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Household Savings Decision and Income Uncertainty *

Martin Beznoska[†], Richard Ochmann[‡]

August 11, 2010

Abstract

This paper empirically investigates the effects of changes in the interest rate as well as transitory income uncertainty on households' consumption-savings decision. Applying a structural demand model to German survey data, we estimate the uncompensated interest rate elasticity for savings, in line with the literature, to around zero. Accordingly, any policy-induced variation of net returns to savings is expected to have no significant effects on the level of savings. Moreover, we find significant effects of precautionary savings on the consumption-savings decision. As a result of a doubling of transitory income uncertainty, an average household increases savings by 4.4%. These effects vary by household composition and social status.

Keywords: Consumption-savings decision, interest rate elasticity of savings, income uncertainty.
JEL Classification: D12, D91, E21

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1 Introduction

The consumption behavior of private households in Germany is exposed to a number of recent developments in income taxation and savings subsidization. Private accumulation of financial assets for old-age pension income is subsidized since 2001 in the framework of the so called Riester-scheme, which was extended to the accumulation of owner-occupied housing assets in 2008. The value-added tax rate was raised from 16% to 19% in 2007, and a homogeneous tax rate for capital income in form of a flat tax rate of 25% was implemented in 2008, separating the taxation of capital income from the taxation of labor income.

Such reforms may affect the decision to allocate income to current consumption and to future consumption through effects on the real net return. On the one hand, a price effect shifts the relative returns of current and future consumption, and on the other hand, an income effect alters the disposable budget.[1] As these two effects usually affect the consumption-savings decision in opposite directions, the total effect is theoretically unclear. Public subsidization of private old-age pension savings that increases the relative returns to savings may thus in total well have a zero effect or even a negative effect on the amount of savings.

In theory, the life-cycle/permanent income hypothesis (LCPIH, Modigliani and Brumberg, 1954; Friedman, 1957) suggests consumption smoothing in a deterministic environment. Based on the theoretical ambiguity concerning the relation of savings and the interest rate, a vast literature empirically investigates either the interest rate elasticity of savings in aggregate consumption functions or structural preference parameters as the intertemporal elasticity of substitution in Euler equations. This literature is generally inconclusive w.r.t. the size and even the sign of the interest rate elasticity of savings. Wright (1967) finds a positive uncompensated elasticity of 0.2 and Gylfason (1981) of 0.3, while a greater elasticity is only found by Boskin (1978) with 0.4. However, most of the studies find elasticities not significantly different from zero (Blinder, 1975; Howrey and Hymans, 1978; Giovannini, 1985; Baum, 1988; Makin and Couch, 1989; Skinner and Feenberg, 1989; Schmidt-Hebbel, Webb, and Corsetti, 1992; Montgomery, 2007), and others even find evidence for a slightly negative interest elasticity of savings (Evans, 1983; Friend and Hasbrouck, 1983; Hall, 1988).[2]

[1] Sandmo (1985) provides a survey on general theoretical implications of taxation effects on savings, and Boadway and Wildasin (1994) as well as Bernheim (2002) provide comprehensive surveys on the empirical literature in this field. For a survey on the specific effects of interest rate changes on the consumption-savings decision in various model frameworks, see Elmendorf (1996). Elmendorf (1996) also argues for an additional relevant effect of interest rate changes on the stock of wealth. A general survey on the savings literature beyond interest rate and taxation effects is conducted by Browning and Lusardi (1996).

[2] A literature overview can be found in Smith (1990). Summers (1984) finds variation between permanent and transitory interest rate shifts on savings. One literature strand focuses on cross-country comparisons, e.g. for developing countries (e.g. Ogaki, Ostry, and Reinhart, 1996), where the relevance of financial liberalization for the size of the interest elasticity is emphasized (e.g. Masson, Bayoumi, and Samiei, 1998).

Only few attempts have been made with micro data to estimate the interest rate elasticity of savings. Blundell, Browning, and Meghir (1994) estimate an Euler equation on micro data for the UK based on a preference structure that they derive from demand system estimation. For Germany, Lang (1998) analyses the consumption-savings decision in a demand system as the top stage of a two-stage budgeting model, where the interest rate is modeled rather as a control variable, though. Generally, limited cross-sectional variation in the interest rate and the consumption price at the household level makes the identification of price effects on the consumption-savings decision empirically challenging. In order to better identify price effects, additional price variation at the household-level through differential taxation of capital income is usually exploited in this literature. Cross-sectional variation in after-tax rates of return to savings results from variation in households' income structure and thus marginal tax rates (see e.g. Feldstein, 1976, for portfolio choice).[3] In case the data span a time frame overlapping with a major reform of the tax rules, there is additional potential variation in after-tax returns over time available. In this study, we will build our identification strategy of price effects affecting the consumption-savings decision on this after-tax approach.

Another literature emphasizes a greater relevance of household-level heterogeneity in the form of risk and income uncertainty compared to price effects for the consumption-savings decision. In the concept of precautionary savings, the basic concept of the life-cycle/permanent income hypothesis is extended by letting income be stochastic and relaxing the assumption of certainty equivalence, so that consumption becomes a function of income variation. In the theoretical literature on precautionary savings, the relevance of *transitory* income uncertainty is emphasized. Consumption puzzles, like excess sensitivity to transitory income variation (Flavin, 1981; Zeldes, 1989) or excess smoothness of consumption (Cambell and Deaton, 1989; Caballero, 1991) are explained with precautionary motives. Liquidity constraints are mentioned as another argument for sensitivity to transitory income variation (Kazarosian, 1997). In the buffer stock model (Carroll and Samwick, 1997), households react to transitory income shocks if their asset stock deviates from a target wealth to income ratio.

The empirical literature in this field, though, comes to very inconclusive results regarding the relevance of precautionary savings. There are a couple of studies focusing on stocks of assets, specifying e.g. wealth to permanent income ratios. Some find huge effects in the range of 40-60% of total wealth attributed to precautionary motives (Zeldes, 1989; Caballero, 1990; Dardanoni, 1991; Carroll and Samwick, 1997, 1998). Other studies find much smaller effects in the range of 20-30% (Lusardi, 1997; Kazarosian, 1997; Ventura and Eisenhauer, 2006) or almost no relevance of precautionary savings (Skinner, 1988; Guiso, Jappelli, and Terlizzese, 1992).

[3] Yet another approach evaluates specific tax reforms or subsidization programs and their effects on savings, see Bernheim (2002) for a survey on this literature.

For Germany, there are medium effects found by Bartzsch (2008) (20% of total wealth) and Fuchs-Schündeln and Schündeln (2005) (22% for East-Germany and 13% for West-Germany). Skinner (1988) and Hurst, Lusardi, Kennickell, and Torralba (2010) point out the relevance of risk aversion. They find almost vanishing effects of precautionary savings when differentiating by social status or occupation as a proxy for risk aversion. Also Fossen and Rostam-Afschar (2009) find for Germany no precautionary effects at all when considering that savings of the self-employed are rather dedicated to old age than related to precautionary motives. Then, there is a study from Miles (1997) that focusses on asset *flows* rather than stocks. He analyses consumption flows for the UK and finds modest effects of a doubling of income uncertainty on savings (+9% on a two-decade average).

The paper at hand contributes to this literature by modeling the consumption-savings decisions in a structural demand system as a function of current household income, net returns to savings, and the consumption price level, similar to the approach by Lang (1998). We additionally account for an appropriate treatment of durable goods by accounting for user costs. The model is estimated with official cross-sectional data on household consumption in Germany for the years 2002-2007. Thereby, we can utilize additional household-level price variation through differential taxation of capital income as well as variation in income taxation rules over this time frame. Marginal tax rates at the household level are simulated in an income taxation module. We find that savings are a superior good, while consumption is an inferior good. We estimate the uncompensated interest rate elasticity for savings to slightly below zero or (depending on the specification) not significantly different from zero. Policy-induced variation of net returns to savings is thus expected to have no significant effects on the level of savings. Moreover, a compensated interest rate elasticity of savings that is significantly different from zero, though, indicates that such a variation would not be welfare neutral.

We then extend this basic model following Miles (1997) to allow for effects of uncertainty in transitory household income. We estimate a model for the dynamics of household income on German panel data and find significant effects of precautionary savings on the consumption-savings decision for households in Germany, excluding the self-employed, in the range of Miles (1997). As a result of a doubling of average income uncertainty, an average household increases savings by 4.4% and thereby reduces consumption by 1.8%. These effects are greater for singles and single parents, while lower for couples with two and more kids; they are also greater for capital income households and lower for transfer recipients as well as blue collar workers. In the next section, we present a model for the consumption-savings decision and for income dynamics. Section 3 deals with the estimation approach. Then in Section 4, the data sets and descriptive statistics on savings and income uncertainty are presented. In Section 5, the results for the model with and without income uncertainty are discussed. Section 6 concludes.

2 The Model

The consumption-savings decision shall be embedded in a structural demand system for a two-period model.[4] The budget is allocated between the two periods, where the second period can be interpreted as an approximation for all future periods. Another interpretation of this set up is that every period a given budget is allocated discretely to *immediate* consumption and *future* consumption. In our basic model, we assume that the budget equals the current income. Then, we extend this basic model to future income and uncertainty about future income. Proxies for permanent income and for income uncertainty are integrated in the model in Section 3.

A Demand System for Consumption and Savings

We model the consumption-savings decision in an almost ideal demand system (AIDS) from Deaton and Muellbauer (1980a), which is flexible concerning the factors of influence. The AIDS is based on price-independent generalized logarithmic (PIGLOG) preferences and Engel curves in the Working-Leser form, where budget shares are linear in the log-budget (see Working, 1943; Leser, 1963). It is applied here in an extended version, which allows for more flexible Engel curves, i.e. the quadratic almost ideal demand system (QUAIDS), where budget shares are modeled in a quadratic function of the log-budget (see Banks, Blundell, and Lewbel, 1997). Let $Q_{i,j}$ denote the demand of household i for good j in levels and $s_{i,j} = Q_{i,j}/y_i$ the respective demand share from the budget. Then, consumption-savings demand in this two-good QUAIDS is represented by the following system of $J = 2$ equations:

$$s_{i,j} = \alpha_{0j} + \beta_{1j} \ln(y_i/P^*) + \beta_{2j} \ln(y_i/P^*)^2 + \sum_{k \in \{s,c\}} \gamma_{jk} \ln(p_{ik}) \qquad (1)$$

for households $i = 1, ..., N$ and goods $j = c, s$, where c denotes consumption and s savings. y_i is household i's budget, p_{ik} is the price of good k for household i, and α_{0j} is a good-specific constant. β_{1j} and β_{2j} denote parameters of the budget effects of demand and γ_{jk} a

[4] A structural demand system is a non-standard framework for the intertemporal consumption allocation decision. Since the seminal work by Hall (1978), consumption or savings equations have been estimated in numerous specifications, see Muellbauer and Lattimore (1995) for an overview, but only rarely a complete structural demand system is applied. There are several macroeconomic extensions of the basic portfolio choice model by Brainard and Tobin (1968), where the consumption-savings decision is modeled as the first stage of a two-stage budgeting model in a theoretically consistent demand system (e.g. Conrad, 1980; Taylor and Clements, 1983). In the demand system, the consumption price and the interest rate are integrated into the savings equation in the form of two separate prices. These could be theoretically constrained and the constraints be tested empirically. Further, the consumption-savings decision can be modeled as a simultaneous process in a theoretical framework and compensated and uncompensated elasticities can be distinguished in the estimation, which is relevant for welfare analyses.

parameter of the effect of relative price changes. $\ln(P^*)$ is the translog price index, which can generally be approximated by a linear price index, e.g. by the log-linear Laspeyres index ($\ln(P^*) = \sum_j \bar{s}_j \ln(p_j)$), resulting in the linearized QUAIDS. This functional form implies an income elasticity for demand levels which is non-constant in the budget (see Banks et al., 1997). Omitting household indices for simplicity, the income elasticity corresponds to:

$$\eta_j \;\equiv\; \frac{\partial Q_j}{\partial y}\frac{y}{Q_j} = 1 \,+\, \left(\beta_{1j} + 2\beta_{2j}\ln(y/P^*)\right)/s_j \tag{2}$$

where Q_j is demand for good j in levels. The uncompensated price elasticity for the demand level of good j w.r.t. price of good k is:

$$\varepsilon^u_{jk} \;\equiv\; \frac{\partial Q_j}{\partial p_{jk}}\frac{p_{jk}}{Q_j} = \gamma_{jk}/s_j - \delta_{jk} - \left(\beta_{1j} + 2\beta_{2j}\ln(y/P^*)\right)\bar{s}_k/s_j \tag{3}$$

where $\bar{s}_k$ is the average share of good k and δ_{jk} is the Kronecker delta, i.e. $\delta_{jk} = 1$ if $j = k$ and $\delta_{jk} = 0$ if $j \neq k$. By the Slutsky equation, the compensated price elasticity follows as:

$$\varepsilon^c_{jk} \;\equiv\; \varepsilon^u_{jk} + s_k\eta_j \;=\; \gamma_{jk}/s_j - \delta_{jk} + s_k + \left(\beta_{1j} + 2\beta_{2j}\ln(y/P^*)\right)(s_k - \bar{s}_k)/s_j \tag{4}$$

The two-good consumption-savings demand system in Equation (1) then is linear in the budget parameters (linear Engel curves) and linear in the price parameters. It imposes the following *across*-equations constraints on the parameters: $\alpha_{0c} + \alpha_{0s} = 1$, $\beta_{1c} + \beta_{1s} = 0$, $\beta_{2c} + \beta_{2s} = 0$, and $\gamma_{ss} + \gamma_{cs} = 0$ as well as $\gamma_{cc} + \gamma_{sc} = 0$, where γ_{cs} is the coefficient on the savings price in the consumption equation and γ_{sc} the coefficient on the consumption price in the savings equation. These restrictions together imply adding-up of the budget shares to one for each household: $\widehat{s}_{i,c} + \widehat{s}_{i,s} = 1 \;\forall\, i = 1, ..., N$.[5] It follows in this two-good case that only one equation can be estimated. While adding-up is fulfilled by definition of the system, other properties of the compensated demand function that make a system consistent with demand theory can be imposed or tested for the QUAIDS: compensated own price elasticities shall be non-positive ($\varepsilon^c_{cc} \leq 0$, $\varepsilon^c_{ss} \leq 0$), the Slutsky-matrix is symmetric if the cross-price effects coincide, $\gamma_{cs} = \gamma_{sc}$, and compensated demand is homogeneous of degree zero in prices if the *within*-equation constraints, $\gamma_{cc} + \gamma_{cs} = 0$ as well as $\gamma_{ss} + \gamma_{sc} = 0$, hold (see Deaton and Muellbauer, 1980b).

There are two prices in the two-good consumption-savings demand system: $\ln(p_c)$ and $\ln(p_s)$. For consumption, we construct cluster-specific prices (see Lewbel, 1989), in order to exploit price variation between households within a time period. The aggregate Consumer Price Index

[5] Adding-up of the predicted shares can not be tested, though, given adding-up of observed shares by construction (see Deaton and Muellbauer, 1980a, p. 316).

for the commodity groups is weighted by cluster-specific expenditure shares:

$$\ln(p_{l,c}) = \sum_{g}^{G} w_{lg} \ln(p_g), \quad \forall\, l = 1, ..., L \tag{5}$$

where p_g is the Consumer Price Index for commodity group g and w_{lg} is the budget share of commodity group g in cluster l.[6]

The savings price is the price for substituting immediate consumption for future consumption. It is modeled as a function of the expected level of future prices and a household-specific discount rate. The latter shall be a function of the household-specific real net return to savings,[7] which is approximated by average real gross returns and the household's marginal tax rate on capital income, both differentiated by three types of assets and weighted by the household's structure of capital income (also see Section 4 and Appendix B): $r_i^n = \sum_a^A w_{ia} r_a^g (1 - t_{ia})$, where w_{ia} is household i's share of capital income from asset a, r_a^g is the average gross return to assets of type a, and t_{ia} is household i's marginal tax rate on income from asset a.[8] The expected level of future prices in period t is assumed to equal the actual price level in period $t+1$. This implies that a price shock in t was expected in $t-1$ and does not affect the price expected for $t+1$, which is a reasonable assumption if shocks are not persistent, i.e. prices return to a steady state after one period (i.e. one year here).[9] The household-specific price of savings in logs corresponds to:

$$\ln(p_{i,s}) = \ln\left(\frac{p_{l,c}^{t+1}}{(1 + r_i^n)}\right) \tag{6}$$

where $p_{l,c}^{t+1}$ is the level of future prices for household i in cluster l and r_i^n is the weighted average of net returns to assets relevant for household i. The aggregate price index, $\ln(P^*)$, is approximated by the log-linear Laspeyres index for the two goods: $\ln(P^*) = \bar{s}_c^0 \ln(\bar{p}_c) + \bar{s}_s^0 \ln(\bar{p}_s)$, where $\bar{s}_j^0$ denotes the average expenditure share of good j in the base year and $\ln(\bar{p}_j)$ the average log-price of good j. It follows that $\ln(P^*)$ is constant within each time period and varies only between the time periods.[10]

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[6] Clusters are constructed by household income, age of household head, and household composition. There follow $L = 252$ clusters. In order to control for resulting cluster effects, we regress $p_{l,c}$ on cluster dummies and apply the residuals in the demand system.

[7] Grimes, Wong, and Meads (1994) argue that the specification of the financial portfolio share model that is consistent with the AIDS is a function of the *real* interest rate, as also the budget is denoted in real terms.

[8] For interest income, a time series of the return on medium-term deposits is applied. As a proxy for the return to stocks, the current yield to bonds is applied, and for housing assets, a rate of return to rental income is calculated. For households reporting zero capital income, the return on medium-term deposits is applied.

[9] Alternatively, price expectations could be modeled in an autoregressive process here and the one-period-ahead prediction be applied for the expected level of future prices. We plan to implement this in future research.

[10] A time period could be a month (as it is in our data for the years 2002-2004) or a quarter (2005-2007).

Modeling Income Dynamics

In the basic model, we assume that the relevant budget is defined by current income exclusively. We now loosen this assumption and allow the consumption-savings decision to depend additionally on future income and uncertainty about future income, which we capture by a permanent income based on the LCPIH concept and by transitory income uncertainty based on the precautionary savings concept. Firstly, we introduce an income model, where the dynamics of permanent income and transitory income uncertainty are defined. Proxies for these budget components are then integrated into the demand system in Section 3.

Income uncertainty is naturally not observed by the econometrician, it is barely so by the household members themselves. We do not know whether a household will be hit by a shock next period, while its members might receive a signal. We can thus merely proxy income uncertainty with the help of the information that is reported. We construct a proxy for income uncertainty that is closely related to income risk in a model for income dynamics. The dynamics of income shall be modeled in an error components model (Moffitt and Gottschalk, 2002), in which we decompose the variance of household income into permanent and transitory components over time allowing for permanence of transitory shocks.[11] This decomposition is undertaken differentiated by "household type" in order to account for varying degrees of risk aversion.[12] Household types are going to be defined either by household composition or by main source of income (in the following: social status).

We assume that disposable household income[13] in logs can be modeled by

$$y_{it} = x'_{it}\beta + u_{it} \tag{7}$$

for households $i = 1, ..., N$ at time $t = 1, ..., T$, where x_{it} denotes a $K \times 1$-vector of household-specific characteristics including a constant, β denotes a $K \times 1$ parameter vector, and u_{it} is assumed to be a compound error term. Household-specific characteristics are related to the household head and contain: age, age-squared, education, interactions of age as well as age-squared with education, gender, social status, household type, and moreover federal state dummies for region of residence as well as time dummies.

From now on, we differentiate the analysis by household type (h). We further allow for un-

[11] Myck, Ochmann, and Qari (2009) apply similar error components models for the variance of individual labor earnings as well as hourly wages of full-time employed male employees in Germany.

[12] Skinner (1988) uses occupation as a proxy for risk aversion when quantifying the relevance of precautionary savings. Kazarosian (1997) finds positive effects for interactions of occupation with income uncertainty on savings. But, both authors argue for possible biases in this proxy due to self selection of less risk-averse individuals into riskier occupations. As we exclude the self-employed from our analysis, we expect these potential biases to be less of a problem.

[13] Disposable income basically equals net income. For a detailed definition, see Appendix A.

observed household heterogeneity in the income equation and decompose the errors $u_{it(h)}$ into a random effect ($\mu_{i(h)}$) and a transitory shock ($v_{it(h)}$): $u_{it(h)} = p_{t(h)}\mu_{i(h)} + l_{t(h)}v_{it(h)}$, where $\mu_{i(h)}|x_{it(h)} \sim iid(0, \sigma^2_{\mu(h)})$, $v_{it(h)}|x_{it(h)} \sim iid(0, \sigma^2_{v(h)})$; $p_{t(h)}$ and $l_{t(h)}$ are year-specific factor loadings that allow the components to vary over time. In the standard error components model (see Moffitt and Gottschalk, 2002), it is assumed that the two components are uncorrelated, i.e. $Cov(\mu_{i(h)}, v_{it(h)}) = 0$, and that there is no serial correlation among transitory shocks, i.e. $Cov(v_{it(h)}, v_{iht-s}) = 0$. By independence of $\mu_{i(h)}$ and $v_{it(h)}$, it follows for the variance of the income residual:

$$\sigma^2_{u(h)} \equiv var(u_{it(h)}) = p^2_{t(h)}\sigma^2_{\mu(h)} + l^2_{t(h)}\sigma^2_{v(h)} \tag{8}$$

In the standard model, this cross-sectional variance may then be decomposed into a permanent part $p^2_{t(h)}\sigma^2_{\mu(h)}/(p^2_{t(h)}\sigma^2_{\mu(h)} + l^2_{t(h)}\sigma^2_{v(h)})$ and a transitory part $l^2_{t(h)}\sigma^2_{v(h)}/(p^2_{t(h)}\sigma^2_{\mu(h)} + l^2_{t(h)}\sigma^2_{v(h)})$. We remove the rather arbitrary assumption that transitory shocks are not correlated and account for persistence of transitory shocks. We introduce autocorrelation in the structure of the transitory errors and allow them to follow an AR(1) process:[14]

$$v_{it(h)} = \rho_{(h)}\, v_{it-1(h)} + \varepsilon_{it(h)} \tag{9}$$

where $\varepsilon_{it(h)}$ is a white noise term with zero mean and variance $\sigma^2_{\varepsilon(h)}$. It follows for the composite error term:

$$u_{it(h)} = p_{t(h)}\, \mu_{i(h)} + l_{t(h)}(\rho_{(h)}\, v_{it-1(h)} + \varepsilon_{it(h)}) \tag{10}$$

Altogether, it follows for the log of disposable household income:

$$y_{it(h)} = x'_{it(h)}\beta_{(h)} + p_{t(h)}\, \mu_{i(h)} + l_{t(h)}(\rho_{(h)}\, v_{it-1(h)} + \varepsilon_{it(h)}) \tag{11}$$

where we interpret $x'_{it(h)}\beta_{(h)}$ as the population's mean income profile, $\mu_{i(h)}$ are deviations of individual profiles from the mean profile, and $\rho_{(h)}\, v_{it-1(h)} + \varepsilon_{it(h)}$ is the process for transitory deviations from the individual profiles. After a transitory shock has decayed, a household's income would revert to the individual level, $x'_{it(h)}\beta_{(h)} + \mu_{i(h)}$. Given $E[\mu_{i(h)}] = E[v_{it(h)}] = E[\varepsilon_{it(h)}] = 0$ and $E[\mu_{i(h)}\varepsilon_{it(h)}] = E[\varepsilon_{it(h)}\varepsilon_{js(h)}] = 0$ for all i, h and j and for all $t \neq s$, the covariance matrix

[14] Alternatively, an ARMA(1,1) process is common in the error components literature (MaCurdy, 1982), or an ARCH(1) process (Meghir and Pistaferri, 2004). If we specify an ARMA(1,1) process for transitory errors we find similar results for the fractions of permanent variance. Moreover, the permanent component could be specified by a random walk, see e.g. Moffitt and Gottschalk (2002) or Baker and Solon (2003). However, this would imply an infinitely increasing variance, for which we do not find evidence in the panel data for the time frame of ten years. This might be different for a longer time period, though, which is why we intend to allow for a random walk in future research.

of the compound residuals is given by:

$$cov(u_{it(h)}, u_{it-s(h)}) = p_{t(h)} p_{t-s(h)} \sigma^2_{\mu(h)} + l_{t(h)} l_{t-s(h)} E[v_{it(h)} v_{it-s(h)}] \tag{12}$$

where $E[v_{it(h)} v_{it-s(h)}]$ evolves recursively from:

$$E[v_{it(h)} v_{it-s(h)}] = \begin{cases} \sigma^2_{v0(h)} & , t = 0, s = 0 \\ \rho^2_{(h)} \sigma^2_{v0(h)} + \sigma^2_{\varepsilon(h)} & , t = 1, s = 0 \\ \rho^2_{(h)} E[v_{it-1(h)} v_{it-1(h)}] + \sigma^2_{\varepsilon(h)} & , 2 \leq t, s = 0 \\ \rho^s_{(h)} E[v_{it-s(h)} v_{it-s(h)}] & , s + 1 \leq t,\ 1 \leq s \leq T - 1 \end{cases} \tag{13}$$

where $\sigma^2_{v_0(h)} = var(v_{i0(h)})$ is the initial condition for the AR(1)-process.

We then compute for each household type h at time t the fraction of permanent variance from overall cross-sectional group-specific variance as:

$$\lambda_{t(h)} \ = \ \frac{p^2_{t(h)}\, \sigma^2_{\mu(h)}}{var(u_{it(h)})} \tag{14}$$

This fraction will become a determinant in our construction of proxies for permanent income and transitory income uncertainty, which will be described in the next section. We present results on $\lambda_{t(h)}$ from the estimation of the error components model in Section 4.

3 Empirical Strategy

Firstly, we explain how consumption-savings demand is estimated. Then, the empirical strategy for the construction of proxies for permanent income and transitory income uncertainty as well as for their integration into the demand equations is presented. Demand will be estimated on pooled cross-sectional household consumption data, and for the estimation of the model for income dynamics, we will additionally apply household panel data (also see Section 4).

Estimation of Demand for Consumption and Savings

In our basic model, current disposable household income is allocated to consumption and savings, where consumption is durable and non-durable consumption. For a consistent treatment of durable consumption, we apply user costs or service flows and analyze what we label "real" consumption, as opposed to actual expenditures.[15] Expenditures for durable consumption

[15]For a similar treatment of durable goods in aggregate consumption, see Slesnick (1992) or Christensen and Jorgenson (1969).

goods are reallocated among households: those reporting a purchase have lower real consumption than actual expenditures, while those not purchasing get a positive value imputed for real consumption. For details on the calculation of user costs, see Appendix A. Savings are then defined residually from income and real consumption. We analyze exclusively voluntary savings, such as accumulations of financial assets, expenditures for a house purchase, premiums to private insurances, and repayments of loans.[16] By the residual savings definition, we follow the concept of *net* savings, as expenditures for asset purchases are netted out against income from asset sales. The resulting net savings ratio defined by savings related to income falls in the open interval $[-\infty, 1]$.

Observing the fact that a great number of households have a savings ratio that falls in the negative part of this interval, for econometric concerns, the consumption-savings decision could be separated into the decision whether to demand positive savings at all and the decision of which share of income to allocate to savings conditional on positive savings. We however find no evidence for selection effects when estimating demand in a Tobit approach. The relevant marginal effects are not significantly different from the OLS estimates on the non-censored observations. We thus reduce the estimation of the consumption-savings decision to the conditional decision of income allocation, whereby we restrict the estimation to households with positive savings, and apply OLS. By the adding-up implication of the two-good demand system in Eq. (1), only one equation can be estimated and estimates for the second equation follow residually. We thus estimate a single equation for savings demand on cross-sectional data:

$$
\begin{aligned}
s_{i,s} = \alpha_{0,s} &+ x_i'\beta + \beta_{1,s} \ln(y_i/P^*) + \sum_{h=1}^{H} \beta_{1(h),s} \ln(y_i/P^*) * hhcomp_h \\
&+ \beta_{2,s} \ln(y_i/P^*)^2 + \sum_{h=1}^{H} \beta_{2(h),s} \ln(y_i/P^*)^2 * hhcomp_h \\
&+ \gamma_{ss} \ln\left(\frac{p_{l,c}^{t+1}}{(1+r_i^n)}\right) + \gamma_{sc} \ln(p_{l,c}) + \epsilon_{i,s}, \quad s_{i,s} \in \left]0;1\right], \quad \forall\, i = 1, ..., N
\end{aligned}
\tag{15}
$$

where x_i denotes a $K \times 1$-vector of household-specific characteristics and the stock of net assets. Interactions allow budget effects to vary with household composition.[17] The stock of net assets as well as the level of debt are potentially endogenous in the Eq. (15). As we imputed the stock

[16] Mandatory or contractual savings such as contributions to the statutory pension insurance system and employer-based savings plans are directly subtracted from gross income and are thus not part of the disposable budget. For a detailed definition of savings, see Appendix A.

[17] For the relevance of household composition in consumption-savings decisions, see e.g. Blundell et al. (1994). In the literature on demand for consumer goods, various specifications are applied to take into account effects of household composition in demand system estimation, see Pollak and Wales (1981) for an overview.

of net assets by the observed flows, endogeneity is probably less of a problem with the former. For the latter, we apply an instrumental variables approach, where the potentially endogenous level of debt is instrumented by the interest rate on debt and some of its polynomials in a Tobit regression (see Appendix A for details).

Measuring Income Uncertainty and Estimation of the Extended Model

When we extend the basic consumption-savings demand model by income uncertainty, we additionally apply household panel data in order to estimate the error components model for the income process. The estimated variance components are then imputed in the cross-sectional consumption data. They provide variation over time and household types for the construction of proxies for permanent income and transitory income uncertainty.[18]

The estimation is conducted in three steps. Firstly, we estimate a one-level random effects model for disposable household income on our panel data according to Eq. (11) simultaneously with the AR(1) error process:[19]

$$y_{it} \;=\; x_{it}'\beta_{(h)} + \mu_i + \rho v_{it-1} + \varepsilon_{it}, \quad \forall\, i = 1, ..., N;\; t = 1, ..., T \tag{16}$$

where y_{it} is disposable household income in logs, and x_{it} contains the same household characteristics as in Eq. (7), including household composition and main source of income. Assumptions for the AR(1) specification of the stochastic terms are maintained from Section 2. From Eq. (16), we predict the compound residuals as $\widehat{u}_{it} = \widehat{\mu}_i + \widehat{\rho}\,\widehat{v}_{it-1} + \widehat{\varepsilon}_{it}$ and construct separately for each household type an empirical $(T \times T)$ covariance matrix $\mathbf{C}_{(h)}$ of the residuals.

This is done for two different definitions of household types. In the first variant, household types are defined by household composition, where the following types are considered: single households, single parents, parents with no kids (younger than 18), parents with one kid, parents with two and more kids, and large households.[20] In the second variant, household types are defined by social status, which we relate to the main source of household income

[18] For a similar strategy of imputing parameters of income dynamics estimated on a household panel in consumption cross-sections for Germany, see Buslei, Mouratidis, Steiner, and Weale (2006). Alternatively, a pseudo panel could be constructed from the cross-sectional data and the analysis of income uncertainty could be modeled on the cohort level. See e.g. Banks, Blundell, and Brugiavini (2001) or Blundell and Preston (1998) for applications in the context of precautionary savings. We plan to attempt a construction of pseudo panel data in future research.

[19] Given this structure of households observed over time and nested in groups of household type, the model could be extended to a multilevel random effects model. Also, the specification of the AR(1) error process could alternatively be omitted here, as it appears again in the error components model estimated in the second step. If we omit the AR(1) process in the random effects estimation, the results do not change much.

[20] The group "large households" is the residual group of all remaining households. It mainly consists of households with more than two adults.

and differentiate the following types: white collar workers, public servants, blue collar workers, pensioners, transfer recipients, and capital income households.[21]

In the second step, we estimate the parameters of the theoretical covariance matrix in Eq. (12) by fitting the implications of the error specification in Eq. (10) to the empirical covariance matrix, separately for each household type. The parameters of the model are estimated by the generalized method of moments, where the distance between the empirical and the theoretical moments is minimized (Chamberlain, 1984). For $T = 10$ periods, we can exploit $T(T+1)/2 = 55$ moments from each covariance matrix. Specifically, we apply "equally weighted minimum distance GMM estimation" (Baker and Solon, 2003), which effectively is non-linear least squares.[22] We then calculate the fraction of group-specific permanent variance from the parameter estimates as:

$$\widehat{\lambda}_{t(h)} \;=\; \frac{\widehat{p}^{2}_{t(h)}\,\widehat{\sigma}^{2}_{\mu(h)}}{var(\widehat{u}_{it(h)})} \tag{17}$$

In a third step, the parameter estimates from the income estimation of Eq. (16), $\widehat{\beta}$ are imputed in the consumption cross-sections to predict disposable household income:

$$\widehat{y}_i \;=\; x_i'\widehat{\beta}, \quad \forall\, i = 1, ..., N \tag{18}$$

where x_i includes the same characteristics as in Eq. (7). This allows us to derive the compound residual for the consumption cross-sections as: $\widehat{u}_i \;\equiv\; \widehat{y}_i - y_i$. It is then decomposed into a random effect and a shock by the time-variant group-specific fractions of permanent variance, $\widehat{\lambda}_{t(h)}$, from the estimation of the error components model in Eq. (10):

$$\widehat{\mu}_{i(h)} \;=\; \widehat{\lambda}_{t(h)}\,\widehat{u}_i \tag{19}$$

where $\widehat{\mu}_{i(h)}$ is the best linear unbiased prediction (BLUP) estimator of the random effect for household i of type h observed in cross-section t (Prasad and Rao, 1990) and $\widehat{\lambda}_{t(h)}$ is defined in Eq. (17). It follows for the shock:

$$\widehat{v}_{i(h)} \;\equiv\; \left(1 \,-\, \widehat{\lambda}_{t(h)}\right)\widehat{u}_i \tag{20}$$

We then interpret the random effect as the systematic component of the compound residual, which is systematically linked to household characteristics but unobserved, and the shock as the

[21]The group "capital income households" is the residual group of all remaining households. It largely consists of pensioners and unemployed, in case they receive a greater part of their income from the investment of capital than from transfers. Most of the remaining households consist of students.

[22]Also see Myck et al. (2009) for further details on the implementation of this method.

true random element, which is unknown even to the household. If the systematic component is known to the household, the effects of $\widehat{y}_i$ and $\widehat{\mu}_{i(h)}$ in a consumption function should be of similar size (Miles, 1997). We thus define our proxy for a permanent disposable household income by the estimated mean population income profile plus the predicted random effect:

$$\widehat{y}^{p}_{i(h)} \equiv \widehat{y}_i + \widehat{\mu}_{i(h)} \tag{21}$$

This estimator for permanent income in logs together with the residual shock ($\widehat{v}_{i(h)}$) then substitute current income in the savings demand equation in Eq. (15). As a result, budget effects can be differentiated by permanent shifts and effects that are rather transitory. By the QUAIDS model, this results in a log-linear quadratic specification of the savings function in permanent income and transitory shocks.

At constructing a proxy for income uncertainty, we follow the concept of precautionary savings in that income uncertainty or income risk can be measured by variation in transitory shocks.[23] We assume that the remaining random element, $\widehat{v}_{i(h)}$, resulting from the imputation of $\widehat{\lambda}_{t(h)}$ and as defined in Eq. (20), is of purely transitory nature. This follows directly from the decomposition in the error components model, where permanent and transitory variance components are defined.[24] We can then apply a function of $\widehat{v}_{i(h)}$ in constructing our proxy for income uncertainty.[25] We specify a third polynomial for the transitory residuals, because we find concavity in their effect on savings.[26] We then interpret the polynomial in the second and the third moment of $\widehat{v}_{i(h)}$ as effects of transitory income uncertainty on the consumption-savings decision, i.e. for a given first moment.[27] When we quantify the effects of income uncertainty, we evaluate the effects of a doubling of transitory income uncertainty, which we measure by the variance of transitory shocks conditional on household type ($\sigma^{2\,c}_{\widehat{v},(h)}$). We finally estimate

[23] As already mentioned in Section 1, the literature on precautionary savings very often finds stronger reactions towards transitory shocks than towards permanent shocks (also see the empirical literature, e.g. Hall and Mishkin, 1982; Pistaferri, 2001).

[24] Miles (1997) also finds that true shocks to income are rather transitory. It could be argued, though, that the interpretation of variation in individual-specific income residuals, even conditional on a random effect, should be further differentiated by permanent and transitory shocks (Kazarosian, 1997).

[25] Similar proxies for income uncertainty have been applied in the literature (Miles, 1997; Dardanoni, 1991; Carroll and Samwick, 1997, 1998; Kimball, 1990; Dynan, 1993).

[26] Miles (1997) also finds nonlinearities in the effects of income shocks on consumption in a similar specification.

[27] The idea here is to interpret a shift in the variance of transitory shocks as transitory income uncertainty or income risk, while leaving the *level* of a shock unchanged. Note that the level of $\widehat{v}_{i(h)}$ is centered around an expected value of zero by construction.

the following single savings equation of the demand system for the extended model:

$$
\begin{aligned}
s_{i,s} = \alpha_{0,s} &+ x_i'\beta + \beta_{1,s}\,\widehat{y}^{p}_{i(h)} + \sum_{h=1}^{H}\beta_{1(h),s}\,\widehat{y}^{p}_{i(h)} * hhtype_h \\
&+ \delta_{1,s}\,\widehat{v}_{i(h)} + \sum_{h=1}^{H}\delta_{1(h),s}\,\widehat{v}_{i(h)} * hhtype_h \\
&+ \delta_{2,s}\,(\widehat{v}_{i(h)})^2 + \sum_{h=1}^{H}\delta_{2(h),s}\,(\widehat{v}_{i(h)})^2 * hhtype_h \\
&+ \delta_{3,s}\,(\widehat{v}_{i(h)})^3 + \sum_{h=1}^{H}\delta_{3(h),s}\,(\widehat{v}_{i(h)})^3 * hhtype_h \\
&+ \gamma_{ss}\ln\left(\frac{p^{t+1}_{l,c}}{(1+r^n_i)}\right) + \gamma_{sc}\ln(p_{l,c}) + \epsilon_{i,s}, \quad s_{i,s} \in \,]0;1]\,, \quad \forall\, i = 1,...,N
\end{aligned}
\tag{22}
$$

where $\widehat{y}^{p}_{i(h)}$ is the proxy for permanent income in logs (Eq. 21), $\widehat{v}_{i(h)}$ is the deviation of current income from permanent income in logs (Eq. 20). The second moment $(\widehat{v}_{i(h)})^2$ and the third moment $(\widehat{v}_{i(h)})^3$ of the residuals denote the polynomial of our proxy for transitory income uncertainty. The proxies for permanent income and the transitory shock are interacted with household type, similarly as the budget in the basic demand model is interacted with household composition. However, price and income effects are not affected by uncertainty.[28] Furthermore, we allow the effects of income uncertainty to differ by household type estimating two specifications of Equation (22), either interacting the uncertainty proxy with household composition or with social status.[29] For the interpretation of average budget elasticities and average effects of income uncertainty, we estimate a third specification ("pooled"), where we omit the interactions with uncertainty. Results are presented and discussed in Section 5.

4 Data and Descriptive Evidence on Household Savings and Income Uncertainty

Firstly, the data sets applied are introduced and the simulation of the tax rate is briefly summarized. Then, some descriptive evidence on household savings and on income uncertainty for the various groups is presented. Finally, the evolution of income dynamics over time for the various household types estimated in the error components model is described.

[28] We plan to implement interactions of uncertainty with price and income effects in future research.

[29] In these specifications, we omit the second moment of $\widehat{y}^{p}_{i(h)}$ as we found no significant effects here once it is interacted with the respective group variable.

Data and Simulation of the Tax Rate

The cross-sectional consumption data applied in this analysis stem from the Continuous Household Budget Survey for Germany ("laufende Wirtschaftsrechnungen", LWR). It contains information on income, consumption, and savings, very detailed by single components, at the household level. The LWR is maintained by the German Federal Statistical Office (Statistisches Bundesamt).[30] The six cross sections for the years 2002 to 2007 applied here contain 92,091 households when pooled together. For more details, see Appendix A.

In order to apply after-tax returns to savings in Eq. (6), income taxation is simulated for each household on the basis of information on income components that is observed for the time when the consumption-savings decision is taken. A marginal tax rate is generated for each household member who is considered relevant for the allocation decision by incrementing taxable income and assuming the increment is fully taxable and is not accompanied by any deductible expenses. Individual marginal tax rates are aggregated to a household marginal tax rate on taxable income in general, which is assumed relevant for the household's consumption-savings decision. For details on the taxation module, see Appendix B. Figure B.1 in Appendix B displays some descriptive statistics on the simulated marginal tax rate.

The panel data applied for the estimation of the model for income dynamics stem from the German Socio-Economic Panel (SOEP). We apply a balanced panel on waves 1999-2008, where we include all subsamples available until 1999.[31] In the balanced panel, we end up with 4,234 households in each t. By household composition, these can be split into: 900 singles, 255 single parents, 1,355 couples with no kids, 674 couples with one kid, 972 couples with two and more kids, and 78 large households. By social status of the household head, they can be grouped into: 1,296 white collar workers, 200 public servants, 820 blue collar workers, 1,368 pensioners, 347 transfer recipients, and 203 capital income households. We excluded some 536 households with a self-employed head, as they are excluded from the consumption data as well. Income in the error components model is monthly observed household net income. For the balanced panel design, in case of variation in household type within i over t, household i is grouped in the household type that is most frequently observed for i over t.

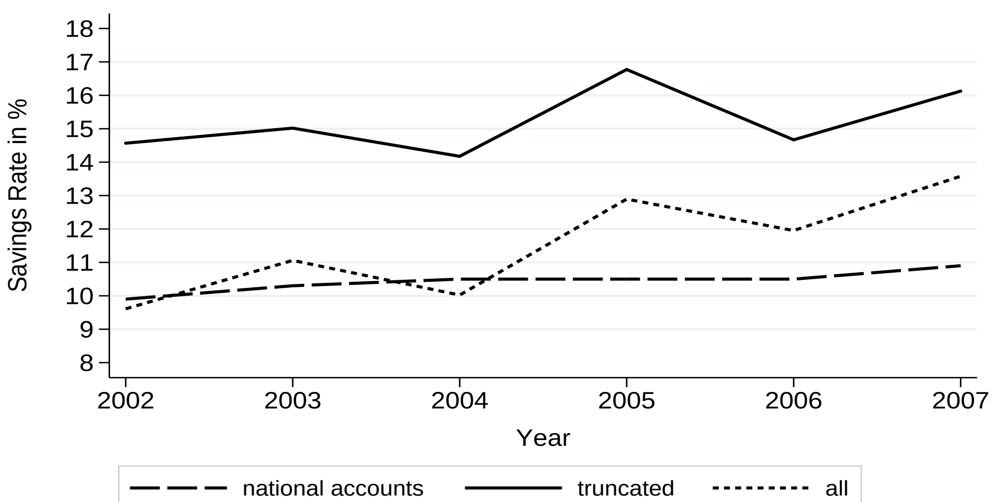
[30] The LWR data were provided by the Research Data Centre of the Statistical Offices of the Länder *(Forschungsdatenzentrum der Statistischen Landesämter, FDZ)*.

[31] These are the subsamples labeled A-E, which exclude a high-income subsample. For further details on the SOEP data, see Wagner, Frick, and Schupp (2007). Extending the sample to earlier waves would substantially reduce the number of observations for the balanced panel. We also estimated the model on an extended unbalanced panel and did not find significant differences in the results. A balanced panel approach ensures consistency with the underlying theoretical model and that any changes in the distribution of wages do not result from compositional changes.

Descriptive Micro Evidence on Household Savings and Income Uncertainty

Over the time frame that we analyze here, there was not much variation in the aggregate savings rate of private households in Germany. It increased only slightly from 9.9% in 2002 to 10.8% in 2007. Figure 1 compares the average savings ratio from the LWR data to the aggregate savings rate from national accounts. In the full sample of all observations, the average savings ratio is on average similar in size to the macro savings rate from national accounts. It increases from 9.6% in 2002 to 13.6% in 2007 (plot "all"). It should be noted, though, that comparability is limited as the sums for private households are derived residually in national accounts and include non-profit institutions serving households (*private Organisationen ohne Erwerbszweck*), which are not included in the micro data. Comparability of the micro savings ratio with the macro savings rate is moreover limited by the definition of savings. We widen the definition of savings in the micro data by durable goods, the interest component of loans, and expenditures for contributions to several private insurances, see Appendix A for details, which shifts the mean savings ratio slightly upwards.[32]

Figure 1: Savings Rate of Private Households in Germany (National Accounts vs. Micro Data)



Notes: Savings rate from national accounts includes changes in net claims from company pension plans.
Truncated savings rate from micro data is average savings rate truncated at −100%.
All−plot refers to the average non−truncated savings rate from micro data.
Micro data weighted by population weights.
Source: Own calculations with the LWR data (2002−2007) provided by the FDZ.
National accounts from Statistisches Bundesamt (2009).

Based on this micro savings ratio (plot "all"), we restrict the sample of households for estimation purposes. We exclude some 1% outliers with a savings ratio of below -1, whereby we shift

[32]Slesnick (1992) also finds a great upward shift in the savings rate when accounting for service flows from durable consumption.

the savings ratio upwards by about 4 percentage points on average. This results in what we label the "unconditional" savings ratio (the "truncated" plot in Figure 1). The unconditional savings ratio increases on average from 14.6% in 2002 to 16.1% in 2007.[33] In the estimation, we further restrict the sample to households with a savings ratio greater than zero ("conditional" savings rate), as argued in Section 3, which shifts the savings ratio further upwards, as Table 1 reveals. The average unconditional savings ratio in the population – when weighting the micro data by population weights – is 14.9%, and the average conditional savings ratio is 29.1% in the population of savers.[34]

Table 1: Descriptive Statistics on Income, Savings, and Income Uncertainty by Household Type

	Unconditional					Conditional				
	N	N_j/N	$\bar{s}^u_{(h)s}$	$\bar{y}^u_{(h)}$	$\sigma^{2\,u}_{\hat{v},(h)}$	N	N_j/N	$\bar{s}^c_{(h)s}$	$\bar{y}^c_{(h)}$	$\sigma^{2\,c}_{\hat{v},(h)}$
average hh:	90,863	100.0	14.9	2,264	0.0322	73,194	100.0	29.1	2,599	0.0299
hh-composition:										
Singles	22,388	24.7	8.6	1,431	0.0409	15,794	21.6	26.1	1,645	0.0380
Single parents	3,282	3.6	9.5	1,675	0.0523	2,479	3.4	23.4	1,837	0.0510
Couples, no kids	32,085	35.3	15.5	2,775	0.0219	25,406	34.7	28.2	3,038	0.0205
Couples, 1 kid	4,857	5.3	22.0	3,089	0.0396	4,205	5.7	31.2	3,309	0.0368
Couples, 2+ kids	10,284	11.3	26.0	3,783	0.0351	9,356	12.8	32.5	3,930	0.0336
Large households[a]	17,967	19.8	24.3	3,470	0.0305	15,954	21.8	32.0	3,688	0.0276
social status:										
White collar w.	33,063	36.4	22.6	2,948	0.0391	28,833	39.4	32.2	3,213	0.0366
Public servants	9,684	10.7	26.3	4,103	0.0200	8,773	12.0	32.5	4,235	0.0190
Blue collar w.	8,881	9.8	16.5	2,673	0.0284	7,170	9.8	26.4	2,915	0.0254
Pensioners	25,573	28.1	7.7	1,668	0.0135	18,223	24.9	22.6	1,837	0.0129
Transfer recipients	4,010	4.4	1.1	1,050	0.0733	2,488	3.4	19.3	1,198	0.0658
Capital income hh[a]	9,652	10.6	16.8	2,390	0.0723	7,707	10.5	25.5	2,925	0.0650

Notes: $\bar{s}^u_{(h)s}$ is the average savings ratio in percent, $\bar{s}^c_{(h)s}$ is the average savings ratio conditional on positive savings, $\bar{y}^u_{(h)}$ is current monthly disposable household income, $\bar{y}^c_{(h)}$ is current monthly disposable household income conditional on positive savings, $\sigma^{2\,u}_{\hat{v},(h)}$ is the variance of a transitory shock, and $\sigma^{2\,c}_{\hat{v},(h)}$ is the variance of a transitory shock conditional on positive savings. Data weighted by weighted by population weights for all figures, except for N.

[a]: Large households and capital income households are residual groups. They are defined in footnotes 20 and 21.

Reading example: The share of public servants in the population is 10.7%. Among this group, the average savings ratio is 26.3%. In the population conditional on positive savings, there are 12.0% public servants and their average savings ratio is 32.5%.

Source: Own calculations using the SOEP data (1999-2008) and LWR data (2002-2007), the latter provided by the FDZ.

[33] We adjusted the times series for a structural break in 2005 due to changes in the survey scheme of the LWR data.

[34] Note that the population weights applied do not take into account the distribution of savers in the population, though, so that the interpretation of the conditional savings ratio should be limited to the sample, rather than extended to the population.

Taking a closer look at the descriptive statistics in Table 1 also reveals that there is great cross-sectional variation in income and savings by household composition as well as by social status. Generally speaking, the savings ratio appears to be positively correlated with income. An average household is equipped with a monthly disposable household income, in real terms[35] and on a six-year average, of 2,264 euros in the unconditional and of 2,599 euros in the conditional population. Households with below-average income (singles and single parents) have a below-average mean savings ratio (8.6% and respectively 9.5% in the unconditional population), while households with above-average income (couples with one kid, with two and more kids, and large households) have an above-average mean savings ratio (22.0%, 26.0%, and 24.3%). Couples without any kids have about-average income and average savings ratios. This relation between income and savings is also observed for groups of social status. Public servants as well as white collar workers have above-average income and have the greatest savings ratios (26.3% and 22.6%), while pensioners and transfer recipients have the lowest incomes and also the lowest savings ratios (7.7% and 1.1%). Blue collar workers and capital income households have about-average income and average savings ratios.

This between-group variation in the savings ratios is greatly reduced if the population is conditioned on positive savings. Though, the positive correlation between group-average income and the savings ratio still holds. The average conditional savings ratio varies by household composition between 23.4% for single parents and 32.5% for couples with two and more kids. It varies by social status between 19.3% for transfer recipients and 32.5% for public servants.[36] The average conditional savings ratio is 29.1%.

Moreover, there is between-group heterogeneity in group-specific average income uncertainty, measured by variation in transitory income shocks ($\sigma^{2\,u}_{\hat{v},(h)}$ and $\sigma^{2\,c}_{\hat{v},(h)}$). While single parents, singles, as well as couples with kids face above-average income uncertainty, the variation in transitory shocks is lower for couples without kids and for large households. Again, there is more variation by social status, where transfer recipients as well as capital income households face the greatest levels of uncertainty, while public servants as well as pensioners face the lowest levels. This descriptive relation between household demographic characteristics and non-systematic variation in income is what we would expect. Groups of households whose members probably have a relatively unstable employment profile, like single parents, transfer recipients,

[35]Income is deflated by the log-linear Laspeyres index for consumption and savings, $\ln(P^*)$, as in the demand system.

[36]By conditioning on positive savings, the relative group sizes of single households, pensioners, and transfer recipients slightly decrease, as there are relatively more households with negative savings in these groups compared to e.g. couples with two and more kids and white collar workers, whose relative group sizes increase in turn. As a consequence, the savings ratio of transfer recipients is shifted upwards significantly by conditioning on positive savings, as there are many households in this group that have great dissavings compared to their income.

and capital income households face relatively greater transitory variation in income residuals. However, households with relatively stable employment like couples without kids and public servants, or those with relatively stable income streams that are based on prior employment patterns like pensioners have relatively lower residual variation. In the next subsection, we take a closer look at the income dynamics and the persistence of shocks.

Income Dynamics

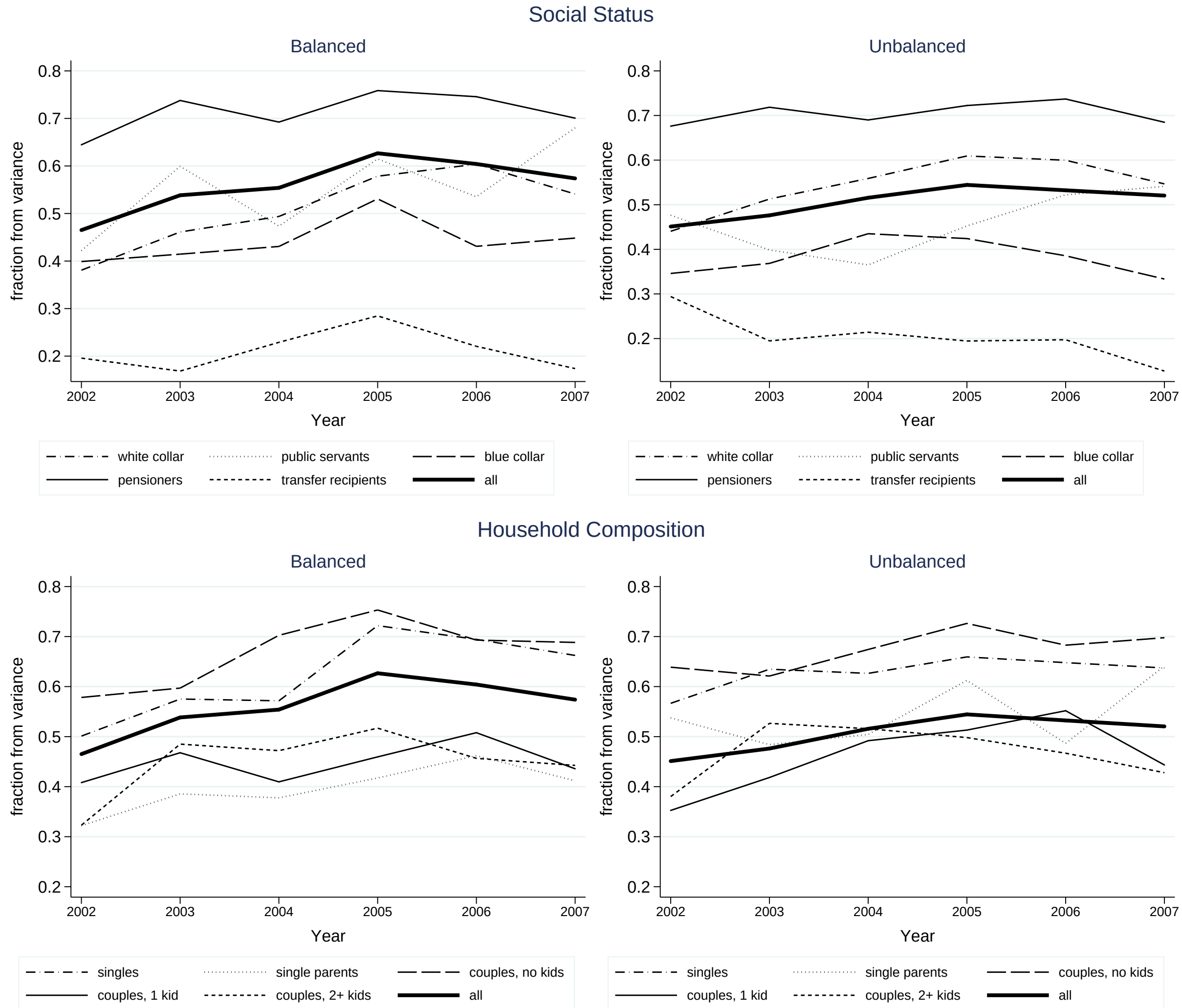
We now briefly describe the evolution of income dynamics over time for the various household types estimated in the error components model. The complete results for the NLS estimation of Eq. (12) on the balanced panel are compiled in Table C.1 by groups of household composition and in Table C.2 by groups of social status, both to be found in Appendix C. The autoregressive parameter of the AR(1)-specification of transitory shocks, ρ, is estimated to between 0.48 and 0.57 depending on the group. These estimates imply that a shock in period t, ε_{it}, is reduced to some 26% already after two periods.[37] Thus, random shocks to income as we model them can be characterized as transitory rather than permanent.[38] This finding confirms our assumption that the variation in the imputed random shocks, $\widehat{v}_{i(h)}$ from Eq. (20), is of predominantly transitory nature and can thus be applied as a proxy for transitory income uncertainty, as we already argued in Section 3.

For the imputation of the group-specific random effect, $\widehat{\mu}_{i(h)}$ from Eq. (19), the estimated group-specific permanent variance component, $\widehat{\lambda}_{t(h)}$, is applied. Figure 2 plots the evolution of the cross-sectional income variance and its permanent component for the six groups by household composition and the six groups by social status over the time frame 2002-2007, on the balanced and on the unbalanced panel. In all four panels, a similar picture evolves. The permanent variance component steadily increases until 2005 for most of the groups. After that, it slightly decreases again, or remains constant, depending on the group. For an average household in the balanced panel, about 50-60% of overall variance are permanent and 40-50% transitory. There is little variation between the groups by household composition, with single households and couples with no kids facing more than average permanent variance, while for

[37] If ρ is constrained to 0.35, which is the coefficient estimate from the simultaneous estimation of the random effects model and AR(1) error specification, we get similar results for the variance components. There is a little level effect, shifting the fraction of the permanent component upwards by 0-10%-points depending on the group, but the general evolution over time does not change for any group. One of the few studies that applies the same method to income at the household level is from Biewen (2005). In an ARMA(1,1) specification for transitory income in West-Germany during 1990-1998, he estimates a ρ of 0.28 and a γ of -0.37, which implies similar dynamics of shocks as we find them.

[38] Although his shock definition includes the random effect, Miles (1997) also concludes from differing estimated coefficients for permanent income and income shocks that true shocks to income are rather transitory and income does not follow a random walk.

Figure 2: Fraction of Permanent Component from Cross-Sectional Income Variance



Source: Own calculations with the SOEP data (1999–2008).

single parents and couples with one as well as couples with two and more kids, transitory variance is more relevant. There is more variation between the groups by social status. For pensioners, permanent variation is dominant, while for blue collar workers as well as transfer recipients, transitory variation plays a greater role. The picture is similar for the balanced and the unbalanced panel. While there is a little level effect, with a 10%-points greater permanent variation in the more stable balanced panel, the structure over the groups is mostly similar. We thus apply the $\widehat{\lambda}_{t(h)}$ from the balanced panel estimation, as it ensures consistency with the underlying theoretical model and that any changes in the income distribution do not result from compositional changes.[39]

[39]For the residual groups, i.e. large households and capital income households, we apply the average $\widehat{\lambda}_{t(h)}$.

5 Results

The main results we want to focus on are related to the interest elasticity of savings and to the effects of income uncertainty on the consumption-savings decision. We firstly present results for the base model neglecting income uncertainty and then for the extended model with income uncertainty. For both models, we calculate and interpret budget and price elasticities of consumption and savings levels for the conditional population of savers. Although the results for consumption follow implicitly from the results for savings by definition (and vice versa), we nevertheless present resulting elasticities for both of them for the sake of illustration. Then, results for the estimated effects of income uncertainty are presented, though here limited to the case of savings. Group-specific effects of conditional income uncertainty on the level of savings are derived and interpreted.

Price and Income Effects on the Consumption-Savings Decision

We can confirm the dominant result from the literature that the uncompensated interest elasticity of savings is close to zero. Apparently, a shift in the rate of return to postponed consumption does not induce agents to alter their projected consumption path. In turn of an interest rate increase, current consumption on the one hand decreases due to a significantly negative substitution effect, while on the other hand it increases by a significantly positive income effect. In sum, these two effects leave the levels of consumption and savings essentially unchanged. Extending our base model by income uncertainty does not change this fundamental finding. In the base model, there results only a slight decrease in consumption and thus a slight increase in savings, whereas for the extended model, consumption is slightly increased. We compute budget and price elasticities according to Eqs. (2)-(4) based on the coefficient estimates of the OLS estimations and evaluated for a mean conditional savings share of $\bar{s}^c_{(h)s} = 29.1$ and a mean conditional consumption share of $\bar{s}^c_{(h)c} = 70.9$.[40] The results are presented in Table 2 and will in the following be interpreted in more detail. Coefficient estimates for the estimation of the savings equation in all specifications are compiled in Table C.3 in Appendix C.

In the base model, for the conditional population of savers, the point estimate for the income elasticity of the level of consumption is 0.66, i.e. consumption is found to be a relatively inferior good, and the income elasticity of savings is estimated to 1.84,[41] i.e. savings are found to be

[40] As we find no selection effects for estimating the demand system on the conditional sample (see Section 3), we conclude that the estimated coefficients for the budget effects could be considered as valid for the entire population. However, as the QUAIDS model applied here is only defined for the conditional population of savers, we evaluate the budget elasticities for this population only. Also, we would rather restrict the interpretation of the estimated coefficients for the price effects to the conditional population.

[41] Note that by adding-up, the weighted budget elasticities sum up to unity: $\bar{s}^c_{(h)s}\eta_s + \bar{s}^c_{(h)c}\eta_c = 1$.

a superior good.[42] If current income in the conditional population increases by 10% from a monthly average income of 2,600 euros, an average household that consumes 1,843 euros (share of 70.1%) and saves 757 euros (share of 29.1%), would allocate these additional 260 euros more or less evenly between consumption and savings. As $2,600 * 0.701 * 0.066 = 121$ euros are consumed, savings are increased by the residual $2,600 * 0.291 * 0.184 = 139$ euros. This implies a marginal savings ratio of 53.5%, which is, as a result of the finding that savings are a superior good, greater than the average (conditional) savings ratio of 29.1%.

Table 2: Estimated Demand Elasticities for Levels of Consumption and Savings

	No Uncertainty		**Income Uncertainty**	
at the conditional mean[a]	Savings	Consumption	Savings	Consumption
Budget Elasticities:[b]				
current income	$+1.84^{***}$	$+0.66^{***}$	–	–
permanent income	–	–	$+1.84^{***}$	$+0.66^{***}$
transitory income	–	–	$+2.64^{***}$	$+0.33^{***}$
Price Elasticities:[b]				
Compensated:				
p_s	-0.55^{**}	$+0.23^{**}$	-0.28^{***}	$+0.12^{***}$
p_c	$+1.43^{**}$	-0.59^{**}	$+1.32^{**}$	-0.54^{**}
Uncompensated:				
p_s	-0.11^{*}	$+0.05^{*}$	$+0.18^{***}$	-0.07^{***}
p_c	$+0.06$	-1.03^{c}	$+0.00$	-1.00^{c}

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, based on robust standard errors.
[a]: Elasticities evaluated for the population of savers, at a mean conditional savings share of $\bar{s}^c_{(h)s} = 29.1$ and a mean conditional consumption share of $\bar{s}^c_{(h)c} = 70.9$.
[b]: Budget elasticities computed according to Eq. (2) and as weighted averages over the group-specific effects (groups by household composition); for the case of uncertainty, in the pooled version omitting group interactions; fraction of permanent variance imputed by household composition. Price elasticities computed according to Eqs. (3) and (4).
[c]: The null hypothesis for the consumption own-price elasticity is -1, see Eq. (3).
Reading example: In the approach with income uncertainty, savings are increased by 1.84% in turn of a 1%-increase in income if it is a permanent increase and by 2.64% if it is a transitory increase. A 1%-increase in the price for savings lowers current consumption in total by 0.07% and increases savings in total by 0.18%.

Source: Own calculations using the SOEP data (1999-2008) and LWR data (2002-2007), the latter provided by the FDZ.

The compensated consumption cross-price elasticity is estimated to 0.23. The negative substitution effect largely offsets the positive income effect implied by an interest rate increase and

[42] Our estimated budget effects are comparable in size to the results in Lang (1998). For consumption, he finds an income elasticity of 0.85 and for savings, an budget elasticity of 1.5-2.0, where 1.5 is for savings in financial assets and 2.0 for housing assets. We find a lower income elasticity of consumption here, as we evaluate the budget effects for the conditional population of savers with a relatively great average savings share. If we evaluate our estimated budget effects for the *un*conditional population ($\bar{s}^u_{(h)s} = 14.9$), the budget elasticity of consumption increases to 0.72.

the resulting total effect of a savings price decrease on consumption is slightly negative, though almost zero (uncompensated cross-price elasticity of 0.05). Everything else unchanged, an increase in the interest rate, i.e. a decrease in the savings price, slightly decreases consumption, as on the one hand, the implied increase in income increases the level of consumption (positive income effect), but on the other hand, consumption is substituted for savings due to the shift in relative prices (negative substitution effect), slightly more than it is increased by the income effect alone.

The effects of an interest rate increase on the level of savings follow implicitly. The compensated savings own-price elasticity is estimated to -0.55. On the one hand, savings decrease by the positive income effect of an interest rate increase on consumption, while on the other hand, they increase by the negative substitution effect on consumption. As the latter dominates the former, savings effectively slightly increase in turn of an interest rate increase. The uncompensated own-price elasticity of savings is estimated to -0.11, but this effect is statistically almost zero.[43] The effects of a shift in the consumption price are also found to be small. We estimate the compensated own-price elasticity of consumption to -0.59 and the uncompensated own-price elasticity to -1.03, statistically not different from -1.00. This implies that a 1%-decrease in the consumption price increases consumption effectively by 1% and in turn leaves savings unchanged (uncompensated cross-price elasticity of 0.06, statistically not different from zero).[44] The entire effect of a consumption price effect is absorbed by current consumption so that the level of savings remains unaffected.[45]

The effects we find have important policy implications. Finding an uncompensated interest rate elasticity for savings with a slightly negative point estimate that is though statistically almost zero, we conclude that policy-induced variation of net returns to savings is expected to have no effects on the amount of savings. Moreover, a compensated interest rate elasticity of savings that is significantly different from zero, though, indicates that such a variation would not be welfare neutral. Increasing the incentives to save more for old-age by increasing the net return to certain assets, e.g., would not have any effects on the exterior margin, as the amount of total savings is unchanged. Increases of savings in a certain type of assets (e.g. in

[43] The resulting total effect on consumption in $t+1$ is greater (uncompensated own-price elasticity of -1.11) than the effect on savings as it additionally includes the effect of the interest rate change on the budget.

[44] This result is precisely the Cobb-Douglas case, where cross-price effects are zero and thus uncompensated own-price effects are -1.

[45] When interpreting the size of these estimated effects on both savings and consumption, it must be kept in mind that the implied reactions are more of a long-term nature, as we account for the investment character of the consumption of durables goods by calculating user costs. If only a fraction of durable consumption is interpreted as current consumption and the residual as savings, the reaction of a price shift on durable consumption has a mitigated total effect on real consumption, compared to an approach, where the entire durable consumption is treated as current consumption.

the Riester-scheme) can thus only be obtained on the interior margin by shifting savings from other assets, while the general consumption-savings behavior is not affected by price-related incentives. The level of total savings could only be increased by indirect incentives through disposable income. As savings are found to be a superior good, policy reforms that increase disposable income could induce households to increase their level of savings. These qualitative policy implications also hold for policy reforms affecting the consumption price. An increase, e.g., in the value-added tax would induce households to reduce their current consumption, but would leave their level of savings unchanged. Again, only by reforms affecting disposable income, the level of savings could be affected.

The results in Table 2 together with the coefficient estimates from Table C.3 moreover indicate that the theoretical homogeneity restriction ($\widehat{\gamma}_{ss} + \widehat{\gamma}_{sc} = 0$) does not hold empirically for consumption-savings demand here ($\widehat{\gamma}_{ss} = 0.05,\ \widehat{\gamma}_{sc} = 0.21$; F-test statistic $F_{1,\,73064} = 8.46$). We thus do not impose the homogeneity restriction in the estimation; all results presented refer to the unconstrained estimation. In the theoretically consistent context of the demand system, this result indicates that in the savings equation, either our estimate for the own-price elasticity ($\widehat{\varepsilon}^{c}_{ss}$) is too low or our estimate for the cross-price elasticity ($\widehat{\varepsilon}^{c}_{sc}$) is too high. This empirical finding suggests that households react slightly differently in response to a shift in the consumption price and in response to a change in the interest rate. This could be interpreted as an overreaction to shocks on the consumption price in a sense of surprise inflation compared to interest rate shocks that are perceived less sensitively. Or households mistake a nominal interest rate increase for an increase in the real rate so that effects of the consumption price may to some extent also reflect reactions to shifts in the nominal interest rate.[46] The coefficient of the savings own-price effect has a lower standard error and could thus be interpreted statistically as a more robust estimate.[47] For welfare analyses, we would prefer to take the estimate of the savings price when evaluating an interest rate change and the estimate of the consumption price when analyzing a shift in the consumption price. One possible policy implication of this finding could be that if households' demand for savings is more elastic to price shocks than to shocks in the interest rate, a tax on capital income would be favorable regarding welfare effects compared to a consumption tax.

For the extended model including income uncertainty, the estimated elasticities do not differ

[46] Lusardi and Mitchell (2009) in evaluating questions on financial literacy find that only about half of the respondents understand the basic implications of interest rates and inflation. They moreover conclude that this fundamental lack of financial knowledge has relevant effects on households' decision to save for retirement.

[47] If we constrain the estimation to homogeneity, the savings price is mostly unchanged and only the consumption price is altered to fulfill the constraint.

much from the base model elasticities.[48] Budget elasticities can now be interpreted differentiated by the degree of permanence of a budget shift. We find that the reaction in savings is relatively stronger if the budget shift is of transitory nature than if it is a permanent shift, and thus the opposite holds for consumption.[49] The estimated effects of a 1%-increase in income that is of permanent nature equal the budget effects found in the base model: savings are increased elastically by 1.84%, and thereby consumption is increased inelastically by 0.66%. If however the 1%-increase in income is of transitory nature, savings are increased by even 2.64%, and in turn consumption is increased by only 0.33%.[50] As in the base model, an increase in the interest rate does not affect consumption significantly. There only results a small effect, which this time slightly increases consumption and thus decreases savings. Again, effects of a shift in the consumption price are entirely absorbed by current consumption.

Effects of Income Uncertainty on the Consumption-Savings Decision

We now present and discuss the estimated effects of transitory income uncertainty or income risk on the consumption-savings decision. We find significantly positive effects of transitory income uncertainty on savings and thus significantly negative effects on consumption. Table 3 presents the results. We estimate the elasticity of savings w.r.t. a doubling of transitory income uncertainty for an average household to about 0.04 and thus of consumption to about -0.02. A doubling of transitory income uncertainty is measured by a doubling of the variation in transitory income shocks ($+\sigma^{2\,c}_{\hat{v},(h)}$) from the average level. This means that if an average household faces twice the average transitory income risk, its members shift an amount of 43 euros from current monthly consumption to savings, thereby decreasing the level of consumption by 1.8% and increasing the level of savings by 4.4%.[51] If this average reaction would hold for each household, the average conditional consumption ratio in the population would decrease from 70.9% to 69.6% and the average conditional savings ratio would in turn increase from 29.1% to 30.4%.[52]

[48] Note that in the savings equation estimated for the extended model, Eq. (22), our proxy for income uncertainty is interacted with household type, but neither with permanent income nor with the prices, so that this result would be expected.

[49] Paxson (1992) also finds great reactions of savings towards transitory income shifts in Thailand, measured by variability in seasonal rain fall.

[50] Miles (1997) estimates similar relative sizes for permanent income and shock elasticities of consumption. But, it should be noted that his shock definition differs from ours, as it additionally includes the random effect.

[51] In Table 3, uncertainty effects are displayed for savings only. The corresponding effects on consumption follow implicitly from adding-up. They can be computed from the effects on savings, Mfx_s, as follows: $\text{Mfx}_c = -\,\text{Mfx}_s * \bar{s}^{c}_{(h)s}/\bar{s}^{c}_{(h)c}$.

[52] This may seem a rather little effect. But, it should be kept in mind that we evaluate the effects of doubling of solely *transitory* income uncertainty. From our estimates of the model for income dynamics, transitory variance for an average household amounts to about 40-50% of overall variance (Figure 2).

Table 3: Marginal Effects (in %) of a Doubling of Income Uncertainty on the Level of Savings

	Uncertainty Effects ($+\sigma^{2\,c}_{\widehat{v},(h)}$)		Budget Elasticities		Savings		
	Mfx$_s$	t-stat	η_s^{perm}	η_s^{tran}	Mean	$\bar{s}^{\,c}_{(h)s}$	$\sigma^{2\,c}_{\widehat{v},(h)}$
average household:	4.4***	(22.2)	1.843	2.636	756	29.1	0.0299
hh-composition:							
Singles	4.0***	(15.5)	1.959	2.662	429	26.1	0.0380
Single parents	4.0***	(7.7)	2.151	3.185	430	23.4	0.0510
Couples, no kids	3.1***	(16.7)	1.810	2.632	857	28.2	0.0205
Couples, 1 kid	2.8***	(8.2)	1.803	2.708	1,032	31.2	0.0368
Couples, 2+ kids	2.2***	(8.0)	1.865	2.597	1,277	32.5	0.0336
Large households[a]	2.9***	(16.3)	1.729	2.533	1,180	32.0	0.0276
social status:							
White collar w.	3.0***	(21.8)	1.801	2.748	1,035	32.2	0.0366
Public servants	2.4***	(8.7)	2.089	3.223	1,376	32.5	0.0190
Blue collar w.	2.6***	(10.6)	1.713	2.596	770	26.4	0.0254
Pensioners	3.4***	(8.2)	1.761	2.778	415	22.6	0.0129
Transfer recipients	2.3	(1.4)	1.786	2.672	231	19.3	0.0658
Capital income hh[a]	4.5***	(13.2)	1.682	2.530	746	25.5	0.0650

Notes: $\bar{s}^{\,c}_{(h)s}$ is the population average savings ratio conditional on positive savings. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, based on robust standard errors.

[a]: Large households and capital income households are residual groups. They are defined in footnotes 20 and 21.

Reading example: A doubling of group-specific income uncertainty from the group-average level conditional on positive savings increases the level savings of by 3.1% for a couple household with no kids. For an average household, a doubling of average income uncertainty from the average level conditional on positive savings increases the level of savings by 4.4%.

Source: Own calculations using the SOEP data (1999-2008) and LWR data (2002-2007), the latter provided by the FDZ.

A comparison of our results to the empirical literature on precautionary savings demands caution concerning comparability of the approaches. Comparability to the results found for uncertainty effects on the stock of precautionary wealth appears to be limited. Even when comparing to the uncertainty effects on consumption flows by Miles (1997), comparability in the interpretation of income uncertainty needs to be accounted for. Miles (1997) finds a decrease in consumption by 3-9% (for the UK in the time frame of 1968-1990) – on average 5% – in turn of a doubling of income uncertainty. But, he evaluates a doubling of average *permanent*, rather than transitory income risk, and his measure for variation in income shocks additionally includes a random effect. If we relate our estimates to a doubling of *permanent* income variation, measured by the variance of permanent income, $var(\widehat{y}^{\,p}_{i(h)})$, we find a decrease in consumption by 9.1%, which is about what Miles (1997) finds as a maximum reaction in the cross-section for the year 1983. We conclude that the uncertainty effects we find are comparable in size to the results found in the literature that applies a similar approach, i.e. Miles (1997). However, on the one hand, our results are considerably more conservative compared to even those mid-level effects in the range of 20-30% found in the literature on precautionary savings for Germany, see Section 1. On the other hand, we find greater uncertainty effects for households in Germany excluding the self-employed than Fossen and Rostam-Afschar (2009).

Moreover, we find that the effects of income uncertainty on the consumption-savings decision vary by household composition and especially by social status. Table 3 shows that the effects of a doubling of transitory income uncertainty on the level of savings vary over all groups between 2.2% and 4.5%. The estimated effects are evaluated at the average group-specific conditional transitory income uncertainty ($\sigma^{2\ c}_{\hat{v},(h)}$)). The evolution of uncertainty over time by the groups of household type has been described in Section 4, based on the the plots for the fraction of permanent variation in Figure 2. The uncertainty effects vary by household composition from 2.2% for couples with two and more kids to 4.0% for singles as well as single parents.[53] Savings of the latter two groups are also more than average elastic to permanent and transitory income shocks (η_s^{perm}, η_s^{tran}).

We interpret these results on savings as follows: for households with otherwise equal characteristics, couples with kids generally are less elastic to transitory income shocks than couples without kids or singles, and couples with two and more kids are the most inelastic. Apparently, kids in a couple's household restrict the part of the budget that is flexibly disposable for purposes of precautionary savings. As couples with one or with two and more kids both have above-average savings ratios, this result indicates that their savings are probably dedicated to other purposes, like intergenerational transfers, e.g. future higher education for the kids or bequests.[54] Single parents, however, are more elastic to transitory shocks than couples without kids. A relatively great group-specific shock variance (Table (1)) indicates, that single parents are probably more often and more severely than couples affected by transitory income shocks, e.g. due to unstable employment patterns, and thus react more strongly by saving for precaution.[55] There might in turn not be enough room for other savings purposes besides the precautionary one, as a below-average group-specific savings ratio indicates.

[53]The maximum group-specific uncertainty effect by household composition (4.0%) is lower than the effect for an average household (4.4%). This at first sight seemingly odd relation results from the evaluation of uncertainty effects by a non-linear combination of the group-specific mean savings share, the group-specific mean variance of transitory shocks, and the coefficient estimate.

[54]Yilmazer (2008) finds that higher education for kids is a major savings purpose of parents. On savings motives of German households, see Börsch-Supan and Essig (2003). For the relevance of intergenerational transfers in general concerning household savings, see Kotlikoff (1988). Gale and Scholz (1994) identify transfers from parents to their children as the major part of intergenerational household transfers.

[55]There is a vast literature on the employment patterns of single parents compared to couple households, see e.g. Millar and Rowlingson (2001).

Moreover, we find that the effects of income uncertainty also vary by social status: for transfer recipients, they are not significantly different from zero, and for public servants as well as blue collar workers they are also relatively low. For pensioners and white collar workers, uncertainty effects are only slightly greater. The greatest effects are found for capital income households (4.5% increase in savings when income uncertainty is doubled). We interpret these results as follows: transfer recipients – although they have a relatively great shock variance (Table 1) – react rather inelasticly to transitory income shocks. They most likely do not have many possibilities to significantly reduce consumption, as their relatively low disposable income indicates ($\bar{y}^{c}_{(h)} = 1,198$). White collar workers, blue collar workers, and public servants usually devote at least some additional savings on a regular basis to mandatory contractual savings (statutory pension insurance or employer-based contracts), so that we would expect their voluntary savings reaction towards uncertainty to be attenuated. Public servants moreover face a relatively low group-specific transitory income uncertainty (Table 1). The latter also holds for pensioners, but they react nevertheless more elasticly towards income uncertainty. The most elastic reaction is found for capital income households. As mentioned in footnotes 20 and 21, this group largely consists of households for which savings determine the main source of income. Nevertheless, they have a slightly below-average savings ratio. If their capital income is affected by a transitory shock, we would expect that these households respond by adjusting the level of savings in order to balance out the income shock.[56]

It remains to note that the results we discussed here can only be a proxy for the actual effects of transitory income uncertainty that households face. Limitations of our understanding of households' savings rationale become apparent when we speculate about the causality of the effects we find. But, we believe that we can contribute a proper approximation of the actual mechanism behind temporary uncertainty in the income stream and intertemporal consumption allocation for households that take their composition and social status as given and observe group-specific income risk.

6 Conclusion

The theory as well as the empirical literature are not unambiguous about the question whether tax reforms that affect the after-tax rate of return to postponing consumption or reforms of the pension system that should generate incentives to save for old age do have any effect on the intertemporal consumption decision of households at all. We can confirm the predominant result from the literature that the uncompensated interest rate elasticity of savings is close to

[56]For capital income households, the buffer stock model of precautionary savings (Carroll, 1997) mentioned in Section 1 could give a good explanation for the savings behavior.

zero. We conclude that policy reforms that aim at an increase in private savings for retirement in certain types of assets through incentives on the net rate of return can at most be obtained on the interior margin by shifting savings from other assets, while the amount of aggregate savings is not affected by incentives related to the interest rate. Such policy reforms would moreover not be welfare neutral, as the compensated interest elasticity is significantly different from zero. Similarly, policy reforms that are related to the consumption price, as e.g. an increase in the value-added tax, do not affect the level of household savings, as the entire effect is absorbed by current consumption.

We conduct an empirical analysis of income and interest rate effects on the consumption-savings decision with consumption survey data from official statistics on private households in Germany for the time of 2002 to 2007. In our base model, we construct a structural demand system for the consumption-savings decision. We can identify effects of the consumption price by expenditure-specific price weights and effects of interest rate variation with the help of household heterogeneity in marginal tax rates on capital income. An income tax module was constructed to simulate differential taxation of labor income and income from the investment of capital. We additionally account for an appropriate treatment of durable goods in the definition of savings by accounting for user costs. We find that savings are a superior good and thus that consumption is an inferior good estimating the income elasticity of savings to 1.8 and of consumption to 0.7. Policy reforms that mainly aim at an increase in aggregate savings should thus focus on increasing households' disposable income, rather than on the net rate of return.

Moreover, we contribute to the vast literature on precautionary savings finding significant effects of transitory income uncertainty on the consumption-savings decision. We model income dynamics in an error components model with panel data for Germany and extend the base demand model to account for income uncertainty. We find that an average household increases savings by 4.4% in response to a doubling of average income risk. In addition, we find that the effects of income uncertainty on the consumption-savings decision vary by household composition and especially by social status. Apparently, kids in a couple's household restrict the part of the budget that is flexibly disposable for purposes of precautionary savings. As couples with one or with two and more kids both have above-average savings ratios, this result indicates that their savings are dedicated to other purposes, like intergenerational transfers, e.g. future higher education for the kids or bequests. We also find that transfer recipients are rather inelastic towards transitory income uncertainty, as they only have a small budget disposable for adjusting savings to a shock. So are public servants, who face a relatively low group-specific income risk and usually devote additional savings to mandatory contractual savings that are beyond the analysis here. The greatest uncertainty effects are found for capital income households, for which savings determine the main source of income.

We also conclude that generally, our understanding of households' savings rationale is limited by the quality of our proxy for income uncertainty. As a transitory income shock is naturally unknown, we can only approximate the actual mechanism behind temporary income uncertainty and households' intertemporal consumption allocation. A plan to improve on our research includes the construction of a pseudo-panel on the LWR data in order to control for household/cohort-specific effects and in order to circumvent the imputation of the estimates of the process for income dynamics from the panel data and have a better capture of household heterogeneity in our proxy for income risk at the household-level.

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A Appendix - Data and Definition of Income and Savings

Data

For the LWR consumption data, households are recruited voluntarily for reports every year, according to stratified quota samples from Germany's current population survey (Mikrozensus), and report for a time of four months (one month out of each quarter of the year). Since 2005, recruited households stem from a subsample of the Income and Consumption Survey for Germany (Einkommens- und Verbrauchsstichprobe, EVS). They are aggregated to the population according to a marginal distribution of demographic variables. The entire population covered by the LWR is restricted, as there are groups that are not covered: self-employed, institutionalized people (i.e. military people in caserns, students in dormitories, elderly and disabled people in nursery homes or hospitals, nurses or migrant workers in residences, people in jails), homeless people, and households with monthly net household income greater than 18,000 euros. When descriptive statistics on the LWR data are presented (see Section 4), data are weighted by population weights. Population weights for the LWR are constructed w.r.t. the marginal distribution of households in the Mikrozensus-population by strata of household composition, social status, and net household income. For further details on the LWR data, see Statistisches Bundesamt (2007).

Treatment of Durables

We account for the investment character of the consumption of durables goods by calculating user costs or depreciation rates for these goods for current consumption and interpret the residual of actual expenditures and user costs as savings. For most of the "relevant" durable goods, user costs are computed by mean imputation. A durable good is considered "relevant" if nearly every household can be assumed to consume at least a small amount of the good every period and the macroeconomic expenses on that good are above an arbitrary threshold. These goods include e.g. furniture, electric devices, entertainment electronics, clothes, shoes, and carpets. In performing the mean imputation, we construct household clusters depending on six age groups, seven income groups, and six household types. We then sum the expenditures for a durable good in each cluster and reallocate the sum equally among all observations in the cluster. Afterwards, we add an estimated quarter effect to every adjusted category of expenditure to avoid a bias in the quarter dummies of the main equation. This is necessary because non-durable consumption is not adjusted for quarter effects.

Expenditures for car purchases form the most significant durable good related to the macroeconomic expenditures, except for housing expenditures. This good is treated a little differently from the described mean imputation. We first estimate a tobit-regression for households owning exactly one car with the reported expenditures for leasing as dependent variable and the disposable income and household characteristics as explanatory variables. We then predict the unconditional value for each household owning at least one car assuming that 90% of the leasing rate is depreciation and 10% is interest payment.[57] The depreciation is calibrated dependent on the number of cars in the household and their characteristics (newly or second-hand bought). If the household reports expenditures for car purchases, 15% of this value is taken directly as depreciation for the first year (5% in case of second-hand purchase). Furthermore, if there are expenditures reported for preventive maintenance or spare parts then these are taken into account in calculating the depreciation. Finally, the macroeconomic sum of expenditures for all the involved goods shall be roughly conserved after adjustment.[58] Following Ruggles and Ruggles (1970), we also apply the market rental value approach to the measurement of services from owner-occupied housing. We apply rents for owner-occupied housing provided with the data and impute them both in current income as well as in consumption. The rents applied are computed by the Federal Statistical Office as follows: an average gross rent (excluding heating and maintenance) per square meter differentiated by federal states is applied to the reported size of the house or flat, and this is added to the reported expenditures for heating and maintenance (Statistisches Bundesamt, 2005).

Definition of Income and Savings

For the relevant budget in our basic consumption-savings model, we apply disposable household income. Disposable household income is defined as net household income added income from sales of home-made products, second-hand goods, and jewelery. Net household income results from subtracting compulsory contributions to the social security funds and to employer-based pension funds as well as income tax prepayments from gross household income. Gross household income in turn is defined as the sum of income from agriculture and forestry, income from trade or business, income from self-employment,[59] income from dependent employment, income from transfers from the social security funds, income from inter-household transfers, income from

[57] In case positive leasing payments are reported, they are applied here.

[58] On arguments for this market rental value approach for the measurement of services from durables, see Ruggles and Ruggles (1970). For a survey on various approaches for the measurement of durable service flows, see Katz (1983).

[59] Although there are no households with a self-employed head in the LWR data, some 2% of all households report positive income from self-employment. In this group, 50% of the households are categorized as white collar workers by main source of income. However, given the low number of households with any income from self-employment, we assume that additional income from self-employment does not affect the group of white-collar worker households differently than all other groups in the savings reaction to increasing income uncertainty.

investment of capital, and income from renting and leasing. Income from renting and leasing additionally includes the imputed rent for owner-occupied housing, as explained in the previous subsection.

As explained in Section 3, we define savings residually from disposable household income and real consumption. In detail, this definition of savings includes net accumulations of the following assets: housing assets that are owner-occupied or rented, financial assets such as bank deposits (i.e. savings accounts, fixed deposits, and money market investments), building society deposits (or home-building savings plans), stocks (including mutual stock funds, certificates, and other shareholdings), and bonds (i.e. private and public securities). Savings moreover include contributions to capital life and private pension insurances net of payouts, and net repayments of loans such as mortgages and consumer credits, where we include the interest component, because it is usually not disposable given the fixed annuity of a loan, see Morgan (1951) for a similar argumentation.

Additionally, in our definition of savings, we include user costs for durable consumption goods, such as cars and furnitures (see the previous subsection for details), and expenditures for contributions to several private insurances such as term life insurances, private health and long term care insurances, and voluntary contributions to the statutory pension insurance funds, and moreover premiums to personal liability insurances, to household insurances, and to liability as well as own-damage insurances for cars. The treatment of these private insurance premiums as savings is debatable, as it is for insurance premiums in general. Premiums to insurances with a pure risk-insuring character, rather than a provisional character, could equally well be treated as consumption. Yet, we argue with the investment character of insurances, as claims for future payoffs are generated by current contributions. Forgoing current consumption and insured future consumption form a trade off that attaches an intertemporal dimension to insurance premiums that allows a treatment as savings. For a comparison of the effects of applying various concepts of the definition of savings on the household savings ratio as well as on the national savings rate, see Blades and Sturm (1982).

Imputation of Wealth

Accounting for owner-occupied housing tax allowances and for wealth and debt as control variables in the demand equations, Eqs. (15) and (22), requires information that is not available in the LWR data. For this purpose, calculations on the basis of income values and imputations on the basis of the EVS data are implemented. Three types of wealth are considered: financial wealth, owner-occupied housing, and rented housing. Financial wealth is imputed via capital income components assuming a market interest rate (varying with time period and maturity). Note that also capital income is partly imputed (see Appendix B). Two methods for the imputation of housing wealth are applied and then compared. Firstly, classical regression imputation is used to match the housing market values given in the EVS data with the LWR data. In both data sets, almost the same information on household characteristics and income components is available. Secondly, tax payments on land and real estate are reported in the LWR for owner-occupied housing in each sample wave and for rented housing in the 2002 sample wave. With this information and applying the reverse assessment of tax on land and real estate, an assessed tax value of housing wealth can be inferred.[60] Using the correlation between the assessed tax value and the market value of the housing wealth, again estimated with the EVS, the value of housing wealth can be determined and then compared to the one resulting form classical regression imputation. By this procedure, an improvement of imputed housing wealth can be achieved for those households that do not report tax payments on land and real estate. Additionally, information on income from renting and leasing is used to improve the imputation of rented housing wealth.

[60] There are different tax parameters for the tax on land and on real estate varying across municipalities. Here, we apply average parameters on federal-state level differentiated by levels of agglomeration.

B Appendix - A Module of Income Taxation

In order to apply after-tax returns to savings, we simulate a marginal tax rate on capital income at the household level in a tax simulation module that implements the German income tax law as of the time of 2002 to 2007. This is necessary, since the actually assessed income tax burden is not observed in the data. Households only report tax prepayments in the LWR data based on the current income from dependent employment in the particular month (for the years 2002 to 2004), respectively in the particular three months period (2005 to 2007). Thus, to simulate a tax assessment for each household, the observed income and expenditure components need to be aggregated to an entire year. Generally, this is done assuming the monthly/quarterly observation is representative for the entire year and thus multiplying it by twelve/four. Deviations from this procedure, in case of strong irregularities or seasonal patterns observed, are explicitly stated in the following.

The household head is assumed the relevant taxable person, with the possibility of joint assessment if a spouse is observed in the household. In case of joint assessment, the progressive tax scale is applied to half of the spouses' joint taxable income and the resulting tax burden is doubled. In addition, several tax-exempt amounts in the assessment are doubled. The procedure is advantageous for the couple in most cases and thus all eligible households are assumed to exercise the option of joint assessment. If there are other adult persons in the household beyond the household head (in case of single assessment), respectively the married couple (in case of joint assessment), household income, deductions, and additional income components that influence the marginal tax rate ("Progressionsvorbehalt", see below) are cut by an arbitrary percentage rate.[61]

Taxable income at the household level is derived according to the scheme in Table B.1. In the following, the single income components are described in further detail with respect to its subcomponents, with respect to specific regulations on eligibility, maximum amounts, lump-sum amounts, and application, and with respect to the implementation in the module of income taxation. As mentioned in Section 4, there are structural differences between the LWRs 2002 to 2004 and the LWRs 2005 to 2007. In the years 2002 to 2004, every household is observed one month per quarter, which results in four observations per household. This household panel structure is used for most of the income components to improve on the annual values. In the years 2005 to 2007, however each household is observed only once with a quarterly value. This is accounted for in the treatment.

[61] In case of single assessment, the amounts are cut by 30% for the first additional person and another 10% for the second and every other person, while for married couples they are cut by 20% for the first additional person and 10% for the second and every other person.

Table B.1: Derivation of Taxable Income According to German Income Tax Law (EStG)

	Single income components:
	income from agriculture and forestry
+	income from trade or business
+	income from self-employment
+	income from dependent employment
+	income from investment of capital
+	income from renting and leasing
+	other income
=	**sum of all forms of income**
-	allowance for agriculture and forestry
-	relief for elderly retired people
=	**adjusted sum of all forms of income**
-	special expenses
-	extraordinary financial burden
-	tax shields for owner-occupied housing
-	loss deductions
=	**income**
-	child allowances
-	household allowance for single parents
=	**taxable income**

Source: § 2 German income tax law (EStG).

Income from agriculture and forestry, **income from trade or business**, as well as **income from self-employment** are corrected for seasonal variation and multiplied by four from quarterly values to annual values.[62] **Income from dependent employment** as considered in the tax module includes basic salaries, contributions to capital formation, gross income from part-time work, in-kind transfers, retirement pensions for public servants from own occupation or as a surviving relative. These income components are aggregated as observed to annual values. Moreover, irregular components are included: compensations for early termination of a contract, bridge money, income from employee profit sharing, and gratifications. These values are treated as annual, no matter in which sample wave they are observed. Further, Christmas

[62]There are no households in the LWR data with a self-employed head or self-employment as main source of income. Moreover, there are only about 2% of all households with any income from agriculture, trade or business. Thus, these sources of income are generally under-represented in the data.

bonuses and vacation bonuses are included. For them, a seasonality is observed, they occur more often in the 4th quarter than in all others. If such payments are not observed but the household receives salary, a value is imputed based on a tobit-regression on salary, employment status, age of household head, employment level, etc. For retirement pensions for public servants, there is an allowance granted: 40% of the pensions, a maximum of 3,000 euros, were tax-exempt in 2005. This allowance is slightly reduced in every year since 2005, where the Retirement Income Act ("Alterseinkünftegesetz") was enacted (see also below at "Other income"). For compensations for early termination of a contract, there are tax allowances increasing with age granted, for persons aged 50 and older. Generally, income from dependent employment can be reduced by income-related expenses, where for every individual, the lump-sum allowance of 920 euros since 2004 is applied (before 2004, it was 1,044 euros).

Income from investment of capital is observed differentiated by dividends, interests, and other payouts, such as those from mutual funds. It is assumed that all taxable income from exogenous investment of capital is captured by these components. Since there occurs some seasonality (dividends are paid mainly in the first or second quarter) and sporadic reporting of these income components, values are imputed by a tobit-regression. For this procedure, all capital income components are aggregated, imputed by the regression, and then reallocated to the components according to the observed structure. If there is no capital income observed, the imputed value is assumed to be interest income. The single income components are reported net of withholding tax on capital income (Kapitalertragsteuer, KEST), a prepayment on income tax. The KEST payment is not observed, it is inferred here from the sum of all income from investment of capital. An allowance is granted on income from investment of capital, 1,550 euros in 2002 shrinking to 750 euros in 2007 for each individual. It is assumed that this allowance is simultaneously applied to income from interests and to income from dividends. Income that exceeds the allowance is assumed to be subject to KEST. KEST was 30% on income from interests in all years. Dividends were subject to personal income taxation, where only 50% of the dividend are taxable (the so called "Halbeinkünfteverfahren"). KEST on income from dividends was 20% in all years. The KEST payments can be credited against the income tax liability as a tax credit. Generally, income from investment of capital can be reduced by income-related expenses, where for every individual, the greater of reported expenses for financial services and a lump-sum of 51 euros is applied. Income from interest payments included in premiums to capital wholesale and private old-age pension insurances were tax-exempt before 2005 if there are contributions paid for at least 5 years and the entire contract duration is at least 12 years. This is assumed here for any income from selling insurance assets.

Income from renting and leasing is observed as income from renting and income from subleasing. These components are reported net of income-related expenses, such as depreciation, interest payments, maintenance costs, insurances, and administration costs. The sum of these net income components is applied here as income from renting and leasing. The annual value is derived by multiplying the seasonally adjusted quarterly, respectively monthly amount.

Other income is observed as income from retirement and other pensions (e.g. private pension insurances), income from speculative trading, and income from alimony. Income from any pensions is applied with a taxable fraction of 27% for the years 2002 to 2004.[63] By the Retirement Income Act, retirement pensions are taxable with a fraction of 50% in 2005, increasing to 54% in 2007. Income from speculative trading occurs if households sell certain assets in a specific time frame from the point of acquisition. If equities (i.e. stocks and bonds here) are sold within 12 months from acquisition net profits generated (i.e. income from selling equities, less costs of their acquisition) are applied here as income from speculative trading.[64] Income from selling owner-occupied housing was tax-exempt, whereas income from selling non-owner occupied housing was tax-exempt if there are at least 10 years between acquisition and realization, otherwise net profits are fully taxable. The values for capital gains from selling stocks and bonds were imputed. Profits from selling non-owner occupied housing were inferred from reducing observed revenues by imputed acquisition costs.[65] Generally, income from speculative trading was only taxable in case net profit generated exceeded 512 euros, but in this case the entire net profit was taxable. Income from alimony is assumed taxable here upon approval of the recipient.[66]

The **sum of all forms of income** is reduced by two allowances: An **allowance for agriculture and forestry** is granted up to 670 euros if income from agriculture and forestry does not exceed 30,700 euros. A **relief for elderly retired people** is granted, 40% of income from dependent employment less income-related expenses, up to a maximum of 1,900 euros, are tax-exempt in 2005 (decreasing to 36.8% and a maximum of 1,748 euros in 2007). There results the adjusted sum of all forms of income.

Further deductions are granted in the form of **special expenses**, such as alimony payments, donations and membership fees devoted to certain public institutions, church tax payments, tuition fees, expenses for child care, and expenses for insurance premiums with provisional character. **Alimony payments** are deductible (given the assumed approval of the recipient) up to a maximum of 13,805 euros. The sum of **donations and membership fees devoted to certain public institutions** is deducted as far as it does not exceed 5% of the adjusted

[63] Since there is no information on the age at which income from old-age pensions was received for the first time, the statutory retirement age of 65 years is assumed here for all income from pensions.

[64] There may occur losses from speculative trading, which may be deducted from any profits from speculative trading. Such losses are assumed to be zero here.

[65] See Appendix A, for imputation of wealth and parameters of the portfolio.

[66] In this case, the payer may deduct the alimony payments as special expenses.

sum of all forms of income (since 2007: 20%). **Church tax payments** are imputed for self-employed and retirement pensioners since they are not regularly paid every month/quarter in these groups. **Tuition fees** for taxpayer's children under the age of 18 are deductible. **Expenses for child care** of children under the age of 14 can be deducted dependent on the tax year. In 2006, the maximum deduction for child care expenses was raised to 4,000 euros per child.

Expenses for insurance premiums with provisional character that are applied here as special expenses are only those expenses that can be considered "inevitable" for the individual. These are compulsory as well as voluntary contributions to the statutory pension insurance, to the statutory health insurance, and to the social long-term care insurance, contributions to private health and long term care insurances, contributions to the unemployment insurance, premiums to personal liability insurances, and premiums to casualty insurances. The greater of actual expenses and a lump-sum allowance for provisional expenses is applied, where the lump-sum allowance is a stepwise function of income from dependent employment reduced by the relief for elderly retired people and the allowance for retirement pensions for public servants (§10c EStG). There is a section for low incomes, one for mid-level incomes, and one for high incomes. For pensioners and employees who do not contribute to the statutory pension insurance, there is an alternative lump-sum allowance. The resulting expenses can only be deducted up to a maximum allowance for provisional expenses. This maximum is a function of income from dependent employment reduced by income from retirement pensions for public servants. Again, there are three sections by level of applied income. Actually deductible expenses for insurance premiums with provisional character result.[67] The greater of the sum of all special expenses and a lump-sum allowance of 36 euros is deducted.

Further deductions are granted for expenses due to **extraordinary financial burden**. These may be related to illness, to disability, to the death of relatives, or to the presence of household members in need of care. Households report expenses for drugs, medical care, services related to assistance for old people, disabled people, and people in need of care. Since neither the degree of disability, nor the degree of need for care are observed, it is assumed that all reported expenses exceeding the level of reasonable burden[68] can be deducted. Children that are not members of the household are identified by the difference between the number of children reported and the number of children derived by received child benefits. For these children, a lump-sum allowance of 924 euros per child is deducted. Other extraordinary financial

[67] The calculations of the maximum deductible expenditures and the lump-sum allowance slightly differ since 2005.

[68] The reasonable burden is determined by a specific percentage rate of the sum of all forms of income, see §33 (3) EStG.

burden may result from occupation of domestic help, for which households report expenses. They are deductible up to 624 euros for individuals aged 60 or older.

Further deductions are granted in the form of **tax shields for owner-occupied housing**. The relevant tax shield regulations are found in §10e, §10h, and §10i EStG. §10e and §10h EStG are relevant in case construction of the building was started before 01.01.1996, §10i EStG in case it was started after this date. According to **§10e and §10h EStG**, if construction was started before 01.01.1996, 6% of the costs of purchasing the building (a maximum of 10,124 euros) may be deducted each year in the first four years, and another 5% in the following four years (a maximum of 8,437 euros). The building needs to be occupied by the owner and may not be occupied for weekends or holidays only. Here, for the sake of simplicity and because of the fact that we face only old cases (anyway only in 2002 and 2003), a fraction of 5% of imputed purchasing costs[69] (up to 8,437 euros) of owner-occupied housing are assumed to be deductible. Because the date of purchasing or construction is not observed in the data, an exclusion restriction is implemented with the help of observed information, i.e. year of construction has to be after 1991, mortgage interest payments greater than zero, and mortgage interest payments exceed the loan repayments.

There is no information observed on **loss deductions**. It is assumed that households do not deduct any losses that emerged in the current or in any previous year. Reducing the adjusted sum of all forms of income by special expenses, expenses due to extraordinary financial burden, and tax shields for owner-occupied housing results in **income** according to tax law.

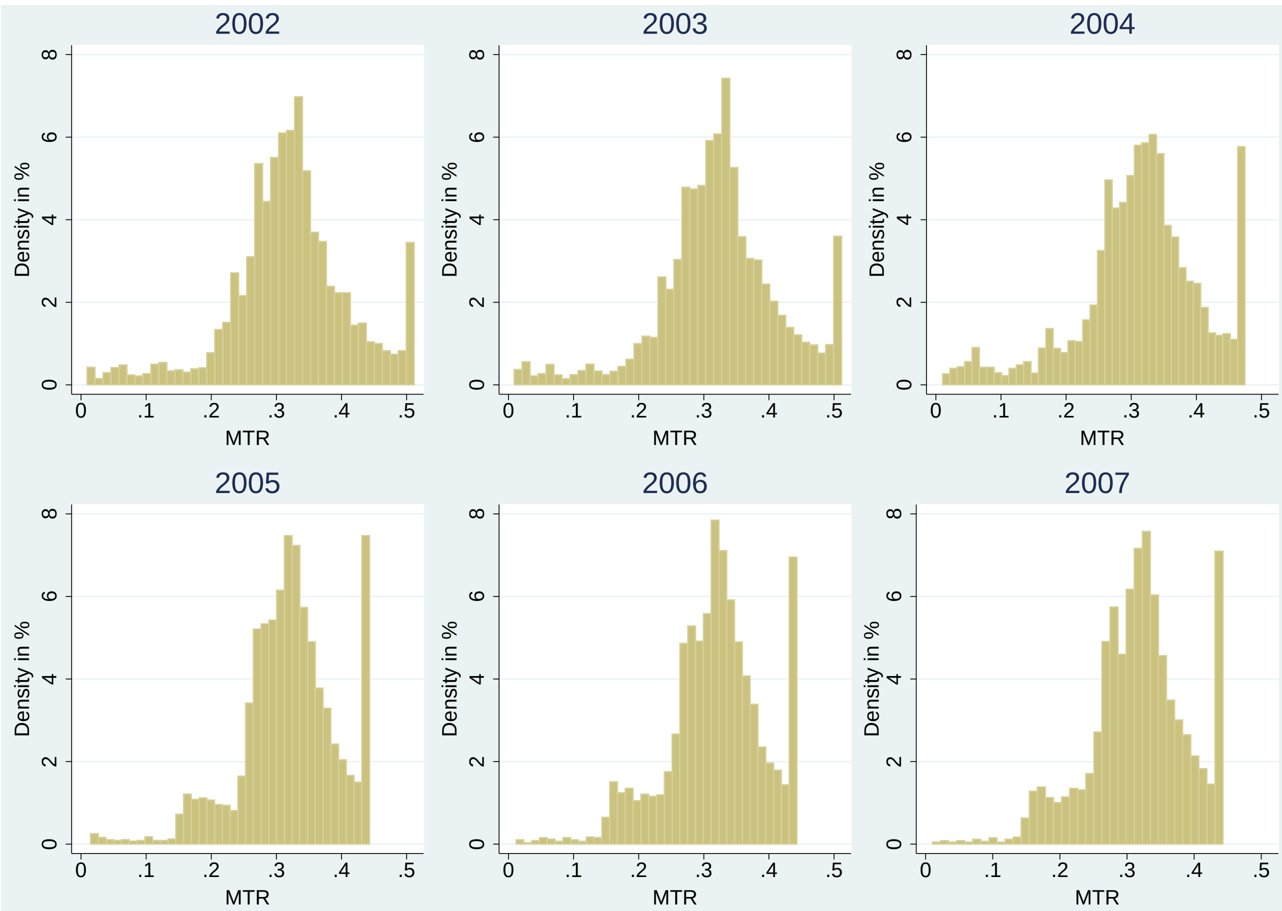
Income may be reduced by a child allowance as well as a household allowance for single parents. Either a **child allowance** is deducted or households get the monthly child benefits which amounted to 154 euros. There is a check undertaken here for which variant is the more favorable for the household, a so called higher-yield test. In case the child benefits are more favorable, the child allowance is not applied and households keep the received child benefits. The child allowance applied amounts to 2,904 euros in each year. It is deducted for both, the household head and its partner. In case spouses are jointly assessed for income taxation, the child allowance is doubled. Children are eligible for child allowance if they are aged below 18, or if they are aged between 18 and 21 and searching for a job, while unemployed, or if they are younger than 27 and currently in education. Furthermore, a **household allowance for single parents** is granted for individuals who are not married and are either eligible for child allowance or live in a household with children that are eligible for child benefits. This allowance amounts to 2,340 euros until 2003 and to 1,308 euros since 2004.

Deducting the household allowance for single parents and the child allowance in case it is

[69] For the imputation of wealth, see Appendix A.

more favorable than child benefits, results in **taxable income**. There remain some income components which are not taxable, but which affect **progressive taxation** (Progressionsvorbehalt). As such are treated here: unemployment benefits, unemployment assistance, transfers related to employment promotions, compensations for short-time work, benefits for part-time retirement, benefits for maternity leave, sickness benefits and other transfers from the statutory health insurance, and transfers from the European Social Fund. The relevant tax rate is derived by adding these income components to taxable income and applying the tax tariff according to §32a EStG to this sum. The resulting tax rate is then applied to taxable income and the tax burden results. As noted above, married couples are assumed to choose joint assessment which means applying the tax tariff to the half of the spouses' joint taxable income and then doubling the resulting tax burden.

Figure B.1: Conditional Distributions of the Marginal Tax Rate by Cross-Section (2002-2007)



Source: Own calculations with the LWR data (2002−2007).

Household specific marginal tax rates are generated by incrementing taxable income assuming the increment is fully taxable and is not accompanied by any deductible expenses. The difference in tax burdens resulting from the increment is applied as a general marginal tax rate on income. Zero is imputed for the tax rate in case the allowance on income from investment of capital is not fully exploited at the household level yet. Thus, the resulting marginal tax rate can be interpreted as a tax rate on capital income specifically.

Figure B.1 plots the conditional distributions of the resulting household marginal tax rate over time, where the condition is on a positive tax rate. Comparing the distribution over time, the variation that results from the final implementations of the income tax reform starting in the year 2000 becomes apparent. The marginal tax rate on the lowest incomes was reduced from 23% (excluding solidarity surcharge and church taxes) in 1998 to 15.0% in 2005 and the top income tax rate was reduced from 51.0% in 2002 to 42.0% in 2005 and raised again to 45.0% in 2007,[70] while the general tax-free allowance was steadily increased.

[70]There are no cases in the data, though, that are affected by this increase in the tariff at the top, see Figure B.1.

C Appendix - Results

Table C.1: NLS Estimates for Variance Components - By Househ. Comp. (Balanced)

dv.: $Var(y_t, y_{t-s})$	singles Coeffs (SE)	single parents Coeffs (SE)	couple, no kids Coeffs (SE)	couple, 1 kid Coeffs (SE)	couple, 2+ kids Coeffs (SE)	pooled Coeffs (SE)
$\sigma^2_{v_0}$	0.1734	0.1371	0.1120	0.0684	0.0279	0.1006
	(0.0332)***	(0.0492)**	(0.0251)***	(0.0310)*	(0.0296)	(0.0268)***
σ^2_{ε}	0.0568	0.0545	0.0445	0.0447	0.0497	0.0490
	(0.0053)***	(0.0094)***	(0.0033)***	(0.0053)***	(0.0045)***	(0.0043)***
σ^2_{μ}	0.0568	0.0328	0.0445	0.0410	0.0320	0.0437
	(0.0029)***	(0.0053)***	(0.0016)***	(0.0034)***	(0.0027)***	(0.0023)***
ρ	0.5211	0.5685	0.4526	0.5265	0.4809	0.5032
	(0.0236)***	(0.0365)***	(0.0217)***	(0.0278)***	(0.0279)***	(0.0231)***
p_{2000}	1.0583	1.1162	1.1065	0.9521	0.9438	1.0466
	(0.0349)***	(0.1123)***	(0.0256)***	(0.0524)***	(0.0543)***	(0.0365)***
p_{2001}	1.0224	1.1809	1.1591	0.9239	0.9950	1.0609
	(0.0358)***	(0.1218)***	(0.0274)***	(0.0555)***	(0.0595)***	(0.0387)***
p_{2002}	1.1637	1.1249	1.2660	1.0191	1.0305	1.1527
	(0.0406)***	(0.1273)***	(0.0302)***	(0.0634)***	(0.0660)***	(0.0432)***
p_{2003}	1.2552	1.2613	1.3368	1.1080	1.1442	1.2375
	(0.0447)***	(0.1455)***	(0.0323)***	(0.0714)***	(0.0731)***	(0.0474)***
p_{2004}	1.2893	1.2871	1.3996	1.0795	1.2118	1.2760
	(0.0470)***	(0.1551)***	(0.0342)***	(0.0746)***	(0.0788)***	(0.0500)***
p_{2005}	1.3680	1.3822	1.4156	1.1655	1.2513	1.3299
	(0.0516)***	(0.1643)***	(0.0351)***	(0.0787)***	(0.0803)***	(0.0520)***
p_{2006}	1.4022	1.3882	1.3860	1.2497	1.1581	1.3246
	(0.0512)***	(0.1631)***	(0.0335)***	(0.0799)***	(0.0734)***	(0.0505)***
p_{2007}	1.3666	1.3821	1.3709	1.1643	1.1247	1.2914
	(0.0482)***	(0.1551)***	(0.0326)***	(0.0715)***	(0.0683)***	(0.0476)***
p_{2008}	1.3244	1.6005	1.3734	1.1498	1.1474	1.2870
	(0.0447)***	(0.1670)***	(0.0315)***	(0.0663)***	(0.0656)***	(0.0452)***
l_{2001}	1.0317	1.1772	0.9295	0.9985	0.8982	0.9823
	(0.0548)***	(0.1054)***	(0.0458)***	(0.0712)***	(0.0567)***	(0.0526)***
l_{2002}	0.9872	1.0376	0.9641	0.9987	1.0499	1.0071
	(0.0593)***	(0.1083)***	(0.0486)***	(0.0761)***	(0.0594)***	(0.0563)***
l_{2003}	0.9195	1.0149	0.9803	0.9620	0.8292	0.9343
	(0.0627)***	(0.1148)***	(0.0504)***	(0.0795)***	(0.0635)***	(0.0589)***
l_{2004}	0.9521	1.0543	0.8130	1.0549	0.9013	0.9337
	(0.0642)***	(0.1179)***	(0.0547)***	(0.0806)***	(0.0648)***	(0.0606)***
l_{2005}	0.7242	1.0420	0.7234	1.0288	0.8506	0.8371
	(0.0755)***	(0.1205)***	(0.0593)***	(0.0824)***	(0.0671)***	(0.0641)***
l_{2006}	0.7935	0.9562	0.8235	1.0014	0.8884	0.8745
	(0.0713)***	(0.1207)***	(0.0535)***	(0.0839)***	(0.0631)***	(0.0621)***
l_{2007}	0.8324	1.0539	0.8235	1.0785	0.8877	0.9076
	(0.0665)***	(0.1192)***	(0.0522)***	(0.0812)***	(0.0614)***	(0.0596)***
l_{2008}	0.8641	1.0575	0.8615	1.1447	0.9681	0.9510
	(0.0626)***	(0.1232)***	(0.0501)***	(0.0812)***	(0.0602)***	(0.0578)***

Notes: N=55 moments. Signif. lev.: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. p_{99}, l_{99} and l_{00} normalized to 1.
Source: Own calculations with the SOEP data (1999-2008).

Table C.2: NLS Estimates for Variance Components - By Social Status (Balanced)

dv.: $Var(y_t, y_{t-s})$	white collar Coeffs (SE)	public servants Coeffs (SE)	blue collar Coeffs (SE)	pensioners Coeffs (SE)	transfer recipients Coeffs (SE)	pooled Coeffs (SE)
$\sigma^2_{v_0}$	0.1256	0.1674	0.0615	0.0742	0.1318	0.1006
	(0.0287)***	(0.0348)***	(0.0356)	(0.0305)*	(0.0535)*	(0.0268)***
σ^2_{ε}	0.0587	0.0285	0.0428	0.0432	0.0662	0.0490
	(0.0050)***	(0.0053)***	(0.0043)***	(0.0038)***	(0.0098)***	(0.0043)***
σ^2_{μ}	0.0332	0.0192	0.0268	0.0620	0.0243	0.0437
	(0.0026)***	(0.0031)***	(0.0023)***	(0.0021)***	(0.0057)***	(0.0023)***
ρ	0.5269	0.5763	0.4208	0.4347	0.5306	0.5032
	(0.0235)***	(0.0354)***	(0.0275)***	(0.0281)***	(0.0288)***	(0.0231)***
p_{2000}	1.0672	1.0533	1.0566	1.0365	1.2560	1.0466
	(0.0535)***	(0.1053)***	(0.0600)***	(0.0231)***	(0.1781)***	(0.0365)***
p_{2001}	1.0799	1.1325	1.0077	1.0842	1.0325	1.0609
	(0.0562)***	(0.1130)***	(0.0616)***	(0.0249)***	(0.1661)***	(0.0387)***
p_{2002}	1.2014	1.4320	1.1415	1.1547	1.0277	1.1527
	(0.0634)***	(0.1381)***	(0.0695)***	(0.0271)***	(0.1793)***	(0.0432)***
p_{2003}	1.2847	1.5944	1.1595	1.2012	1.0543	1.2375
	(0.0696)***	(0.1626)***	(0.0727)***	(0.0288)***	(0.1967)***	(0.0474)***
p_{2004}	1.3560	1.4780	1.2215	1.1865	1.1015	1.2760
	(0.0749)***	(0.1560)***	(0.0766)***	(0.0287)***	(0.2050)***	(0.0500)***
p_{2005}	1.4393	1.5384	1.2591	1.1896	1.2578	1.3299
	(0.0801)***	(0.1736)***	(0.0786)***	(0.0290)***	(0.2234)***	(0.0520)***
p_{2006}	1.4411	1.6269	1.2268	1.2117	1.0964	1.3246
	(0.0800)***	(0.1755)***	(0.0749)***	(0.0288)***	(0.1953)***	(0.0505)***
p_{2007}	1.4203	1.6695	1.1677	1.1901	0.9148	1.2914
	(0.0748)***	(0.1915)***	(0.0703)***	(0.0276)***	(0.1656)***	(0.0476)***
p_{2008}	1.3981	1.5471	1.1825	1.1481	1.2037	1.2870
	(0.0702)***	(0.1599)***	(0.0681)***	(0.0259)***	(0.1890)***	(0.0452)***
l_{2001}	0.9515	1.2247	0.9497	0.9623	1.0002	0.9823
	(0.0493)***	(0.1105)***	(0.0627)***	(0.0558)***	(0.0850)***	(0.0526)***
l_{2002}	0.9775	1.1034	1.0054	0.9253	1.0680	1.0071
	(0.0534)***	(0.1257)***	(0.0663)***	(0.0586)***	(0.0921)***	(0.0563)***
l_{2003}	0.8872	0.8682	0.9889	0.7729	1.2019	0.9343
	(0.0565)***	(0.1489)***	(0.0677)***	(0.0642)***	(0.1002)***	(0.0589)***
l_{2004}	0.8773	1.0421	1.0079	0.8538	1.0376	0.9337
	(0.0593)***	(0.1386)***	(0.0695)***	(0.0617)***	(0.0965)***	(0.0606)***
l_{2005}	0.7852	0.8152	0.8495	0.7245	1.0238	0.8371
	(0.0649)***	(0.1552)***	(0.0730)***	(0.0669)***	(0.1002)***	(0.0641)***
l_{2006}	0.7462	1.0150	1.0116	0.7637	1.0580	0.8745
	(0.0665)***	(0.1422)***	(0.0692)***	(0.0649)***	(0.0959)***	(0.0621)***
l_{2007}	0.8363	0.7668	0.9297	0.8397	1.0241	0.9076
	(0.0598)***	(0.1646)***	(0.0676)***	(0.0608)***	(0.0909)***	(0.0596)***
l_{2008}	0.8890	1.0334	0.9677	0.8989	1.0808	0.9510
	(0.0565)***	(0.1335)***	(0.0664)***	(0.0580)***	(0.0960)***	(0.0578)***

Notes: N=55 moments. Signif. lev.: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. p_{99}, l_{99} and l_{00} normalized to 1.
Source: Own calculations with the SOEP data (1999-2008).

Table C.3: OLS Estimates for Savings (Share) Demand Equation

	No Uncertainty		Income Uncertainty					
			Pooled		HH Comp.		Social Status	
dep. var.: $s_{i,s}$	Coeffs	(SE)	Coeffs	(SE)	Coeffs	(SE)	Coeffs	(SE)
Income Polynom.:								
y (or $\widehat{y}^p$)	-0.418	(0.05)***	0.250	(0.01)***	0.243	(0.01)***	0.216	(0.01)***
y (or $\widehat{y}^p$) $* hhtype2$	-0.260	(0.13)**	0.020	(0.02)	0.031	(0.02)**	0.054	(0.01)***
y (or $\widehat{y}^p$) $* hhtype3$	-0.284	(0.07)***	-0.022	(0.01)***	-0.018	(0.01)**	-0.008	(0.01)
y (or $\widehat{y}^p$) $* hhtype4$	-0.137	(0.20)	0.001	(0.01)	0.003	(0.01)	0.028	(0.01)***
y (or $\widehat{y}^p$) $* hhtype5$	0.067	(0.12)	0.032	(0.01)***	0.033	(0.01)***	0.047	(0.01)***
y (or $\widehat{y}^p$) $* hhtype6$	-0.491	(0.08)***	-0.017	(0.01)**	-0.013	(0.01)*	0.008	(0.01)
y^2	0.038	(0.00)***	—		—		—	
$y^2 * hhtype2$	0.015	(0.01)**	—		—		—	
$y^2 * hhtype3$	0.013	(0.00)***	—		—		—	
$y^2 * hhtype4$	0.007	(0.01)	—		—		—	
$y^2 * hhtype5$	-0.004	(0.01)	—		—		—	
$y^2 * hhtype6$	0.024	(0.01)***	—		—		—	
Prices:								
p_s	0.046	(0.02)**	0.124	(0.02)***	0.122	(0.02)***	0.120	(0.02)***
p_c	0.209	(0.09)**	0.179	(0.09)**	0.217	(0.09)**	0.112	(0.09)
Transitory Inc.:								
$\widehat{v}$	—		0.434	(0.01)***	0.467	(0.01)***	0.473	(0.01)***
$\widehat{v} * hhtype2$	—		0.078	(0.01)***	0.041	(0.02)**	0.060	(0.01)***
$\widehat{v} * hhtype3$	—		0.027	(0.01)**	0.020	(0.01)	-0.004	(0.01)
$\widehat{v} * hhtype4$	—		0.099	(0.01)***	0.098	(0.01)***	0.097	(0.01)***
$\widehat{v} * hhtype5$	—		0.086	(0.01)***	0.089	(0.01)***	0.087	(0.01)***
$\widehat{v} * hhtype6$	—		0.056	(0.01)***	0.043	(0.01)***	0.037	(0.01)***
Shock Polynomial:								
$\widehat{v}^2$	—		0.549	(0.03)***	0.358	(0.02)***	0.324	(0.02)***
$\widehat{v}^2 * hhtype2$	—		—		-0.165	(0.04)***	0.236	(0.08)***
$\widehat{v}^2 * hhtype3$	—		—		0.180	(0.04)***	-0.056	(0.03)*
$\widehat{v}^2 * hhtype4$	—		—		-0.055	(0.04)	0.308	(0.05)***
$\widehat{v}^2 * hhtype5$	—		—		-0.090	(0.04)**	-0.225	(0.03)***
$\widehat{v}^2 * hhtype6$	—		—		0.035	(0.03)	0.045	(0.04)
$\widehat{v}^3$	—		-0.451	(0.05)***	-0.279	(0.04)***	-0.197	(0.02)***
$\widehat{v}^3 * hhtype2$	—		—		0.252	(0.06)***	-0.467	(0.16)***
$\widehat{v}^3 * hhtype3$	—		—		-0.208	(0.09)**	0.200	(0.05)***
$\widehat{v}^3 * hhtype4$	—		—		0.052	(0.05)	0.002	(0.16)
$\widehat{v}^3 * hhtype5$	—		—		0.075	(0.06)	0.131	(0.04)***
$\widehat{v}^3 * hhtype6$	—		—		0.064	(0.06)	-0.098	(0.05)**
Control Variables:								
age (household head)	yes		yes		yes		yes	
gender (head)	yes		yes		yes		yes	
education (head)	yes		yes		yes		yes	
marital stat. (head)	yes		yes		yes		yes	
hh-comp	yes		yes		yes		yes	
social status	yes		yes		yes		yes	
net assets (2^{nd} pol.)	yes		yes		yes		yes	
(asset pol.)*(renting)	yes		yes		yes		yes	
durables dummies	yes		yes		yes		yes	
dummy for renting	yes		yes		yes		yes	
location (fed. states)	yes		yes		yes		yes	
time dummies	yes		yes		yes		yes	
Observations	73,194		73,194		73,194		73,194	
R^2	0.4208		0.4212		0.4209		0.4224	

Notes: y is current disposable income in logs, $\widehat{y}^p$ is permanent income in logs, and $\widehat{v}$ is residual from log-income regression. Significance levels: $*\,p < 0.10$, $**\,p < 0.05$, $***\,p < 0.01$, based on robust standard errors.
Source: Own calculations using the SOEP data (1999-2008) and LWR data (2002-2007) provided by the FDZ.