestic product trend, while the temporary income stream lacks any trend and exhibits no apparent dynamic structure. The estimate of ρ^{reg} in Column (3) confirms the persistence of the regular income stream obtained using the pooled data in column (1). On the other hand, the temporary income persistence coefficient ρ^{temp} in Column (4) is now not statistically different from zero, suggesting that the corresponding pooled data result may be biased due to the omitted household heterogeneity term in the presence of a lagged dependent variable.

In summary, our results in Table 3 suggest that the regular income stream is rather persistent, with ρ^{reg} coefficient lying the interval 0.7–0.8. On the other hand, the temporary income stream exhibits little or no persistence, with ρ^{temp} belonging to an interval 0–0.25. The estimated range of ρ^{temp} implies that the temporary income shock ν_{it}^{temp} is likely to have little effect on the household consumption plans according to the PIH. On the other hand, the statistical uncertainty regarding ρ^{reg} is of more concern, as our theoretical calculations in Table 1 indicate that the likely effect of ν_{it}^{reg} on the house-

hold consumption responses would be markedly different depending on the exact value of the coefficient in the interval 0.7–0.8.

The lack of household-specific estimates of the persistence of regular and temporary income streams calls for a judicious approach in the estimation of the corresponding income shocks. Therefore, we consider several different assumptions regarding the persistence of the two income streams. For each assumption, we compute residuals from eq. (5), interpreting them as income shocks by analogy to (3), which are then used in Section 5 to test the sensitivity of household consumption responses.

Our baseline assumption is that $\rho^{reg} = 1$ and $\rho^{temp} = 0$. In this case the developments of the two income variables in (5) are closer to the aggregated data evidence in Table 3. Under this assumption, the regular income shock ν_{it}^{reg} is fully persistent, i.e. $\log Y_{it}^{reg}$ is a unit root process, while the temporary income shock ν_{it}^{temp} is a white noise process, having an impact for just a single time period.

We also consider three alternative assumptions regarding the persistence of the income streams in (5). The first alternative assumes that $\rho^{reg} = 0.9$ and $\rho^{temp} = 0$; the second alternative that $\rho^{reg} = 0.8$ and $\rho^{temp} = 0$; and the third alternative that $\rho^{reg} = 0.8$ and $\rho^{temp} = 0.25$. These specifications broadly cover different estimates of the two persistence coefficients, and are used to examine the sensitivity of the estimated consumption responses to different assumptions regarding the persistence of the household income shocks.

The PIH is captured by the theoretical model in eq. (4). The theoretical model assumes that the income shocks are i.i.d. and mutually orthogonal. Table 4 provides the statistics for the empirical equivalents ν_{it}^{reg} and ν_{it}^{temp}, which are computed using the four alternative assumptions regarding the persistence of the shocks. The means of the empirical income shocks are zero in all cases, in line with the computation of the shocks. The standard deviations are very similar, irrespectively of the persistence assumptions. The regular and temporary income shocks appear to be weakly negatively correlated.

Table 4: Descriptive statistics of regular and temporary income shocks, different assumptions about their persistence

	(1)		(2)		(3)		(4)	
	$\rho^{reg} = 1$ $\rho^{temp} = 0$		$\rho^{reg} = 0.9$ $\rho^{temp} = 0$		$\rho^{reg} = 0.8$ $\rho^{temp} = 0$		$\rho^{reg} = 0.8$ $\rho^{temp} = 0.25$	
	ν_{it}^{reg}	ν_{it}^{temp}	ν_{it}^{reg}	ν_{it}^{temp}	ν_{it}^{reg}	ν_{it}^{temp}	ν_{it}^{reg}	ν_{it}^{temp}
Mean	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
St. dev.	0.355	0.360	0.343	0.360	0.340	0.360	0.340	0.348
Correlation	–0.185		–0.188		–0.186		–0.240	

Notes: The empirical income shocks ν_{it}^{reg} and ν_{it}^{temp} are the residuals of constrained linear regressions of eq. (5). The constraints refer to assumptions on the persistence of the income measures and are provided in the column headings.

5. Consumption estimations

5.1. PIH estimations

The empirical model originates from eq. (4), but to reduce the risk of omitted variables bias, control variables in the form of preference shifters and annual dummies (to capture aggregate economic developments) are added.[14] Thus, the following equation is used for the estimation of consumption sensitivities to different income shocks:

$$\Delta \log C_{it} = Z_{it}\alpha + \beta_1 \nu_{it}^{reg} + \beta_2 \nu_{it}^{temp} + \varepsilon_{it} \qquad (6)$$

The dependent variable $\Delta \log C_{it}$ is the change of the logarithm of consumption between two time periods. In most estimations, the dependent variable is non-durable consumption is, but it is total consumption in some robustness analyses. The row vector Z_{it} consists of control variables. It includes two important preference shifters, i.e. the change in household size and the logarithm of the age of the household head; cf. Attanasio (1999). It also includes annual time dummies, which capture aggregate effects on household consumption.[15] The column vector α contains the coefficients of the control

[14] The additional features are commonly used in empirical consumption models; see the survey papers of Attanasio and Weber (2010) and Japelli and Pistaferri (2010a).

[15] We also tested the inclusion of monthly dummies for seasonal effects, but found that the dummies were typically statistically insignificant while the results remained the same. The reason for the absence of seasonality effects is likely that the regressions include changes in consumption and income from the *same month* of the previous year.

variables. The coefficient of the regular income shock is β_1 and the coefficient of the temporary income shock is β_2. Finally, ε_{it} is an error term.

Table 5 shows the first set of estimation results in which changes in non-durable consumption are explained by income shocks of different persistence and the specified control variables. Column (1) provides the results of the baseline estimation in which the regular income shocks are assumed to be fully persistent ($\rho^{reg} = 1$) and the temporary income shocks to be without persistence ($\rho^{temp} = 0$). An increase in regular income by 10% induces a consumption increase of 2.6% in the same period. It is consistent with the PIH when the persistence of the regular income is 0.89, which is within the range obtained in the estimations in Subsection 4.2.

Table 5: Sensitivity of non-durable consumption to income shocks, different assumptions about the persistence of the shocks

	(1)	(2)	(3)	(4)
	$\rho^{reg} = 1$ **$\rho^{temp} = 0$**	**$\rho^{reg} = 0.9$** **$\rho^{temp} = 0$**	**$\rho^{reg} = 0.8$** **$\rho^{temp} = 0$**	**$\rho^{reg} = 0.8$** **$\rho^{temp} = 0.25$**
ν_{it}^{reg}	0.260*** (0.033)	0.259*** (0.034)	0.243*** (0.033)	0.266*** (0.034)
ν_{it}^{temp}	0.121*** (0.029)	0.120*** (0.028)	0.116*** (0.028)	0.176*** (0.034)
Wald test (*F*-stat)	11.81 [0.001]	11.61 [0.001]	9.86 [0.002]	4.59 [0.032]
No. of obs.	2351	2351	2351	2351
R^2	0.076	0.073	0.069	0.077

*Notes: OLS estimation. Household size, log of age, and year dummies are included in the estimations but are not shown in the table. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively. The Wald test tests the null hypothesis that the difference between the coefficients of the regular shock and the temporary shock is not statistically significant. The values in square brackets are p-values.*

The response to a temporary income shock is higher than predicted by the PIH: a 10% increase in temporary income leads to a 1.2% increase in consumption while strict adherence to the PIH would suggest it should be below 0.5%. Nevertheless, among households in Estonia, non-durable consumption is more sensitive to regular, high-persistence, income shocks than to temporary, low-persistence, income shocks. The difference between the two coefficients is statistically significant at the 1% level. The result is, in isolation, consistent with the PIH.

Columns (2)–(4) in Table 5 show the estimations when different assumptions about the persistence of the income shocks are used. The results in Columns (2) and (3) are qualitatively similar to the results of the baseline estimation, indicating that the results do not depend on the way income shock variables are composed. This suggests that the inability to identify the true income process of the households does not affect the results of the consumption estimations. In Column (4) where a different assumption about the temporary income shock has been made, the point estimates of the coefficient of the temporary income shock are slightly higher than found in the other estimations in Table 1.

We have examined the robustness of the results in Table 5 in different ways. Estimations with total instead of non-durable consumption produce the same results in qualitative terms; cf. Table D.1 in Appendix D. The response of total consumption to income shocks is larger than that of non-durable consumption and the responses to the regular and temporary income shocks are significantly different. The results are robust to different assumptions regarding the persistence of the income shock variables.

It has been argued that income innovations may be endogenous, for instance due to non-separability of leisure and consumption choices. The most studied issue in the literature is the *retirement consumption puzzle* according to which consumption is lowered at retirement (Attanasio and Weber (2010)). Deliberate coincident changes in consumption and labour supply occur in other situations as well. We mitigated to some extent the issue of endogeneity by the exclusion of households in which the household head is inactive or has changed the labour market status (from inactive to active or vice versa) during the year observed. As working time is rather inflexible in Estonia (Leetmaa and Karu (2009)), one can assume the labour supply is inelastic for active households, and possible endogeneity problems may therefore be limited.[16]

We can test the robustness of the estimated coefficients to a change in employment status by using a dummy depicting the employment status of other household members. We add the variable to regression (6), but its estimated coefficient is statistically insignificant as shown in Table D.2 in Appendix D. It provides some evidence that the non-separability of leisure and consumption does not affect the results.

[16] A standard solution would be instrumentation, but no variables are readily available to instrument income changes. Experimentation revealed that the possible instruments did not give statistically significantly different estimations while giving higher standard errors; additionally, the instrumented income shock variable tended to have an interpretation of the expected income shock vs. the unexpected one. The exogeneity of the income variables was not rejected by the Hausman test, whether because of weak instruments or because the income shock variables are indeed exogenous in the sample of active households.

Table D.2 in Appendix D also shows the results of inclusion of other control variables depicting changes in the economic situation of the household. This exercise is particularly important in this case; the dataset has only two observation points per household which implies that the differenced specification in eq. (6) has only one observation per household, ruling out fixed effects estimation.

We also added other control variables as reported in Table D.2. The inclusion of variables capturing particular consumption behaviour, household wealth and availability of liquidity do not change the coefficients of the income shocks in substantial ways, confirming the robustness of the estimations.

We are aware of the usual measurement error issue in survey data, which may lead to coefficient estimates that are downwards biased. One method to address this issue is to use instrument variables estimation, but this is impractical in our case as the database does not include good measures to distinguish between income shocks of different persistence. Using weak instruments could lead to inconsistent estimates.

We believe that the issue of measurement error in Estonian HBS might not be a large problem. Households are reporting their consumption and income variables about a short period (one month) which helps them to focus on correct reporting. Moreover, the extent of measurement error may be affected by household characteristics; those who underreport their consumption in one period tend to do it more or less to the same extent the next period. By taking first differences, this type of measurement error is largely eliminated (Dynarski and Gruber (1997)).

5.2. Sensitivity to lagged temporary income shock

The PIH implies that consumption is affected by income shocks that change the discounted future income stream, but not by past income shocks as such shocks already have been incorporated into consumption path. We test this prediction by adding the lag of the temporary income shock to the model in eq. (6):

$$\Delta \log C_{it} = Z_{it}\alpha + \beta_1 \nu_{it}^{reg} + \beta_2 \nu_{it}^{temp} + \beta_3 \nu_{it-1}^{temp} + \varepsilon_{it} \qquad (7)$$

The PIH entails that the coefficient of the lagged temporary income shock is insignificant, i.e. the hypothesis that $\beta_3 = 0$ cannot be rejected. Table 6 reveals a different result for non-durable consumption: the estimated coefficient of the lagged temporary shock is negative and statistically significant in the sample of Estonian households. Non-durable consumption reacts to the

temporary income shock of the previous period, which is inconsistent with the PIH. Again, the results are similar when alternative ways of deriving the income shock are used.[17]

Table 6: Estimations when lagged temporary income shock is included

	(1)	(2)	(3)
	$\rho^{reg} = 1$ $\rho^{temp} = 0$	$\rho^{reg} = 0.9$ $\rho^{temp} = 0$	$\rho^{reg} = 0.8$ $\rho^{temp} = 0$
ν_{it}^{reg}	0.329*** (0.034)	0.328*** (0.035)	0.308*** (0.035)
ν_{it}^{temp}	0.196*** (0.036)	0.194*** (0.035)	0.186*** (0.034)
ν_{it-1}^{temp}	–0.247*** (0.030)	–0.242*** (0.030)	–0.233*** (0.030)
Wald test (*F*-stat)	9.96 [0.002]	10.11 [0.002]	8.38 [0.004]
R^2	0.106	0.102	0.096
No. of obs.	2351	2351	2351

*Notes: OLS estimation. Household size, log of age and year dummies are included in the estimations but not shown in the table. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively. The Wald test tests the null hypothesis that the difference between the coefficients to a regular shock and a temporary shock is not statistically significant. The values in square brackets are p-values.*

Interestingly, the coefficient of the lagged temporary shock is negative and, in numerical terms, close to the coefficient of the current temporary income shock. This holds irrespective of the assumption of persistence in the temporary income shock. The result suggests that consumption reacts to *changes* in temporary income.

When the effect of a lagged temporary income shock is taken into account, the coefficients of the income shocks of the particular period increase compared to the PIH model in Subsection 5.1. An increase in regular income by 10% increases consumption by 3.3%, while a current temporary income shock of the same magnitude increases consumption by 2%. The coefficients of the current income shocks are significantly different, suggesting that

[17] As there are only two observations per household, we have to restrict the persistence of the temporary income shock to zero in order to include a lagged transitory variable. This is likely not a large problem. In the PIH estimations in Table 5 the coefficients of the temporary income shock were rather similar regardless of whether the persistence of the temporary income shock was taken to be 0 or 0.25.

households indeed distinguish between income shocks of different persistence and incorporate this into their consumption decisions.

We continue by using model (7) with the lagged temporary income shock and discuss the robustness of the model. The results are robust to different assumptions regarding the persistence of the income shock variables as illustrated by Columns (2) and (3) in Table 6. Estimations with total instead of non-durable consumption produce the same qualitative results; cf. Table E.1 in Appendix E. The response of total consumption to income shocks is larger than that of non-durable consumption. The inclusion of variables capturing employment changes, particular consumption behaviour, wealth and availability of liquidity do not change the coefficients of the income shocks substantially, confirming the robustness of the estimations.

5.3. The rule-of-thumb consumption among Estonian households

The empirical findings in Subsections 5.1 and 5.2 provided only partial support for the baseline version of the PIH outlined in Section 3. In particular, the household consumption in the Estonian HBS tends to respond to the previous period temporary income shock, which runs contrary to the PIH implication that a rational forward-looking household revises its consumption plans only upon the new information arrival in the current time period. The response coefficient of ν_{it-1}^{temp} is estimated to be negative and statistically different from zero for all three alternative income shock identification schemes in Table 6.

As previously pointed out in Hall and Mishkin (1982) and Campbell and Mankiw (1989), this finding might be explained by the presence of so-called rule-of-thumb consumption by the households. The rule-of-thumb consumption model, sometimes referred to as the proportional or Keynesian model, links current consumption to current income via a constant marginal propensity to consume, regardless of the persistence of income. Hall and Mishkin (1982) find that up to 20% of the US household consumption in the years between 1969 and 1975 can be attributed to the rule-of-thumb behaviour, a finding that is disputed by Altonij and Siow (1987) in light of the measurement error issues in the PSID dataset. More recently, Filer and Fisher (2007), using the 1985–1996 part of the PSID data, estimate that up to 31% of US households follow the proportional consumption rule. Weber (2000) provides a useful summary of several empirical studies on this issue, giving a range of

estimates of the rule-of-thumb consumption share across a variety of different datasets and empirical methodologies.[18]

In this subsection we extend the baseline PIH model of Section 3 along the lines of Hall and Mishkin (1982) and Campbell and Mankiw (1989), and assume that a constant fraction, λ, of the consumption of Estonian households follows the proportional model, while the remaining share, $1-\lambda$, adheres to the rational forward-looking behaviour consistent with the PIH. As mentioned previously, the rule-of-thumb consumption implies a simple constant marginal propensity to consume, which can be expressed as follows:

$$\Delta \log C_{it} = \gamma \Delta \log Y_{it}^{cur} \tag{7}$$

The current household income, $\log Y_{it}^{cur}$, in this expression is the sum of the regular and temporary components, i.e. $\log Y_{it}^{cur} = \log Y_{it}^{temp} + \log Y_{it}^{reg}$. The parameter γ gives the overall marginal consumption propensity, regardless of the persistence of income.

The PIH consumption behaviour, on the other hand, differentiates between the two income sources as follows:

$$\Delta \log C_{it} = \gamma(\nu_{it}^{reg} + \delta \nu_{it}^{temp}) \tag{8}$$

In this parameterisation, γ again gives the overall marginal consumption propensity, similarly to (7).[19] On top of γ, the new parameter δ helps to differentiate the consumption propensity out of the temporary income, which according to the PIH of Section 3 is expected to be close to zero. Note that $\delta = 1$ implies the same consumption behaviour as in the proportional model (7), and is therefore observationally equivalent to the case $\lambda = 1$.

When eqs. (7) and (8) are combined using the fractions of proportional and PIH-driven consumption, the following extended view of household consumption as a function of different income shocks is obtained:

$$\Delta \log C_{it} = \gamma \nu_{it}^{reg} + (\lambda\gamma + (1-\lambda)\gamma\delta)\nu_{it}^{temp} - \lambda\gamma\,\nu_{it-1}^{temp} \tag{9}$$

Statistically, this model is indistinguishable from model (7), where the lagged temporary income shock ν_{it-1}^{temp} is appended to the baseline specifica-

[18] From the macroeconomic perspective, the role of rule-of-thumb behaviour in aggregate consumption dynamics has received much attention; cf. Mankiw (2000) and Gali et al. (2004).

[19] The overall marginal consumption propensity parameters in equations (7) and (8) might be different, because the two equations reflect fundamentally different consumption rules. However, the simple statistical framework in this subsection does not allow an identification of two separate overall marginal propensity parameters.

tion in (6). The structure of estimated coefficients is, however, very different. The extended consumption model (9) yields a vector of structural parameters $(\gamma, \delta, \lambda)$ out of the linear regression coefficients $(\beta_1, \beta_2, \beta_3)$ in the empirical model (7). In particular, the extended consumption model (9) implies a negative coefficient in front of ν_{it-1}^{temp}, a finding already reported in Table 6.

In Table 7 we report point estimates and corresponding standard errors of the three structural parameters of the extended consumption model (9). As in Table 6, each column represents an alternative income shock identification scheme; cf. Subsection 5.1 for additional explanations. The empirical results are very similar across all three columns of Table 7. The overall marginal consumption propensity parameter γ is the same as in Table 6, implying that around one third of the total income is consumed in the proportional model (7), and the same share of the combined income is consumed in the PIH-based model (8). The additional temporary income consumption propensity parameter, δ, is found to be statistically insignificant, implying that the fraction of PIH-driven consumption indeed follows the theory presented in Section 3.

Table 7: Coefficient estimates of the rule-of-thumb consumption model

	(1)	(2)	(3)
	$\rho^{reg} = 1$ $\rho^{temp} = 0$	$\rho^{reg} = 0.9$ $\rho^{temp} = 0$	$\rho^{reg} = 0.8$ $\rho^{temp} = 0$
γ	0.329*** (0.034)	0.328*** (0.035)	0.308*** (0.035)
δ	–0.609 (0.591)	–0.560 (0.553)	–0.620 (0.658)
λ	0.749*** (0.098)	0.737*** (0.099)	0.756*** (0.108)
No. of obs.	2351	2351	2351
R^2	0.106	0.102	0.096

*Notes: Calculations are based on the coefficient estimates and the variance-covariance matrix from Table 6. Household size, log of age and year dummies are included in the estimations but not shown in the table. Robust standard errors are calculated using the delta method and reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from zero at the 1%, 5% and 10% level, respectively.*

Remarkably, the parameter λ is estimated at around 0.75, suggesting that only about 25% of Estonian household consumption follows the baseline PIH model, while the remaining share, about 75%, adheres to the rule-of-thumb. This empirical finding is different from the 80%–20% split in the seminal paper of Hall and Mishkin (1982). However, more recent empirical evidence on

the share of the rule-of-thumb consumption summarised in Weber (2000) is less conclusive, giving a range of estimates from 2% to 94% depending on the particular dataset and estimation methodology

5.4. Consumption response to positive and negative income shocks

In this subsection we extend the investigation of the consumption model and examine whether there is asymmetry in the response of consumption to positive and negative income shocks. A few studies differentiate between positive and negative income changes in order to examine whether the consumption reaction is symmetric. These studies generally investigate the reasons of excess sensitivity to *predicted* income changes.

Shea (1995) focuses on households in the USA where the head is employed under a long-term union contract, which makes it possible to investigate the sensitivity of consumption to predictable wage movements. She finds an asymmetric consumption response as consumption is more sensitive to predictable income declines than to increases. Garcia et al. (1997) estimate consumption sensitivities to predictable income changes separately for liquidity constrained and unconstrained consumers and finds an asymmetric reaction to positive and negative income changes: unconstrained households react stronger to negative income changes, while constrained households show stronger reaction to positive predicted income changes. Dynarski and Gruber (1997) assess the ability to smooth consumption among the US households and do not find evidence of an asymmetric response for non-durable consumption. They find, however, a strong asymmetry for durable consumption as earnings reductions lead to a larger effect on consumption than earnings increases. Finally, Japelli and Pistaferri (2000) test for consumption sensitivity to anticipated income changes by using subjective income expectations in a panel survey of Italian households. They do not find any excess sensitivity or asymmetry in anticipated income changes.

As mentioned, these studies do not differentiate between income shocks of different persistence when investigating asymmetry. As we estimated different consumption sensitivity regarding different income shocks, there can be expected to be differences in the asymmetry as well. The most conventional explanation for excess sensitivity in *anticipated* income changes is liquidity constraints (Zeldes (1989)). The presence of liquidity constraints would hinder consumption smoothing, resulting in stronger reaction to negative transitory income shocks.

To explore whether the consumption behaviour in Estonia exhibits asymmetry, we split both regular and temporary income shocks into positive and negative ones.[20] Although the dataset originates from a period of rapid economic growth in Estonia accompanied by corresponding increases of household income, there is substantial heterogeneity at the household level. In numbers, 35% of households in the sample experienced a decrease in regular income between the two observations and 17% were affected by temporary negative income shocks during the period.

The positive and negative income shocks are included in the model with the lagged temporary income shock, eq. (7). The analysis in Subsection 5.2 showed that inclusion of the lagged income shock affects results markedly so its exclusion may lead to bias estimates of other coefficients. The model we estimate is provided in eq. (11):

$$\begin{aligned}\Delta \log C_{it} = {} & Z_{it}\alpha + \beta_1 \nu_{it}^{reg\_pos} + \beta_2 \nu_{it}^{reg\_neg} + \beta_3 \nu_{it}^{temp\_pos} + \beta_4 \nu_{it}^{temp\_neg} \\ & + \beta_4 \nu_{it-1}^{temp\_pos} + \beta_5 \nu_{it-1}^{temp\_neg} + \varepsilon_{it}\end{aligned} \tag{11}$$

Table 8 shows the estimation results when positive and negative income shocks are included separately. The result for the baseline shock identification scheme is given in Column (1), while the results for alternative identification schemes of the regular income shock are provided in Columns (2) and (3). The estimations reveal in all cases a broadly symmetric response to regular income shocks, while there is an asymmetric response to both current and lagged temporary shocks. Focusing on the current temporary shocks, it is puzzling that households react strongly to positive shocks but not to negative shocks since the result cannot be rationalised by the presence of liquidity constraints.

Eq. (11) is also estimated for total consumption as Dynarski and Gruber (1997) find a different pattern of asymmetry for non-durable and total consumption. The results are shown in Table F.1 in Appendix F. The results are qualitatively as for non-durable consumption although most coefficients generally are larger in numerical terms.

[20] The positive shock variables contain the value of the shock if the shock is positive and zero otherwise. The negative shock variables are constructed in an analogue way.

Table 8: Estimations of consumption sensitivities for positive and negative income shocks

	(1)	**(2)**	**(3)**
	$\rho^{reg} = 1$ $\rho^{temp} = 0$	$\rho^{reg} = 0.9$ $\rho^{temp} = 0$	$\rho^{reg} = 0.8$ $\rho^{temp} = 0$
$\nu_{it}^{reg\_pos}$	0.329*** (0.058)	0.319*** (0.059)	0.287*** (0.059)
$\nu_{it}^{reg\_neg}$	0.397*** (0.042)	0.402*** (0.056)	0.383*** (0.058)
$\nu_{it}^{temp\_pos}$	0.367*** (0.042)	0.357*** (0.042)	0.338*** (0.042)
$\nu_{it}^{temp\_neg}$	0.048 (0.039)	0.051 (0.040)	0.051 (0.040)
$\nu_{it-1}^{temp\_pos}$	–0.343*** (0.041)	–0.332*** (0.041)	–0.314*** (0.041)
$\nu_{it-1}^{temp\_neg}$	–0.149*** (0.048)	–0.149*** (0.048)	–-0.148*** (0.048)
Wald test for regular shocks (F-stat)	0.57 [0.452]	0.81 [0.368]	1.01 [0.314]
Wald test for current temporary shocks (F-stat)	26.83 [0.000]	24.86 [0.000]	22.10 [0.000]
R^2	0.117	0.113	0.105
No. of obs.	2351	2351	2351

*Notes: OLS estimation. Household size, log of age and year dummies are included in the estimations but not shown in the table. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively. The Wald test tests the null hypothesis that the difference between the coefficients of positive and negative shocks (regular or temporary, respectively) is not statistically significant. The values in square brackets are p-values.*

The pattern of asymmetry differs markedly from findings in other studies and the findings cannot be explained by liquidity constraints. The results suggest that in case households blend rational forward-looking behaviour with rule-of-thumb consumption decisions as described in Subsection 5.3, the combination of the two types of behaviour may vary across different income developments. Whether the asymmetric behaviour is a characteristic of the particular phase of the business cycle, namely a period of strong economic growth, is a question that cannot readily be answered using data only for the time period of 2002–2007.

6. Final comments

The consumption dynamics of households is important for microeconomic welfare analysis as well as macroeconomic policy study. It is therefore vital to obtain detailed knowledge of the consumption behaviour of households, including the reaction of household consumption to income changes. Using the Permanent Income Hypothesis (PIH) as the theoretical starting point, this paper analyses how households in Estonia reacted to income shocks of different persistence.

The main innovation of the analysis is the use of the Estonian Household Budget Survey (HBS) which allows a decomposition of income shocks into high-persistence regular shocks and low-persistence temporary shocks based on information from the interview of the individual household. This eliminates the need for restrictive statistical decomposition, which typically utilises PIH assumptions regarding the co-movements of consumption and income.

The data sample consists of 2351 households interviewed twice during the period 2002–2007, i.e. a period of rapid economic growth and increasing household income in Estonia. The regular income shock is derived directly from the answers of the households. The temporary income shock is derived from temporary income defined as the difference between the current and regular income. In order to assess the properties of the self-reported income measures, different empirical methods are used to produce approximate estimates of their persistence. The analyses show that Estonian households diligently assess the persistence of the two income measures; shocks to regular income are very persistent, while shocks to temporary income exhibit little persistence.

The starting point for the consumption estimations is a model with regular income shocks and contemporaneous temporary income shocks. The results of this parsimonious specification are generally supportive of the PIH. The sensitivity of consumption to regular income shocks is significantly higher than the sensitivity to temporary shocks. Moreover, the sensitivity of regular income shocks is consistent with the estimated degree of persistence of this variable. The estimations are robust to different consumption measures, to different degrees of persistence of the income processes and the inclusion of additional control variables.

The PIH posits that households are forward-looking, which entails that contemporaneous consumption does not react to *lagged* temporary income shocks. The estimations reveal, however, that consumption reacts to the lagged temporary income shock when this variable is included in the estimations. This implies that changes in the Estonian household consumption dur-

ing the boom years of 2002–2007 cannot be fully explained by forward-looking behaviour as hypothesised by the PIH. The coefficient of the lagged temporary shock is negative and, in numerical terms, close to the coefficient of the contemporaneous temporary income shock.

One explanation of the finding that consumption reacts to changes in temporary income is the presence of proportional or *rule-of-thumb* consumption, which entails a backward-looking behaviour according to which changes in consumption simply react to income changes. The computations suggest that substantially less than half of the results show behaviour consistent with the PIH, while substantially more than half of overall consumption can be attributed to rule-of-thumb behaviour. The calculations, however, are based on restrictive assumptions and subject to substantial uncertainty.

When positive and negative income shocks are included separately, the reaction of consumption to regular income shocks is symmetric, but the reaction to temporary income shocks is highly asymmetric. Households appear to smooth consumption in case of negative temporary income shocks, but not in case of positive temporary income shocks. The latter finding is not consistent with the PIH and cannot easily be explained by theories incorporating liquidity constraints.

The study contributes to the empirical literature on consumption behaviour by analysing consumption smoothing in a fast-growing emerging-market economy and by making use of self-reported information on the persistence of income shocks. In spite of the unique sample and shock identification, the results are broadly in line with findings in earlier studies. Households react differently to income shocks of different persistence as predicted by the PIH, but they also react to lagged income changes which is not predicted by the PIH. The findings using the rule-of-thumb model are in accordance with previous studies, although the fraction of household consumption derived from rule-of-thumb behaviour is relatively large.

Estonia experienced very rapid economic development during the sample years 2002–2007; incomes grew at a fast rate and financing possibilities developed rapidly. In spite of the extraordinary economic changes experienced in Estonia, households appear to have formed expectations and made consumption decisions in ways comparable to experiences from countries with a more stable economic environment. As data are not available from the deep recession experienced by Estonia in 2008–2009, it is not readily examined whether the same pattern continued during the downturn or whether the findings reflect factors that are unique for the upturn.

References

ALTONJI, J. G., AND A. SIOW (1987): "Testing the Response of Consumption to Income Changes with (Noisy) Panel Data". *Quarterly Journal of Economics*, Vol. 102, No.2, pp. 293–328.

ARRELANO, M., AND S. R. BOND (1991): "Some Specification Tests for Panel Data: Monte Carlo Evidence and an Application to Employment Equations". *Review of Economic Studies*, Vol. 58, pp. 277–298.

ATTANASIO, O., AND G. WEBER (1995): "Is Consumption Growth Consistent with Intertemporal Optimization? Evidence from Consumer Expenditure Survey". *Journal of Political Economy*, Vol. 105, No. 6, pp. 1121–1157.

ATTANASIO, O., AND G. WEBER (2010): "Consumption and Saving: Models of Intertemporal Allocation and Their Implications for Public Policy". *Journal of Economic Literature*, Vol. 48, No. 3, pp. 693–751.

ATTANASIO, O. (1999): "Consumption", in Taylor, J. and M. Woodford (eds.). *Handbook of Macroeconomics*, Rotterdam: Elsevier, pp. 741–812.

BERTOLA, G., AND R. J. CABALLERO (1990): "Kinked Adjustment Costs and Aggregate Dynamics", in Blanchard, O. J., and S. Fisher (eds.). NBER Macroeconomics Annual, Cambridge MA: MIT Press.

BLUNDELL, R., L. PISTAFERRI, AND I. P. PRESTON (2008): "Consumption Inequality and Partial Insurance". *American Economic Review*, Vol. 98, No. 5, pp. 1887–1921.

CAMPBELL, J. Y., AND N. G. MANKIW (1989): "Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence", in Blanchard O., and S. Fischer (eds.). *NBER Macroeconomics Annual*, Cambridge, MA: MIT Press, pp. 185–216.

CHAO, H.-K. (2003): "Milton Friedman and the Emergence of the Permanent Income Hypothesis". *History of Political Economy*, Vol. 35, No. 1, pp. 77–104.

DEATON, A. S. (1987): "Life-Cycle Models of Consumption: Is the Evidence Consistent with the Theory?", in Bewley, Truman F. (ed.). *Advances in Econometrics: Fifth World Congress*, Vol. 2. New York: Cambridge University Press.

DYNARSKI, S., AND J. GRUBER (1997): "Can Families Smooth Variable Earnings?" *Brookings Papers on Economic Activity*, No. 1/1997.

ES (2012): "Household budget survey 2010: Methodology". *Statistics Estonia Publication*. Available at: www.stat.ee/dokumendid/59873.

EUROSTAT (2012a): "Statistics Explained. Statistical Glossary". Available at: epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:COICOP/HICP.

EUROSTAT (2012b): "Statistics database". Available at: epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home.

FILER, L., AND J. D. FISHER (2007): "Do Liquidity Constraints Generate Excess Sensitivity in Consumption? New Evidence form a Sample of Post-Bankruptcy Households". *Journal of Macroeconomics*, Vol. 29, pp. 790–805.

FLAVIN, M. (1981): "The Adjustment of Consumption to Changing Expectations about Future Income". *Journal of Political Economy*, Vol. 89, No. 5, pp. 974–1009.

FRIEDMAN, M. (1957): "*A Theory of the Consumption Function"*. Princeton and Oxford: Princeton University Press.

GALI, J., J. D. LOPEZ-SALIDO, AND J. VALLES (2004): „Rule-of-Thumb Consumers and the Design of Interest Rate Rules". *NBER Working Paper No. 10392*, National Bureau of Economic Research, Inc.

GARCIA, R., A. LUSARDI, AND N. SERENA (1997): "Excess Sensitivity and Asymmetries in Consumption: An Empirical Investigation". *Journal of Money, Credit and Banking*, Vol. 29, No. 2, pp. 154–176.

HALL, R. E., AND F. MISHKIN (1982): "The Sensitivity of Consumption to Transitory Income: Evidence from PSID Households". *Econometrica*, Vol. 50, No. 2, pp. 461–481.

HALL, R. E. (1978): "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence". *Journal of Political Economy*, Vol. 86, No. 6, pp. 971–987.

HURST, E., G. LI., AND B. PUGSLEY (2010): "Are Household Surveys Like Tax Forms: Evidence from Income Underreporting of the Self Employed". NBER Working Paper, No. 16527.

JAPPELLI, T., AND L. PISTAFERRI (2000): "Using Subjective Income Expectations to Test for Excess Sensitivity of Consumption to Predicted Income Growth". *European Economic Review*, Vol. 44, No. 2, pp. 337–358.

JAPPELLI, T., AND L. PISTAFERRI (2010a): "The Consumption Response to Income Changes". *Annual Review of Economics*, Vol. 2, pp. 479–506.

JAPPELLI, T., AND L. PISTAFERRI (2010b): "Financial Integration and Consumption Smoothing". *Economic Journal*. Vol. 121, No. 553, pp. 678–706.

KRUEGER, D., AND F. PERRI (2010): "How Does Household Consumption Respond to Income Shocks?" *Annual Review of Economics*, Vol. 2, No. 479–506.

KULIKOV, D., A. PAABUT, AND K. STAEHR (2009): "A Microeconometric Analysis of Household Saving in Estonia: Income, Wealth and Financial Exposure", in Mayes, D. (ed.). *Microfoundations of Economic Success: Lessons from Estonia*, Edward Elgar, Ch. 6, pp. 190–241.

LEETMAA, R., AND M. KARU (2009): "Flexible Working Time Arrangements in Estonia". *An external report to the EU Directorate-General Employment and Social Affairs*. Available at: www.fgb-egge.it/public/documets/Flexible%20working%20time%20arrangements%20in%20Estonia.pdf.

MANKIW, G. (2000): "The Savers-Spenders Theory of Fiscal Policy". *American Economic Review*, Vol. 90, pp. 120–125.

PISTAFERRI, L. (2001): "Superior Information, Income Shocks, and the Permanent Income Hypothesis. *Review of Economics and Statistics*, Vol. 83, No. 3, pp. 465–476.

QUAH, D. (1990): "Permanent and Transitory Movements in Labor Income: An Explanation for "Excess Smoothness" in Consumption". *Journal of Political Economy*, Vol. 98, No. 31, pp. 449–475.

SHEA, J. (1995): "Union Contracts and the Life-Cycle Permanent Income Hypothesis". *American Economic Review*, Vol. 85, No. 1, pp. 186–200.

WEBER, C. E. (2000): ""Rule-of-Thumb" Consumption, Intertemporal Substitution, and Risk Aversion". *Journal of Business & Economic Statistics*, Vol. 18, No. 4, pp. 497–502.

ZELDES, S. P. (1989): "Consumption and Liquidity Constraints: An Empirical Investigation". *Journal of Political Economy*, Vol. 97, No. 2, pp. 305–46.

Appendix A: Variable definitions

Table A.1: Definitions of additional variables used in the empirical models of household consumption behaviour

Variable	Definition
$lage_{it}$	Logarithm of the household head's age
$hhsize_{it}$	Number of household members
$belowc_{it}$	Dummy = 1 if household's consumption in a given month is lower than the regular level, otherwise = 0
$abovec_{it}$	Dummy = 1 if household's consumption in a given month is higher than the regular level, otherwise = 0
$partempl_{it}$	Dummy = 1 if not all adult household members are currently employed, otherwise = 0
$renting_{it}$	Dummy = 1 if the household lives in a rented dwelling, otherwise = 0
$realest_{it}$	Dummy = 1 if the household owns real estate in addition to its primary residence, otherwise = 0
$liquid_{it}$	Household liquidity proxy. This variable is derived from household answers on its ability to instantly finance consumption expenditures of different nominal values by getting loans or drawing on own funds; cf. Kulikov et al. (2009). Larger values indicate easier access to liquidity

Appendix B: Identification of income shocks in the Estonian HBS

Figure B.1: Rolling monthly estimates of ρ^{reg} (left scale) and ρ^{temp} (right scale) together with their 95% confidence intervals (dotted line) and the full sample estimates (dashed line)

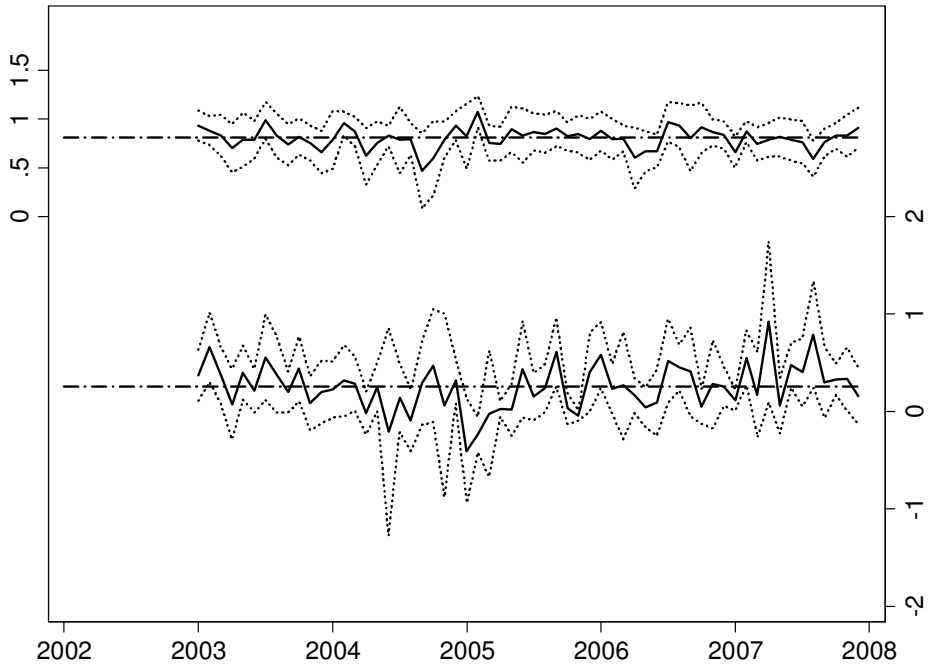
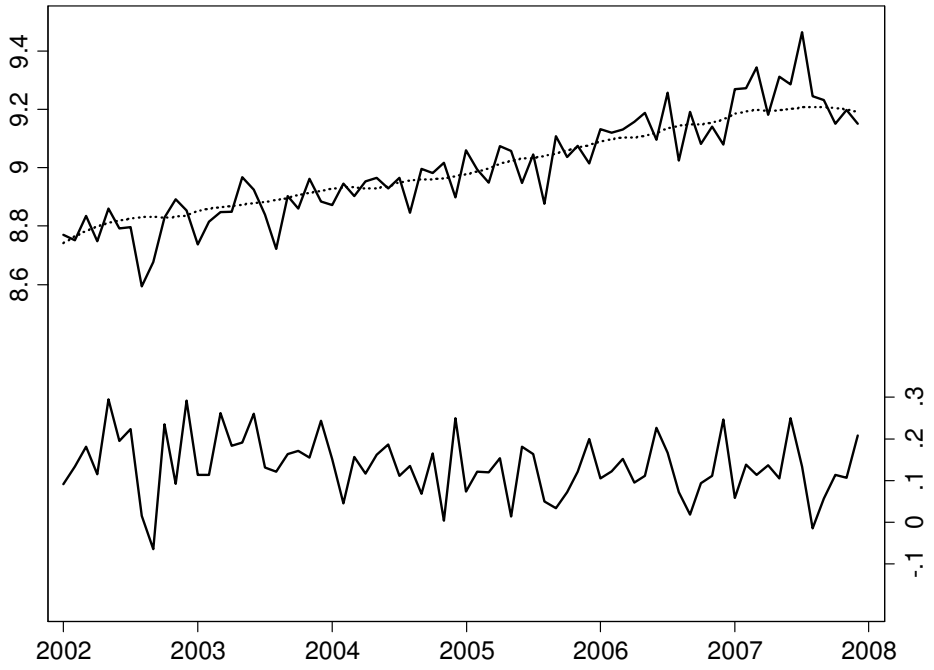


Figure B.2: Variables $\log Y_{it}^{reg}$ (left scale) and $\log Y_{it}^{temp}$ (right scale) averaged across households and the real gross domestic product index (dotted line)



Note: The real gross domestic product is from Eurostat (2012b, variable name namq_gdp_k). Monthly data are obtained by interpolation from quarterly series using flexible polynomials, rescaled to match the average regular income level.

Appendix C: Robustness checks of income persistence estimations

Table C.1: Regular income persistence coefficient with control variables

	(1)	(2)	(3)	(4)	(5)	(6)
$\log Y_{it-1}^{reg}$	0.815***	0.770***	0.769***	0.767***	0.761***	0.681***
	(0.015)	(0.017)	(0.018)	(0.018)	(0.018)	(0.023)
$lage_{it-1}$	..	–0.041	–0.041	–0.041	–0.060**	–0.073***
		(0.027)	(0.027)	(0.027)	(0.028)	(0.028)
$hhsize_{it-1}$	..	0.046***	0.046***	0.045***	0.043***	0.059***
		(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
$partempl_{it-1}$	..	..	–0.008	–0.008	–0.010	–0.002
			(0.016)	(0.016)	(0.016)	(0.016)
$abovec_{it-1}$	..	..	..	0.038***	0.039***	0.035**
				(0.015)	(0.015)	(0.015)
$belowc_{it-1}$	..	..	..	0.036	0.035	0.036
				(0.028)	(0.028)	(0.028)
$realest_{it-1}$	..	..	..	..	0.039*	0.031
					(0.021)	(0.020)
$renting_{it-1}$	..	..	..	..	–0.081***	–0.074***
					(0.027)	(0.027)
$liquid_{it-1}$	..	..	..	..	..	0.040***
						(0.006)
Constant	1.768***	2.197***	2.209***	2.216***	2.349***	2.949***
	(0.132)	(0.180)	(0.184)	(0.184)	(0.194)	(0.228)
R^2	0.634	0.642	0.642	0.643	0.644	0.652
No. of obs.	2351	2351	2351	2351	2351	2351

Notes: OLS estimation with $\log Y_{it}^{reg}$ *as dependent variable. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the corresponding coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively.*

Table C.2: Temporary income persistence coefficient with controls

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$\log Y_{it-1}^{temp}$	0.253***	0.250***	0.250***	0.240***	0.240***	0.240***
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
$lage_{it-1}$	..	–0.038*	–0.038*	–0.040*	–0.029	–0.028
		(0.023)	(0.023)	(0.023)	(0.024)	(0.024)
$hhsize_{it-1}$	..	0.006	0.006	0.005	0.007	0.007
		(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
$partempl_{it-1}$	..	..	–0.007	–0.008	–0.007	–0.008
			(0.015)	(0.015)	(0.015)	(0.015)
$abovec_{it-1}$	..	..	..	0.043***	0.044***	0.044***
				(0.016)	(0.016)	(0.016)
$belowc_{it-1}$	..	..	..	–0.021	–0.019	–0.019
				(0.024)	(0.024)	(0.024)
$realest_{it-1}$	..	..	..	..	0.013	0.014
					(0.020)	(0.020)
$renting_{it-1}$	..	..	..	..	0.071**	0.070**
					(0.035)	(0.035)
$liquid_{it-1}$	..	..	..	..	..	–0.001
						(0.004)
Constant	0.087***	0.215**	0.217**	0.215**	0.162*	0.164*
	(0.009)	(0.092)	(0.092)	(0.092)	(0.098)	(0.099)
R^2	0.065	0.066	0.066	0.07	0.072	0.072
No. of obs.	2351	2351	2351	2351	2351	2351

Notes: OLS estimation with $\log Y_{it}^{temp}$ *as dependent variable. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the corresponding coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively.*

Appendix D: Robustness checks of PIH model

Table D.1: Sensitivity of total consumption to income shocks of different persistence, regression (6)

	(1)	(2)	(3)	(4)
	$\rho^{reg} = 1$ $\rho^{temp} = 0$	**$\rho^{reg} = 0.9$ $\rho^{temp} = 0$**	**$\rho^{reg} = 0.8$ $\rho^{temp} = 0$**	**$\rho^{reg} = 0.8$ $\rho^{temp} = 0.25$**
ν_{it}^{reg}	0.328*** (0.042)	0.325*** (0.043)	0.304*** (0.042)	0.336*** (0.042)
ν_{it}^{temp}	0.194*** (0.041)	0.191*** (0.041)	0.186*** (0.040)	0.268*** (0.050)
Wald test (F-stat)	6.80 [0.009]	6.59 [0.010]	5.16 [0.023]	1.44 [0.23]
R^2	0.075	0.072	0.066	0.079
No. of obs.	2351	2351	2351	2351

*Notes: OLS estimation. Household size, log of age, and year dummies are included in the estimations but are not shown in the table. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively. The Wald test tests the null hypothesis that the difference between the coefficients to regular shocks and temporary shocks is not statistically significant. The values in the square brackets are p-values.*

Table D.2: Robustness test of the regression (6) to different sets of control variables, using baseline specification $\rho^{reg} = 1$ and $\rho^{temp} = 0$

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
ν_{it}^{reg}	0.260*** (0.033)	0.266*** (0.033)	0.265*** (0.033)	0.265*** (0.033)	0.246*** (0.033)
ν_{it}^{temp}	0.121*** (0.029)	0.123*** (0.029)	0.111*** (0.029)	0.111*** (0.029)	0.109*** (0.028)
$lage_{it}$	–0.076** (0.038)	–0.076** (0.038)	–0.078** (0.038)	–0.080** (0.038)	–0.080** (0.038)
$\Delta hhsize_{it}$	0.107*** (0.021)	0.106*** (0.021)	0.100*** (0.021)	0.100*** (0.021)	0.102*** (0.021)
$\Delta partempl_{it}$	..	0.033 (0.032)	0.034 (0.031)	0.033 (0.031)	0.037 (0.031)
$\Delta abovec_{it}$	..	..	0.071*** (0.016)	0.071*** (0.016)	0.071*** (0.016)
$\Delta belowc_{it}$	..	..	–0.098*** (0.033)	–0.099*** (0.033)	–0.097*** (0.033)
$\Delta realest_{it}$	..	..	..	0.032 (0.041)	0.029 (0.042)
$\Delta renting_{it}$	..	..	..	0.049 (0.057)	0.054 (0.057)

	(1)	(2)	(3)	(4)	(5)
$\Delta \text{liquid}_{it}$	..	..	..	..	0.018*** (0.007)
R^2	0.076	0.076	0.091	0.092	0.094
No. of obs.	2351	2351	2351	2351	2351

*Notes: OLS estimation. Robust standard error reported in brackets below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively. Year dummies are added to the regression but not shown in the table.*

Appendix E: Robustness tests of estimations with lagged temporary income shock

Table E.1: Sensitivity of total consumption to income shocks

	(1)	(2)	(3)
	$\rho^{reg} = 1$ $\rho^{temp} = 0$	$\rho^{reg} = 0.9$ $\rho^{temp} = 0$	$\rho^{reg} = 0.8$ $\rho^{temp} = 0$
v_{it}^{reg}	0.423*** (0.041)	0.418*** (0.042)	0.390*** (0.042)
v_{it}^{temp}	0.296*** (0.054)	0.292*** (0.053)	0.282*** (0.051)
v_{it-1}^{temp}	–0.335*** (0.039)	–0.329*** (0.039)	–0.317*** (0.038)
Wald test (F-stat)	5.30 [0.022]	5.36 [0.021]	4.01 [0.045]
R^2	0.119	0.114	0.105
No. of obs.	2351	2351	2351

*Notes: OLS estimation. Household size, log of age, and year dummies are included in the estimations but are not shown in the table. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively. The Wald test tests the null hypothesis that the difference between the coefficients to regular and temporary shocks is not statistically significant. The values in the square brackets are p-values.*

Table E.2: Robustness test of the baseline regression to different sets of control variables

	(1)	(2)	(3)	(4)	(5)
v_{it}^{reg}	0.329*** (0.034)	0.339*** (0.035)	0.334*** (0.034)	0.334*** (0.034)	0.317*** (0.035)
v_{it}^{temp}	0.196*** (0.036)	0.200*** (0.036)	0.186*** (0.035)	0.186*** (0.035)	0.183*** (0.035)
v_{it-1}^{temp}	–0.247*** (0.030)	–0.249*** (0.030)	–0.237*** (0.030)	–0.237*** (0.030)	–0.234*** (0.030)
lage_{it}	–0.086** (0.038)	–0.087** (0.038)	–0.089** (0.037)	–0.090** (0.037)	–0.091** (0.037)
Δhhsize_{it}	0.099*** (0.021)	0.097*** (0.021)	0.092*** (0.021)	0.092*** (0.021)	0.094*** (0.021)
$\Delta\text{partempl}_{it}$	..	0.046 (0.031)	0.046 (0.031)	0.046 (0.031)	0.049 (0.031)
Δabovec_{it}	..	..	0.062*** (0.016)	0.062*** (0.016)	0.062*** (0.016)
Δbelowc_{it}	..	..	–0.090*** (0.032)	–0.090*** (0.033)	–0.089*** (0.033)

	(1)	(2)	(3)	(4)	(5)
$\Delta realest_{it}$	..	..	..	0.024 (0.040)	0.022 (0.041)
$\Delta renting_{it}$	..	..	..	0.060 (0.057)	0.064 (0.057)
$\Delta liquid_{it}$	..	..	..	..	0.015** (0.007)
R^2	0.106	0.107	0.119	0.119	0.121
No. of obs.	2351	2351	2351	2351	2351

*Notes: OLS estimation. Year dummies are added to the regression but not shown in the table. Robust standard error reported in brackets below the coefficient estimates. Superscripts ***, ** and * indicate that the variable is statistically different from 0 at the 1%, 5% and 10% level, respectively.*

Appendix F: Sensitivity of total consumption to positive and negative income shocks

Table F.1: Sensitivity of total consumption to positive and negative income shocks, model (11)

	(1)	**(2)**	**(3)**
	$\rho^{reg} = 1$ **$\rho^{temp} = 0$**	**$\rho^{reg} = 0.9$** **$\rho^{temp} = 0$**	**$\rho^{reg} = 0.8$** **$\rho^{temp} = 0$**
$\nu_{it}^{reg\_pos}$	0.446*** (0.065)	0.442*** (0.066)	0.419*** (0.067)
$\nu_{it}^{reg\_neg}$	0.503*** (0.064)	0.489*** (0.067)	0.443*** (0.068)
$\nu_{it}^{temp\_pos}$	0.530*** (0.049)	0.515*** (0.049)	0.488*** (0.049)
$\nu_{it}^{temp\_neg}$	0.100 (0.063)	0.104* (0.063)	0.106* (0.063)
$\nu_{it-1}^{temp\_pos}$	–0.532*** (0.047)	–0.518*** (0.047)	–0.494*** (0.047)
$\nu_{it-1}^{temp\_neg}$	–0.108 (0.067)	–0.108 (0.068)	–0.105 (0.068)
Wald test for regular shocks (F-stat)	0.32 [0.573]	0.21 [0.654]	0.05 [0.824]
Wald test for current temporary shocks (F-stat)	25.77 [0.000]	23.55 [0.000]	20.47 [0.000]
R^2	0.141	0.134	0.123
No. of obs.	2351	2351	2351

*Notes: OLS estimation. Household size, log of age, and year dummies are included in the estimations but not shown in the table. Robust standard errors are reported in parentheses below the coefficient estimates. Superscripts ***, ** and * indicate that the coefficient is statistically different from 0 at the 1%, 5% and 10% level, respectively. The Wald test tests the null hypothesis that the difference between the coefficients of positive and negative shocks (regular or temporary, respectively) is not statistically significant. The values in square brackets are p-values.*

Working Papers of Eesti Pank 2012

No 1
Kadri Männasoo
Determinants of Bank Interest Spread in Estonia

No 2
Jaanika Meriküll
Households borrowing during a creditless recovery