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Abstract

The life cycle/permanent income hypothesis (LCPIH) makes two postulates: people behave with rational expectations, and people do not have self-control problems. If either or both of these postulates do not apply, we cannot obtain a testable implication of the LCPIH. We use Japanese panel data that include responses to self-reported and retrospective questions to elicit individual characteristics such as forward-looking behavior, experience of self-control problems, and use of commitment devices to overcome self-control problems. First, we test the rational expectations hypothesis and find that it holds for the whole sample. We then test the LCPIH implication and find that consumption does not change in response to expected income changes, which we restrict to fit the assumptions of the LCPIH. This result indicates that the LCPIH is a convincing model to account for the behavior of rational consumers who have rational expectations and no self-control problems. Our results also imply that responses to self-reported and retrospective questions are not meaningless when eliciting information on household characteristics.

Keywords: Life cycle/permanent income hypothesis; Excess sensitivity; Rational expectation; Self-control problems; sophisticated and naïve.
JEL Classification: D12; D91; E21.

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1. Introduction

Understanding the mechanisms of consumer behavior is fundamental for evaluating the macroeconomic impact of public policy. The life cycle/permanent income hypothesis (LCPIH) is a basic model for describing consumption behavior over time. Therefore, many economists have conducted empirical analyses to test the LCPIH. Some researchers have examined the relation between predicted income change and consumption growth, and found that, if the LCPIH holds, the predicted income change does not help explain consumption growth.[1] Despite many empirical studies testing the LCPIH using this method, no consensus on the LCPIH has been reached (Browning and Lusardi, 1996; Attanasio, 1999; Attanasio and Weber, 2010; Jappelli and Pistaferri, 2010).

In rejecting the LCPIH implication, several hypotheses have been tested, including liquidity constraints, precautionary motives, inseparability of consumption and leisure, buffer-stock saving behavior, durability of goods, and habit formation. A fundamental specification error of an economic model is also candidate to induce the excess sensitivity.

Our paper focuses on the implicit and defined assumptions of the standard LCPIH.[2] The standard LCPIH assumes that households can construct consumption plans based on unbiased predictions of future income and that they can execute their plans. In other words, we focus on two postulates of the LCPIH: (1) households have rational expectations; (2) households do not have self-control problems. If either or both of these assumptions are not applicable, we cannot obtain a testable implication of the LCPIH. Moreover, if these assumptions do not describe actual behavior, the economic model will not explain actual behavior. To construct a more suitable model, we must know what assumptions are reasonable.

The rational expectations hypothesis (REH) is implicitly and definitely assumed for any models of dynamic decision making. Some empirical studies have tested REH. For example, Das and van Soest (1999) and Souleles (2004) provided evidence that shows that agents cannot forecast their future income changes correctly. Standard models also assume that people do not have self-control problems. In other

[1] This test, known as the excess sensitivity test, was originally proposed by Flavin (1981). She modified Hall's model assuming that income follows an ARMA process and found excess sensitivity, which means that the response of consumption change to income change is greater than the LCPIH implies.

[2] In this paper, we refer to the standard consumption model as the model proposed by Hall (1978). Hall assumed that the utility function is additively separable for time and quadratic (which makes the instantaneous utility function concave), that the interest rate is equivalent to the subjective discount rate, and that there is a perfect capital market. In addition, Hall introduces uncertainty of future income.

words, under the LCPIH consumers can execute ex ante optimal consumption plans. However, many empirical studies have shown that a certain proportion of people do experience self-control problems.[3] If the assumption of no self-control problems is not valid, the implication of the LCPIH could be rejected.

The purpose of this paper is to investigate whether the LCPIH, and two associated postulates, hold for the households in our sample. If the LCPIH holds, expected income changes should not explain consumption changes for households that not only precisely predict their future income changes but also execute ex ante optimal consumption plans. To examine this prediction, we use data from the *Preference and Life Satisfaction Survey* (PLiSS) conducted as part of a 21st Century Center of Excellent (COE) Program and Global COE Program by Osaka University.[4] The PLiSS is a longitudinal survey conducted from 2004 to 2010 that asks questions about individual preferences and individual future expectations about income and consumption. Responses to self-reported and retrospective questions enable us to identify respondents' forward-looking behavior, which is an element of the REH, and characteristics related to self-control problems. Using these questions, we can identify households whose characteristics coincide with the assumptions of the LCPIH. Of course, some concerns might arise about the usefulness of self-reported or retrospective questions in eliciting household characteristics. One criticism of the method is the difference between actual behavior and behavior described in responses. In particular, this criticism is likely to apply to information on individual self-control problems. Although we cannot fully deal with this issue, we try to provide a robust result by using several kinds of questions.

The excess sensitivity test requires an expectation of income change. We use subjective expectations of income change, which is a better approach than the instrumental variable method because it contains richer information that an econometrician cannot observe (Browning and Lusardi, 1996; Jappelli and Pistaferri, 2000). This approach also helps in examining the REH because we can compare actual incomes with subjective income expectations. Furthermore, the responses to our questions on expected income changes are presented as quantitative measures rather than as qualitative ones and have greater variation than in previous studies such as Das and van Soest (1999), Jappelli and Pistaferri (2000), and Souleles (2004). Thus, our data

[3] Papers examining self-control problems include Frederick, Lowenstein, and O'Donoghue (2002) and Della Vigna (2009).

[4] The full name is the 21st Century Center of Excellence Program titled "Construction of Behavioral Macrodynamics by Large-scale Survey and Experiments." This program was supported by the Ministry of Education, Culture, Sports and Science and Technology since 2003.

enable us to implement the REH test and the excess sensitivity test under more favorable conditions than previous studies.[5]

In the first step of our analysis, to examine the REH and detect households for which the REH holds, we conduct the REH test (unbiased prediction test) for both the whole sample and the subsamples, created by dividing the whole sample according to proxies for forward-looking behavior. We find that, in the whole sample, people can correctly forecast their future income changes. Furthermore, our results of the REH test for the subsamples show that people who always make plans before they actually implement them predict their future incomes more precisely than people who do not make such plans. This result indicates that our proxies for forward-looking behavior successfully detect individual characteristics that relate to rational expectations.

In the second step, we examine whether the LCPIH holds for households whose behavior coincides with the LCPIH assumptions. First, we find that the predicted growth in income explains the growth in consumption for the whole sample, even when controlling for the precautionary saving motive, nonseparability between consumption and leisure, forecast error potentially arising from short panel data, and the effect of liquidity constraints. As expected, our results show stronger excess sensitivity for non-forward-looking households, but weaker excess sensitivity for forward-looking households that make plans. In addition, using survey questions, we identify not only the households for which the REH holds but also those that do not have self-control problems. In this group, we do not observe excess sensitivity. Incrementally, we implement the excess sensitivity test after dividing the sample into sophisticated households and naïve households to investigate the theoretical implications of O'Donoghue and Rabin (1999).[6] We find that sophisticated households have weaker excess sensitivity than naïve households. This result supports our hypothesis. If we confine our sample to the group for which the standard LCPIH is intended, we confirm that the LCPIH is not rejected. This result implies that the LCPIH is useful for predicting consumer behavior for rational households and comprehensive as the benchmark model. Furthermore, our results indicate that responses to self-reported and retrospective questions are not meaningless in eliciting information on households' characteristics.

The rest of the paper is structured as follows. In Section 2, we survey relevant literature related to our hypothesis. Section 3 explains the survey and sample data used in our study. Section 4 provides the empirical model used to examine the REH. Section 5 explains the empirical model used to examine the LCPIH. In Section 6, we report the

[5] Souleles (2004) also implemented the REH test and the excess sensitivity test. However, he used matched data to conduct the excess sensitivity test.

[6] Whereas sophisticated households are aware of their self-control problems, naïve households are not. We divide our sample based on responses to self-reported and retrospective questions.

empirical results of the REH test and the excess sensitivity test. Section 7 concludes the paper.

2. Related literature

We focus on two postulates of the LCPIH: (1) households have rational expectations; (2) households do not have self-control problems. In this section, we survey the literature relevant to these postulates.

2.1. Rational expectations hypothesis

The REH is postulated not only for the LCPIH but also for any macroeconomic models that analyze agent's dynamic decision making. The REH in relation to future income changes is often defined as follows: $EGY_t = E[GY_{t+1}|\Omega_t]$, where EGY_t is the expected income growth rate from t to t+1 expected at t, E is the expectation operator, GY_{t+1} is the income growth rate from t to t+1, and Ω_t is the agent's information set available at t. This equation indicates that agents are forward looking and, on average, correctly forecast their future income changes.

As the REH is the central assumption in any dynamic model, many studies have investigated households' predictions of factors such as the future inflation rate, the interest rate, and change in income (Pesaran and Weale, 2006). However, there is no established consensus on the REH. Although many studies have investigated the REH using aggregate-level data, only a few papers have examined the REH using household-level data because of data limitations. As Manski (2004) mentioned, micro-level data on future expectations are required in order to elicit a household's dynamic decision-making mechanism.

Empirical studies of the REH that use household-level data compare the predicted and actual outcomes. We refer to this method as the unbiased prediction test. As Chamberlin (1984) and Souleles (2004) pointed out, the unbiased prediction test raises some concerns in testing the REH. They emphasized that the forecast error could reject any empirical model testing households' dynamic decisions. Two types of forecast error have been identified (Souleles, 2004). The first type arises from data limitations. According to the LCPIH that assumes the REH, the error term of the Euler equation must be zero. The conditional expectation of the forecast error will be zero when taking an average over long periods of time. However, the forecast error will not be zero across a large number of households. Furthermore, if the forecast error is the sum of an aggregate shock and of an idiosyncratic shock, then the orthogonal condition fails in a short panel even if the LCPIH is true. Aggregate shocks could induce a cross-sectional correlation between expected consumption growth and predicted income growth. Some empirical evidence using household-level data indicates that this forecast error is significant. For example, Das and van Soest (1999) used data from *The Dutch*

Socio-Economic Panel and rejected the REH; their results showed that households tend to underestimate future income changes.

Systematic heterogeneous forecast errors are the second type of error, and can lead to rejection of the REH even if we can use sufficiently long panel data to test it. In this respect, Souleles (2004) is a crucial study because he tested the REH using longer data from *The Michigan Survey of Consumer Attitudes and Behavior*, which contains information on households' expectations about their future income prospects, business conditions, and prices, among others. His test rejected the REH because of evidence showing that the forecast errors were correlated with household demographic characteristics. This result implies that systematic heterogeneity in forecast errors could be a general problem when testing the LCPIH. If the agent's characteristics that could potentially induce systematic forecast errors are correlated with predictions of own future income changes and consumption behavior, excess sensitivity could be observed.[7]

Another possible explanation for the failure of the REH is bounded rationality, which has been used broadly since Simon (1955).[8] Furthermore, the rule of thumb could also cause a rejection of the REH. For example, Campbell and Mankiw (1989; 1990; 1991) assumed rule-of-thumb behavior as current consumption changes depend on current income changes, and showed that 35%–50% of consumers can be classified as rule-of-thumb consumers.

2.2. Self-control problems

The standard consumption model assumes that people do not have self-control problems, which means that they can execute their ex ante optimal consumption plans. However, in the real world, people may struggle with self-control problems in any situation. Therefore, there are many theoretical approaches to modeling self-control problems, as well as considerable empirical evidence showing that people experience self-control problems (Frederick, Lowenstein, and O'Donoghue, 2002; Della Vigna, 2009). In addition, agents' awareness of their self-control problems is an important topic because it relates to aspects of public policy, such as the pension system or bankruptcy rules. It is therefore worthwhile to test whether the assumption of self-control problems is critical in describing consumption behavior.

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[7] Overconfidence and propensity to plan might be candidates to cause systematic forecast errors; for example, see Clark and Friesen (2009) and Ameriks, Caplin, and Leahy (2003).

[8] Conlisk (1996) conducted a survey of studies of bounded rationality. The rule of thumb has been used in a similar way. In the words of Rodepeter and Winter (2000, p. 1), "rule of thumb behavior is as important aspect of bounded rationality".

There are five broad approaches to modeling self-control problems. One approach assumes that people have present-biased quasi-hyperbolic discounting preferences (Strotz, 1995; Ainslie, 1992; Laibson, 1997; O'Donoghue and Rabin, 1999). That is, people put more weight on the present than on the future, leading to dynamic inconsistency.[9] As this model is simple and tractable, many studies have modified it and provide empirical evidence based on it. The second approach is the temptation model, as used in Gul and Pessendorfer (2001); they show that commitment is a useful mechanism to overcome temptation by restricting the agent's choice sets. The third approach is the dual-self model (Thaler and Shefrin, 1981; Fudenberg and Levine, 2006), which analyzes the relationship between two types of self-behavior: an optimal planner and a myopic doer. The fourth approach to modeling self-control problems considers self-signaling, which assumes two periods and imperfect knowledge of one's own type (Béhabou and Tirole, 2004). The fifth approach examines the agent's will or willpower, as in Ozdenoren, Salant, and Silverman (forthcoming); they incorporate willpower into a basic household's dynamic decision-making model as a depletable but renewable resource.

We do not seek to prove these theoretical explanations for self-control problems, as our purpose is to test the validity of the LCPIH assumption for households with rational expectations and no self-control problems—characteristics that coincide with the standard LCPIH assumptions.

Whether or not people are aware of their self-control problems is also an important issue. If they are aware of their self-control problems, they should use commitment devices to work out optimal consumption plans. O'Donoghue and Rabin (1999; 2001) classified households as sophisticated or naïve and discussed the welfare implications in a quasi-hyperbolic discount model.[10] They showed that sophisticated households employ commitment devices to force them to execute their ex ante plans.

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[9] Let ut denote the instantaneous utility at time t, Ut the overall utility at time t, and δ the discount factor. We can write the overall utility as follows: Ut = ut + βδut + 1 + β(δ × δ)ut + 2 + ⋯. In contrast to the standard model (β = 1), parameter β < 1 induces time-inconsistent preferences, which implies that households have self-control problems.

[10] O'Donoghue and Rabin (2001) classified households as (1) sophisticated, (2) partially naïve, or (3) fully naïve. They introduced a person's beliefs about his or her self-control problems $(\tilde{\beta})$. In the case of $\beta < 1$, which means that a self-control problem exists, and where the agent's belief is $\tilde{\beta} = \beta$, which means the agent is fully aware of his or her self-control problem, the person is called "sophisticated." In the case of $\beta < 1$ and where the agent's belief is $\tilde{\beta} = 1$, which means the agent is not at all aware of his or her self-control problem, the person is "fully naïve." They also introduce a "partially naïve" person, for $\beta < 1$ and $\tilde{\beta} \in (0,1)$, which means the person does not precisely know of his or her self-control problem.

Naïve households, by contrast, do not use commitment devices and their ex post lifetime utility is worse off than the lifetime utility evaluated by the ex ante plan. Some empirical studies have analyzed the effect of commitment devices on decisions of participation and savings, focusing on individual retirement accounts, 401(k) retirement savings plans, and social security in the case of the United States (Madrian and Shea, 2001; Choi, Laibson, Madrian, and Metrick 2003; Thaler and Benartzi, 2004). However, sufficient evidence has not been provided to explore the relationship between consumption behavior and the use of commitment devices.

According to the LCPIH, consumption behavior should not change in response to expected income changes if households do not have self-control problems. However, consumption behavior could respond to expected income change if households do have self-control problems.[11] Furthermore, the model proposed by O'Donoghue and Rabin (1999; 2001) predicts that the LCPIH assumption could be rejected for naïve households that do not prepare a commitment device in advance. Our paper examines this hypothesis using self-reported and retrospective questions that proxy for sophisticated households.

3. Data

3.1. Preference and Life Satisfaction Survey

This paper uses micro-level data from the *Preference and Life Satisfaction Survey* (PLiSS), a panel survey conducted by Osaka University as part of the 21st Century COE Program and Global COE Program.[12] This survey gathers useful information on individual preferences and predictions for future income and consumption changes. With this information on future expectations and longitudinal data, we can jointly test the rational expectations and excess sensitivity of the same households. The sample households are selected randomly from across Japan using the Basic Residents Registration System, thus providing a representative sample of the total Japanese population. Households were interviewed once a year from February 2004 to 2010. New households entered the panel in 2006 and 2009.

The annual attrition rate for the panel ranges from 12% to 29% and the sample size decreases over time. Therefore, the sample for our analysis is an unbalanced panel. To test the REH and excess sensitivity, we keep observations that contain sufficient information to obtain the changes in family income and consumption for at least two successive periods. The sample includes married respondents where either the husband

[11] If households have time-inconsistent preferences for immediate costs, they procrastinate in order to decrease their consumption when their future income is expected to decrease (O'Donoghue and Rabin, 1999).

[12] The 21st Century COE Program and the Global COE Program are projects conducted by the Ministry of Education, Culture, Sports and Science and Technology.

or the wife is employed. Retired households are excluded from the sample. After eliminating observations with missing data, the resulting sample includes 7,128 respondents. The total number of observations is 19,052 and the percentages of cross-sectional observations in each year of the survey are 16%(2004-05), 12%(2005-06), 16%(2006-07), 14%(2007-08), 13%(2008-09), and 28%(2009-10).[13] The sample used in our analysis follows the same trend for the proportion of cross-sectional observations as the total sample that includes observations excluded because of missing values.

[Table 1]

Table 1 shows the basic characteristics of the households in our data set. The average age of the respondents is 52.68 years. Half of all respondents are female. Half of all respondents are high school graduates and a quarter of all respondents are university or college graduates.

3.2. Main variables

3.2.1. Income

The PLiSS collects data on income in several ways. We use two income variables: (1) total annual household income and (2) the sum of the monthly incomes of the respondent and spouse over the course of the year.[14] Although we need the rate of income change to test rational expectations, we cannot obtain the precise rate of income change using total annual household income because it is a categorical variable. To mitigate measurement errors arising from basing calculations on a categorical variable, we also use the monthly income data, which are obtained by asking an open-ended question. However, using the monthly income data has two limitations. First, the monthly income variable is not total household income. Because the variable for the expected income growth rate (EGY) asks about total household income, the monthly income variable is not consistent with EGY. Second, panel data for monthly income are available over a shorter period of time than those for the household's total annual income, because the monthly income question was added in 2007. Therefore, to obtain robust results for the rational expectations test, we use two income change rate variables: GY(1), which is calculated using total annual household income, and GY(2), which is calculated as the sum of the respondent's and spouse's monthly incomes over the course of the year. Both variables, GY(1) and GY(2), show that around half of the

[13] Table A in Appendix 1 provides a brief distribution of observations by year.

[14] The wording of the questions is given in Appendix 2.

observations of annual family income are nearly zero.[15] The distribution of GY(1) has more kurtosis than that of GY(2).

3.2.2. Consumption

The PLiSS also collects data on several measures of consumption. For example, the survey tracks household expenses for eating at home, household expenses for eating out, household expenses for durable goods, and primary household expenses excluding durable goods. We use the primary household expenses excluding durable goods as the measure of household expenditure. This question is worded as follows:

> *How much was your entire family's average monthly expenditure in 2009? Exclude durable consumer goods purchased such as houses, cars, expensive electronic products. Also exclude taxes, insurance premiums, and mortgage interest. Include costs of public utilities and energy bills.*

These consumption data offer three advantages. First, excluding expenses for durable goods eliminates the problem of consumption durability. Second, as this survey asks for average expenditure, we do not need to account for seasonal fluctuations in expenditure. Third, these data include expenditure for goods and services, as well as food-related expenses. By contrast, the *Panel Study of Income Dynamics*, a well-known longitudinal panel survey in the United States, only collects data on food expenditure. Using these data, we calculate the growth rate of consumption (GC). The distribution of GC shows that GC has more variation than GY(1) and GY(2).[16]

3.3.3. Expected income change

The expected income change is a key variable for our paper, because it is used for both the rational expectations test and the excess sensitivity test. The PLiSS collects the expected income growth rate (EGY) directly. The wording of the EGY question is as follows:

> *By how much do you estimate that the annual earned gross income of your entire household in 2010 will change compared with the amount in 2009? (1) Increase by more than 9%, (2) Increase by 7%–9%, (3) Increase by 5%–7%, (4) Increase by 3%–5%, (5) Increase by 1%–3%, (6) Increase by less than 1% or decrease by less than 1%, (7) Decrease by 1%–3%, (8) Decrease by 3%–5%,*

[15] See Figures A-1 and A-2 in Appendix 3.

[16] See Figure B in Appendix 3.

(9) Decrease by 5%–7%, (10) Decrease by 7%–9%, (11) Decrease by more than 9%.

We replace these data categories with the midpoint values of each range. We also replace the top-code categories with 0.1125 (0.09 × 1.25) and –0.1125, respectively. The distribution of EGY is shown in Figure 1. It is seen that 11% of the observations are in the top categories. We provide robust results that handle this issue in the test of the REH.

[Figure 1]

4. Rational expectations test

Many authors have suggested various models to empirically test the REH. We follow the model used in Das and van Soest (1999). Let $\mathrm{EGY}_{i,t}$ denote the expected income growth and let $\mathrm{GY}_{i,t+1}$ represent actual income growth where i is the household index and t is the time index (t = 2004, 2005, 2006, 2007, 2008, 2009). Under the REH, expected income growth would be equal to the realized income growth, on average. To test this hypothesis, we introduce the following empirical model:

$$\mathrm{GY}_{i,t+1} = \alpha + \beta \mathrm{EGY}_{i,t} + \varepsilon_{i,t+1}. \quad (1)$$

This is the benchmark model. If the REH holds, we have $\beta = 1$ and $\alpha = 0$.

Next, we add the year dummies, μ_t, to the empirical model (1) to account for macroeconomic shocks.

$$\mathrm{GY}_{i,t+1} = \alpha + \beta \mathrm{EGY}_{i,t} + \mu_t + \varepsilon_{i,t+1}. \quad (2)$$

We should note that our data could not identify macro-economic shocks and non-rational expectations. If the forecast error is not averaged out, the estimated constant term and the estimated coefficients of the year dummies are sometimes significantly different from zero. Thus, our data make it difficult to evaluate the estimated coefficients of the constant term and the year dummies.

Empirical model (2) assumes that macro-economic shocks affect all households' income changes equally. However, the effects of macro-economic shocks could differ by socio-economic attributes. For example, the effects of macro-economic shocks differ between low education and high education individuals. To handle this point, we introduce the empirical model (3), which allows for heterogeneous effects from aggregate shocks. We add the following to the model: a dummy for the interaction of year and respondent age, a dummy for respondent education, and the first lag of the logarithm of the family income level.

$$GY_{i,t+1} = \alpha + \beta EGY_{i,t} + \mu_t + \eta_s \mu_t + \varepsilon_{i,t+1}, \quad (3)$$

where s is group index split by age, education, and family income.

We estimate equations (1), (2), and (3) using an ordinary least squares (OLS) model and a random effects model. We do not estimate using fixed effects because fixed effects models assume that the estimates of forecast error of income are persistent even with short panel data. This assumption is not valid for our aim of detecting the households for whom the REH holds.

5. Excess sensitivity test

5.1. Euler equation

We introduce the following Euler equation that is commonly used to test the LCPIH.

$$\Delta \ln C_{i,t+1} = 1/\rho \left(E_{i,t} r_{i,t+1} - \delta\right) + \rho/2 Var_{i,t}\left(\Delta \ln C_{i,t+1} - r_{i,t+1}/\rho\right)$$

$$+ \xi X_{i,t+1} + \pi \Delta Y^{e}_{i,t+1} + u_{i,t+1}, \quad (4)$$

where i is the household index, $C_{i,t+1}$ is a measure of consumption excluding durable goods, $X_{i,t+1}$ includes predictable indicators of household preferences such as age, $r_{i,t+1}$ is the real after-tax rate of interest, $1/\rho$ is the intertemporal elasticity of substitution, δ is the rate of time preference, $E_{i,t}$ is the expectation operator, and $u_{i,t+1}$ is the forecast error.[17] Equation (4) is derived assuming that preferences are iso-elastic

[17] The notation of this model follows Jappelli and Pistaferri (2000).

and that the distributions of the real interest rate and the consumption growth are jointly lognormal. Under these assumptions, we have equation (4) as a second-order approximation of the first-order condition of the consumer dynamic optimization problem.

The Euler equation implies that the predicted income change does not help in explaining consumption growth regardless of whether the income changes are permanent or temporary. Because the LCPIH predicts that the household will change its consumption at the time it anticipates its future income change and that this behavior will apply for both permanent and temporary anticipated income changes. This implication facilitates the testing of the LCPIH. Thus, many studies in the literature add the predicted income change to the Euler equation and test the relationship between the predicted income change and consumption growth.[18]

5.2. Estimation issues[19]

A degree of caution must be used in conducting the excess sensitivity test, even though this test is simple and convenient. First, obtaining the predicted income change using panel data is rare. Second, the conditional variance of consumption cannot be observed. Ludvigson and Paxson (1997) and Carroll (2000) cautioned that omitting the conditional variance would cause serious bias when estimating the Euler equation. Third, excess sensitivity may result from a failure to control properly for the inseparability of consumption and leisure. Finally, excess sensitivity may result in a spurious correlation because of misspecification of the stochastic structure of the forecast error.

5.2.1. Predicting income growth

Testing for excess sensitivity requires that the predicted growth in income be known. To obtain this variable, three approaches have been proposed: out-of-sample information, two-sample instrumental variable techniques, and subjective income expectations. The limitations of these approaches have been discussed in the literature.[20] Using subjective income expectations is the best approach, because instrumental variable methods can be problematic if the researcher omits critical information related to the income expectation. Thus, we use expected family income growth (EGY) obtained from the PLiSS.

5.2.2. The conditional variance of consumption growth

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[18] We should note that the effect of a temporary income change should be smaller than that of a permanent one.

[19] The discussion in this subsection largely follows Jappelli and Pistaferri (2000).

[20] See, for example, Browning and Lusardi (1996) and Jappelli and Pistaferri (2000).

If the utility function shows decreasing risk aversion, prudent households react to the expected consumption risk, which is the conditional variance of consumption growth in equation (4), by reducing consumption in period t relative to period t+1. As the omission of an expected consumption risk could cause serious bias in the Euler equation estimates, some studies introduced explicit proxies for the conditional variance of consumption growth. For example, Jappelli and Pistaferri (2000) used the conditional variance of expected nominal income growth, and Kohara and Horioka (2006) used the conditional variance of expenditure growth excluding durable goods.

We use the conditional variance of expected total family expenditure (VAR). This variable has at least two advantages compared with the variables used in past studies. First, expected consumption growth is better than expected income growth in terms of rigorously estimating equation (4). Second, the conditional variance of consumption growth is an endogenous variable, whereas expected consumption growth is exogenous. Using expected consumption growth requires that endogeneity bias be accounted for in the model.

5.2.3. Separability of consumption and leisure

If leisure is an argument of the household utility function and if consumption and leisure are inseparable, then current consumption decisions are affected by predictable changes in the household labor supply. We use the change in the number of workers in households (ΔWORKER) as a control variable, as also done by Jappelli and Pistaferri (2000). However, this variable can be problematic in that ΔWORKER might be simultaneously determined with the current change in consumption. The ideal control variable to capture this effect is the expected change in the total hours of work in the household, but our data are not available.

5.2.4. The stochastic structure of the forecast errors

According to the LCPIH, the error term of the Euler equation must be zero. If the forecast error is the sum of an aggregate shock and of an idiosyncratic shock, then the orthogonal condition fails in a short panel even if the LCPIH is true (Chamberlin, 1984; Souleles, 2004). Aggregate shocks induce a cross-sectional correlation between expected consumption growth and predicted income growth. The problem is sometimes handled by including time dummies in the Euler equation. This approach, nevertheless, is restrictive, because it eliminates the possibility that the aggregate shocks are not evenly distributed among the population.

To capture the individual effect of aggregate shocks on consumption growth, we explicitly introduce the interaction of year dummies with the forecast error of consumption change (ERROR), which is calculated by subtracting growth of expected

total family expenditure (EGTC) from growth of total family expenditure including durables (GTC).[21]

The standard Euler equation, for example the model proposed by Hall (1978), implies that consumption is affected only by unpredictable shocks. Therefore, previous studies usually assume that the disturbance implicitly includes the forecast error of consumption change (ERROR). In this paper, we explicitly control ERROR to overcome the forecast error caused by a short panel of unobserved household characteristics.

5.3. Estimation model

We present an empirical model that addresses the estimation issues discussed above:

$$GC_{i,t+1} = \zeta + \pi EGY_{i,t+1} + \xi_1 AD_{i,t+1} + \xi_2 \Delta FAMILY_{i,t+1} + \gamma\xi_3 \Delta WORKER_{i,t+1}$$

$$+\xi_4 VAR_i + \xi_5 ERROR_{i,t+1} \times YD_t + \xi_6 YD_t + u_{i,t+1}, \qquad (5)$$

where $\Delta FAMILY_{i,t+1}$ denotes the change in family size from period t to t+1, $AD_{i,t+1}$ is an age dummy, $\Delta WORKER_{i,t+1}$ is the change in number of workers, VAR_i is the conditional variance of expected total family expenditure, $ERROR_{i,t+1}$ is the forecast error of total family expenditure including durable goods, YD_t is a year dummy, and $u_{i,t+1}$ is the error term with a mean of zero and independently identically distributed.

When the LCPIH holds, previously expected income has no effect on current expenditure growth. In addition, the standard LCPIH predicts that only permanent macroeconomic shocks affect consumption change. However, in some cases, temporary macroeconomic shocks affect temporary consumption Examples are an incomplete financial market, the presence of liquidity constraints, and a failure of model specifications.

6. Empirical results

To investigate our hypotheses, we first test the REH for the whole sample and then for subsamples made by dividing the sample by proxies for forward-looking behavior. We then conduct the excess sensitivity test for subsamples made by dividing the sample by

[21] The distributions of GTC and EGC are provided in Figures C-1 and C-2 of Appendix 3, respectively.

proxies for forward-looking behavior, self-control problems, and use of commitment devices, which indicates that a household is sophisticated.

6.1. Empirical results of rational expectations test

6.1.1. Benchmark empirical results

Before we present the estimation results for equations (1) and (2), we present visual evidence of the degree of precision in predicting future income. We first show the means of GY(1), GY(2), and EGY by year in Figure 2. The mean of EGY in 2005 is expected growth in family income from 2004 to 2005, which is calculated based on 2004 data. While the trend in GY(1) runs parallel to that of EGY until 2007, the means of GY(1) decrease from 2008. This decrease is intuitively consistent with the effect of the global financial crisis in those years. The means of GY(2) are in line with those of GY(1). The similarity of these trends implies that the measurement error of GY(1) might be negligible.

[Figure 2]

To confirm people's predictions, on average, we provide a forecast error of family income change in Figure 3. The forecast error is calculated by subtracting the actual family income growth rate from the expected family income growth rate predicted in the previous period. The expected errors of GY(1) are not statistically different from zero at the 5% significance level from 2005 to 2007. From 2008 to 2009, actual family income growth is less than the expected income growth. Based on Figure 2, we conjecture that this negative forecast error arises because of an unexpected income decrease.

[Figure 3]

Table 2 shows the empirical results of equations (1) and (2). The dependent variable of models (1) and (2) is GY(1) and the dependent variable of models (3) and (4) is GY(2). As mentioned above, GY(1) might have a measurement error in the calculation of the growth rate because of the use of a categorical variable. We estimate models (3) and (4) to address this measurement error using GY(2). However, as GY(2) is a shorter panel, it could be more strongly influenced by a macroeconomic shock than GY(1). Furthermore, the fact that GY(2) is not total family income is another issue in estimating GY(2). We estimate all models using an OLS model and a random effects model. The results of the specification test between the OLS and the random effects models show that OLS is appropriate for estimation; we therefore present the OLS results.

[Table 2]

As can be seen in Table 2, the coefficients of EGY are almost equal to one in all of the models. These results indicate that EGY is a suitable predictor for future family income. The effects of the year dummies in 2008, 2009, and 2010 are negative and significant in model (2). These are consistent with the trends shown in Figure 3. The last row in Table 2 shows the Wald test statistics. The null hypothesis of the Wald test is that the coefficient of EGY are equal to one, that the coefficients of the dummy variables for each year are equal to zero, and that the constant term is equal to zero. The results of the Wald test indicate that the REH does not hold in all models. Our data are from a short panel and, as shown in Figures 2 and 3, the macroeconomic conditions from 2008 to 2010 are unstable. These facts suggest that our results might be influenced by macroeconomic shocks.

[Table 3]

Next, we estimate equation (3) to address the issue of the forecast error in short panel data, and we estimate equation (4), which accounts for group heterogeneous macroeconomic shocks. The results are presented in Table 3. The coefficients of EGY in models (1) and (3) are not statistically different from one. In addition, the magnitudes of the coefficients are not statistically different from the estimates in Table 2.

EGY is a superior expectation variable to the variables used in previous studies. The survey question on EGY contained 11 categories to capture the range of income growth, whereas in previous papers such as Das and van Soest (1999), only five categories were used. However, when using a categorical variable, we must attach an arbitrary number to the top codes, and changes in the top-coding number could alter the empirical results.[22]

To overcome this problem, we estimate models (2) and (4) in Table 3. The coefficient of EGY without the top and bottom categories is 0.90, and it is not statistically different from one. By contrast, in model (4), the coefficient is 0.52 and it is statistically different from one. As shown in Figures 2 and 3, the macroeconomic conditions from 2008 to 2010 are unstable. The estimation of GY(2) could likely be influenced by top-coding because of the shorter panel. For this reason, the results of GY(1) might be reliable.

[22] We estimate several models to attach top (bottom) categories to the following numbers: 0.1 (–0.1), 0.11 (–0.11), 0.12 (–0.12), 0.13 (–0.13). The results are almost the same as those in Tables 2 and 3.

As discussed in Section 4, it is difficult to interpret the estimates of the constant term and the coefficients of the year dummies because our panel data are short and our empirical model has some strong assumptions. If $\pi = 1$ means that the REH holds, our results do not reject the hypothesis for our full sample.

6.1.2. Empirical results according to forward-looking behavior

Proxies for forward-looking behavior

As discussed in Section 2.1, the forecast error could provide spurious results for an unbiased prediction test. To overcome the forecast error problem, we define the REH as forward-looking behavior with unbiased prediction of own income profile. Forward-looking agents make decisions based on intertemporal utility maximization. By contrast, non-forward-looking agents do not look ahead and do not make dynamic consumption plans. Our definition of the REH requires both conditions.

In this definition, we can separate our sample into a forward-looking group and a non-forward-looking group. We conduct unbiased prediction tests in each group. We expect that only the group that consists of forward-looking households will predict future income changes precisely. To detect this behavior in household-level data, we use two self-reported questions in the PLiSS. The first question directly asks households about their planning behavior by inviting survey participants to respond to the following general statement: “I always plan things before I actually do them.” The answer is given on a five-item scale (“Completely agree” = 5, “Somewhat agree” = 4, “Neither agree nor disagree” = 3, “Somewhat disagree” = 2, and “Completely disagree” = 1). We call this variable *Always plan*. The distribution of the responses is shown in Figure 4. Based on the responses, we divide the households into two groups. The first group (Yes) consists of households that choose “4” or “5”; they account for 23% of the observations. The remaining households make up the second group (No).

[Figure 4]

The second question asks the survey participants about their planning behavior for after retirement. The question is worded as follows:

> *Do you have a savings plan for after the household head retires? (If the household head has already retired, do you have a savings plan for the future?)*
> *(1) I have a specific plan*
> *(2) I have a rough plan.*
> *(3) I do not have a plan now, but I am going to make a plan in the future.*
> *(4) I do not have a plan now, and I am not going to make a plan in the future.*

The distribution of the responses is shown in Figure 5. It is natural to divide the households based on whether or not they have made a plan. We set a dummy variable that takes a value of one if the household chooses “I have a specific plan” or “I have a rough plan” and zero otherwise. We call this dummy variable *Retirement plan*. About 43% of households answered that they had a specific or rough plan (Yes).

[Figure 5]

Empirical results

We use two proxy variables, (A) *Always plan* and (B) *Retirement plan*, to identify individual forward-looking behavior. Table 4 presents the empirical results of the REH test split by these proxies. Part (A) presents the results of the REH test split according to *Always plan*, and (B) gives the results split according to *Retirement plan*. The empirical model we use is the same as model (2) in Table 3. From part (A), we confirm that the households that do not have a plan overestimate their future income changes. By contrast, households with a plan suitably predict their future income changes. However, the results in part (B) show that the accuracy of prediction behavior does not differ between the households that have a plan for after retirement and the households that do not have such a plan. The results in Table 4 partly confirm our hypothesis that forward-looking households are likely to predict their future income changes more precisely. A comparison of (A) *Always plan* with (B) *Retirement plan* shows that (A) *Always plan* captures more general forward-looking behavior than (B) *Retirement plan*. (B) *Retirement plan* represents one aspect of forward-looking behavior.

[Table 4]

6.2. Empirical results of the excess sensitivity test

6.2.1. Benchmark empirical results

Table 5 provides the results of the excess sensitivity test. The results for models (1) to (3) use the whole sample and the results for models (4) to (6) exclude liquidity-constrained households. The results of the F-test and Wu–Hausman test show that the OLS model with clustered robust standard error is appropriate to be estimated against the fixed effects model and the random effects model.

[Table 5]

First, we confirm the results for the whole sample. The coefficient of EGY is 0.36 and is significant at the 5% level in model (1). The magnitudes of excess sensitivity are fairly consistent with previous studies. The coefficient of ΔFAMILY is positive and significant. The coefficient of the proxy for consumption risk, VAR, and the coefficient of ΔWORKER are not significant. These results imply that the assumption of separability of leisure and consumption is valid, and a precautionary saving theory is rejected. These results are consistent with Jappelli and Pistaferri (2000). As discussed in Sections 2.1 and 5.2, the forecast error could induce a bias in testing any dynamic model that assumes the REH. To address this issue, we add ERROR to model (1).[23] Whereas the standard consumption model, proposed by Hall (1978), indicates that forecast errors of consumption affect consumption change, the results for model (2) show that the coefficients of ERROR are significant at the 5% level only in 2008 and 2010. This result might arise because of working formal or informal insurance mechanisms.

Under liquidity constraints, the responses of consumption to predicted income changes should be asymmetric (Altonji and Siow, 1987). If liquidity constraints cause excess sensitivity, only the coefficient of expected income up (EGY_up) should be positive and significant. Under the LCPIH, while liquidity-constrained households who decrease their consumption in response to anticipated income declines, they cannot increase it by responding to anticipated income increases because they face liquidity constraints. Model (3) in Table 5 presents the results of the asymmetric model. We find that the coefficient of EGY_up is 0.63 and significant, whereas that of EGY_down is 0.25 and not significant. The response to increasing predicted income change is larger than the response to decreasing predicted income change. This result indicates that liquidity constraints cause excess sensitivity. This result also suggests that rule-of-thumb behavior is not the main cause of the excess sensitivity because the responses of EGY_up and EGY_down to consumption are not of the same magnitude (Flavin, 1985).

Furthermore, to check the robustness of the liquidity-constraints results, we provide the results for the subsample that excludes liquidity-constrained households. We identify liquidity-constrained households using the following question: “Have you ever had a loan application rejected (excluding housing loans)?” We define a household as liquidity constrained if the respondent answers “Yes” to this question. Seven percent of households are thus defined as liquidity constrained. This proportion is slightly less than that in Kohara and Horioka (2006), who find that 8%–15% of young married Japanese households are liquidity constrained. We can identify two possible reasons for the

[23] ERROR is calculated by subtracting growth of expected total family expenditure (EGTC) from growth of total family expenditure including durables (GTC).

slightly smaller proportion in our study. First, Kohara and Horioka use a sample of young married Japanese households, whereas our sample represents a wider age distribution of Japanese households. Second, our proxy variable underestimates the number of liquidity-constrained households. Our classification of liquidity constraints has the following limitations. First, we assume that the economic status of households has not changed since their loan applications were rejected. Second, we do not take into account the households who could potentially be rejected for loan applications.

For models (4) to (6) in Table 5, we provide the results when liquidity-constrained households are excluded. The results for models (4) and (5) show that the coefficients of EGY are significant at the 5% level. In model (6), we confirm that the coefficients of EGY_up and EGY_down are not significant. This result is almost the same as that for model (3). These results imply that factors apart from liquidity constraints induce co-movements between consumption change and expected income change.

6.2.2. Empirical results by forward-looking behavior

Proxies for forward-looking behavior

As discussed in Section 2.1, we test the LCPIH for households for which the REH holds. To examine this, we conduct the excess sensitivity test on groups divided according to their responses to proxies for forward-looking behavior. We use (A) *Always plan* and (B) *Retirement plan*. The results of the REH test in Table 4 indicate that *Always plan* could also serve as a good proxy for whether REH holds or not.

Empirical results

Table 6 presents the empirical results of the excess sensitivity test for the sample divided according to forward-looking behavior. Panel A contains the empirical results for the whole sample, and panel B contains those for the subsample of liquidity-unconstrained households. Part (A) provides the results divided according to *Always plan*, and part (B) gives the results divided according to *Retirement plan*.

[Table 6]

Except for the results in part (A), the consumption of households that have forward-looking behavior does not respond to anticipated income change. By contrast, we find excess sensitivity for households that are likely not to make a plan. Especially in part (A), the coefficient of EGY for the households that answered “No” is larger than that for households that answered “Yes” and is significant even though the sample for “No” is smaller than that for “Yes”. Furthermore, these results do not change even if we exclude liquidity-constrained households. These results indicate that a consumption

behavior consistent with the LCPIH relates to the characteristics of forward-looking behavior, which is a proxy for upholding the REH in this paper. Thus, we confirm that the LCPIH assumption is not rejected if we limit our sample; this is consistent with the LCPIH assumption in terms of the REH.

6.2.3. Self-control problems

Measuring self-control problems

Self-control problems are the main reason for the rejection of the LCPIH, as many studies have pointed out. To elicit self-control problems, we use three questions in the PLiSS. The first question is answered on a five-item scale, as with *Always plan*. The statement is as follows:

When I have something I want, I cannot bear not buying it.

We call this response *Cannot bear not buying*. It contains characteristics of impulsiveness. The distribution of this response is shown in Figure 6. As for *Always plan*, we divide the households into two groups. We classify households as having self-control problems if they agree or somewhat agree with *Cannot bear not buying*; such households account for 21% of the sample.

[Figure 6]

The second question is answered on the same five-item scale as *Cannot bear not buying*. It is worded as follows:

Even if I make plans, I end up procrastinating.

We call this response *End up procrastinating*. The distribution of this response is shown in Figure 7. The distribution of *End up procrastinating* has more symmetry than that of *Cannot bear not buying*. *End up procrastinating* is also divided into two groups; 32% of the sample answer "Yes" for *End up procrastinating*.

[Figure 7]

The final proxy variable for self-control problems consists of two questions in relation to completion of homework: (1) "When did you plan to do your assignments?" (*Plan*); (2) "When did you do your assignments?" (*Actual*).[24] The responses to and

[24] The full wordings of these questions are given in Appendix 2.

distribution of these questions are in Figure 8. As shown for the *Plan* responses in Figure 8, the proportion of those who answered "Got it done right away" was the highest. By contrast, for the *Actual* responses, which indicate the reality of the assignment completion, more than 40% of households answered that they "Got it done at the last minute". These responses show that many households intended to do their assignments almost right away, but they ended up procrastinating. We use the responses to these questions to divide the sample into three groups: (1) can execute the plan (No); (2) cannot execute the plan (Yes); and (3) did not make any plans (Not plan). "No" refers to households finished their assignments earlier than they planned, and "Yes" is for households that could not finish their assignments earlier than they planned. "Not plan" is used for households that answered that "I didn't make any plans". We call this variable *Cannot execute plan*. About 35% of households are in the group "can execute the plan" (No) and 58% of households are in the group "cannot execute the plan" (Yes). In each proxy for self-control problems, we confirm that the majority of households have a self-control problem.

[Figure 8]

Empirical results

Table 7 presents the empirical results of the excess sensitivity test divided according to three proxy variables: (I) *Cannot bear not buying*; (II) *End up procrastinating*; (III) *Cannot execute plan*. All results provide evidence that the coefficients of EGY are positive and significant for households with self-control problems. By contrast, the LCPIH implication is not rejected for households without self-control problems. Furthermore, the broad results are unchanged even if we eliminate the liquidity-constrained sample. These results imply that, if we focus on households without self-control problems, which the standard consumption model assumes, the LCPIH implication is not violated. The results also suggest that self-control might be a critical factor in inducing excess sensitivity.

[Table 7]

6.2.4. Results of excess sensitivity test for the subsample that is consistent with the LCPIH assumptions

In Sections 6.2.2 and 6.2.3, we examined the LCPIH implication in households for which the REH holds and that do not have self-control problems, respectively. As expected, the results in Tables 6 and 7 show that the LCPIH holds for the subsample in which the LCPIH assumptions are valid. In this subsection, we conduct the excess sensitivity test jointly considering both postulates.

[Table 8]

Table 8 presents the results of the excess sensitivity test according to proxies both for forward-looking behavior and for having self-control problems. To identify the effects of liquidity constraints and violation of LCPIH assumptions, we exclude liquidity-constrained households.[25] The columns are divided according to proxies that uphold the REH: (A) *Always plan* and (B) *Retirement plan*. The rows are divided by proxies for having self-control problems: (I) *Cannot bear not buying*; (II) *End up procrastinating*; and (III) *Cannot execute plan*. Thus, we make six combinations using these two types of proxies. Our focus is on the upper-left coefficients of EGY in each combination; these are consistent with the LCPIH assumption that households have rational expectations and no self-control problems.

We estimate the same model as model (5) in Table 5 using OLS in each cell. Clustered robust standard errors are in parentheses and the numbers of observations and the proportions of observations are in brackets. For example, we can see the distribution of our sample using (A) *Always plan* and (I) *Cannot bear not buying*, which tells us that 58% of households enter both "Yes" for (A) and "No" for (I). The proportion of households that answer that they do not plan and can bear not buying is 22%, whereas 7% of households answer that they both do not plan and cannot bear not buying. In each combination, the proportion of rational consumers ranges from 18% to 58%, which is fairly larger than in other cells.

We confirm that, for each result divided by proxies, excess sensitivity is not observed for the subsample that is consistent with the LCPIH assumptions. Furthermore, conditioning each proxy for forward-looking behavior, we find that the magnitudes of excess sensitivity are larger for households who answer that they are facing self-control problems. The results suggest that self-control problems might matter more than the validity of the REH. This result is convincing, considering the finding that the REH holds for the whole sample.

6.2.5. Sophisticated and naïve households

Measuring sophisticated and naïve households

As discussed in Section 2.2, people with self-control problems can be classified as sophisticated or naïve. We define sophisticated households as those that use commitment devices to execute ex ante plans, and naïve households as those that do not use commitment devices because they are not aware of their self-control problems. To

[25] Results for the whole sample are given in Table B in Appendix 4.

identify sophisticated and naïve households, we use (1) *Have cash* and (2) *Use incentives to finish assignments*.

The first proxy is identified using the question on whether a household has cash savings. If a household is sophisticated and aware of its self-control problems in relation to overconsumption, it would not have unnecessary cash at hand. Therefore, sophisticated households should not have cash savings. We construct a dummy variable called *Have cash*, which takes a value of one if the household has cash (Yes) and zero otherwise. The proportion of sophisticated households is 74%.

The second proxy variable, *Use incentives to finish assignments*, is constructed using the following retrospective question called *Types of incentives*:

As a child, what types of incentives did you use to finish your assignments on time?
(Select all options if you apply)

The response options for this question and the proportions of responses are given in Figure 9. As the figure shows, nearly half of the respondents answered "I did not follow any specific regimen". About 20% of respondents answered "I put a homework schedule in a place where I would see it" and "4. I tried to sit at my desk at the same time each day".

[Figure 9]

If respondents are sophisticated, they should have executed their ex ante homework schedules using some commitment devices. We estimate a probit model to determine which choices of *Types of incentives* contribute to the execution. From *Cannot execute plan*, we can identify respondents who acuallyexecuted their schedule. We use this as the dependent variable, *Cannot execute plan*, which takes a value of one if the response is "Yes" and zero if it is "No". The independent variables are choices of *Types of incentives*, age dummy, and female dummy. Table C in Appendix 5 shows the marginal effects estimated by the probit model. The coefficients of the variables "I put a homework schedule in a place where I would see it" and "I tried to sit at my desk at the same time each day" are positive and significant at the 1% level. Our results suggest that other incentives do not contribute to overcoming self-control problems. Therefore, we construct a proxy variable for sophisticated households, *Use incentives to finish assignments*, that takes a value of one if respondents selected "I put a homework schedule in a place where I would see it" or "I tried to sit at my desk at the same time each day" and zero otherwise. According to the variable *Use incentives to finish assignments*, 38% of households are sophisticated.

Note that our proxies catch only one aspect of the characteristics of sophisticated households. However, few empirical studies have examined consumption behavior taking into account self-control problems. Therefore, despite the limitations of our proxies, we believe that our new evidence on personal behavioral aspects contributes to refining consumption theory.

Empirical results

Economic theory predicts that the consumption of the sophisticated households will not respond to expected income changes because such households use commitment devices to overcome their self-control problems (O'Donoghue and Rabin, 1999; 2001). Panel A in Table 9 shows the result using *Not have cash* and Panel B provides the results using *Not use incentives to finish assignments*. We exclude liquidity-constrained households from Table 9.[26]

As expected, the results of the whole sample in both Panels A and B show that the coefficient of EGY is positive and significant at the 1% level for naïve households that do not use commitment devices, but it is not significant for sophisticated households that use commitment devices. The results split by (I) *Cannot bear not buying* show that the excess sensitivity is not observed in the households who use a commitment device. The results in Panel B for (II) *End up procrastinating* and (III) *Cannot execute plan* show that excess sensitivity does not exist for sophisticated households but does exist for naïve households. From the results in Panel A for (II) and (III), we find that the consumption of sophisticated households responds to expected income changes. However, the magnitudes of the responses of sophisticated households are smaller than those of naïve households.

[Table 9]

Our results are generally consistent with our hypothesis that the LCPIH implication is not rejected for sophisticated households because they use commitment devices. Although our proxies represent narrow aspects of the behavior of sophisticated households, our results show that the consumption behavior of sophisticated households is different from that of naïve households.

7. Conclusions

In this paper, we examine whether the LCPIH holds for households whose behavior is consistent with the assumptions of the LCPIH. In particular, we focus on the following

[26] The results for the whole sample, given in Table D in Appendix 6, are almost the same as those shown in Table 9.

two postulates: (1) people have rational expectations; and (2) households do not have self-control problems. These are implicitly assumed in the standard LCPIH. We use Japanese panel data from the PLiSS, which has two advantages for conducting the excess sensitivity test and for detecting the preferences of households in relation to the LCPIH assumptions. The first advantage is that the PLiSS data make it possible to procure subjective expectations of income growth rate, which are valuable not only to conduct the excess sensitivity test but also to test the REH. The second advantage is that the PLiSS contains several self-reported and retrospective questions to elicit individuals' characteristics concerning such aspects as forward-looking behavior, self-control problems, and the use of commitment devices.

First, to examine whether the REH holds for our sample, we regress the actual income changes on expected income changes (unbiased prediction test). Our results of the REH test show that the REH holds for the whole sample. Although some previous studies provide evidence of the rejection of the REH, our results show that the REH is not an irrelevant assumption in any dynamic decision-making model. We also find that, as expected, the households that have forward-looking behavior can predict their future income changes, whereas households that do not have forward-looking behavior cannot. This result indicates that our proxies are successful and useful in eliciting characteristics related to the REH.

Next, we test the LCPIH implication and find that the LCPIH implication is rejected in the sense that excess sensitivity exists both for the whole sample and for the subsample of liquidity-unconstrained households. To test our hypothesis, we used self-reported and retrospective questions to identify households for which the REH holds and that do not have self-control problems. Our results show that the LCPIH implication is not rejected for households whose behavior is consistent with the LCPIH assumptions. Furthermore, we confirmed that excess sensitivity becomes larger for naïve households than for sophisticated ones. As the LCPIH predicts, if the assumptions of the LCPIH are satisfied, then the LCPIH implication is not violated.

Our results are consistent with the theoretical predictions. Thus, our results imply that LCPIH is reasonable benchmark model to describe consumption behavior. Furthermore, our results using several proxy variables indicate that responses to self-reported and retrospective questions are not meaningless when eliciting characteristics of households.

Finally, we review some limitations of our analyses and discuss directions for future research. First, even though we use several self-reported and retrospective questions to provide robust results, the data might not allow us to obtain completely convincing results. A particular issue when using self-reported questions about self-control problems is the potential inconsistency between the behavior described in the responses and actual behavior. We hope to overcome these limitations in future

research, for example, by comparing survey data and experimental data. Second, we do not analyze the causation between survey responses and behavior. We implicitly assume that people respond to survey questions according to their behavior. However, survey responses could influence household's behavior. Finally, our paper assumes that the preferences are time-invariant. However, some papers have shown the possibility that preferences can change over time. The analysis of causation is also left for future research. We hope that future research will overcome these limitations.

Appendix 1. Distribution of observations by year

[Table A]

Appendix 2. Survey questions on income

GY(1)

1	Less than 1,000,000 yen	7	10,000,000 to less than 12,000,000 yen
2	1,000,000 to less than 2,000,000 yen	8	12,000,000 to less than 14,000,000 yen
3	2,000,000 to less than 4,000,000 yen	9	14,000,000 to less than 16,000,000 yen
4	4,000,000 to less than 6,000,000 yen	10	16,000,000 to less than 18,000,000 yen
5	6,000,000 to less than 8,000,000 yen	11	18,000,000 to less than 20,000,000 yen
6	8,000,000 to less than 10,000,000 yen	12	More than 20,000,000 yen

GY(2)

Approximately how much was your and your spouse's salary for 2009 (including business income if you are self-employed)?

You: Salary per month _____ _____ _____ yen

Your spouse: Salary per month _____ _____ _____ yen

Plan

Thinking about when you were a child and you were given an assignment in school, when did you usually do the assignment?

1	Got it done right away	4	Tended to get it done toward the end
2	Tended to get it done early, before the due date	5	Got it done at the last minute
3	Worked on it daily up until the due date		

Actual

Thinking about when you were a child and you were given an assignment in school, when did you plan to do your assignment?

1	I planned to get it done right away	4	I planned to get it done rather toward the end
2	I planned to get it done rather early, before the due date	5	I planned to get it done at the last minute
3	I planned to work on it daily up until the due date		I didn't make any plans

Appendix 3. Distribution of GY(1), GY(2), GC, GTC, and EGC

[Figure A-1]
[Figure A-2]
[Figure B]
[Figure C-1]
[Figure C-2]

Appendix 4. Excess sensitivity test by forward-looking behavior and self-control problems (whole sample)

[Table B]

Appendix 5. Empirical results of *Cannot execute plan* and *Types of incentives*

[Table C]

Appendix 6. Empirical results of Sophisticated vs. naïve households (whole sample)

[Table D]

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Table 1. Descriptive statistics

	Mean	S.D.	Min	Max
Female dummy	0.51	0.50	0.00	1.00
Age	52.68	11.30	24.00	77.00
–≦29	0.01	0.11	0.00	1.00
30–34	0.04	0.20	0.00	1.00
35–39	0.09	0.29	0.00	1.00
40–44	0.12	0.33	0.00	1.00
45–49	0.14	0.35	0.00	1.00
50–54	0.14	0.35	0.00	1.00
55–59	0.15	0.36	0.00	1.00
60–64	0.13	0.33	0.00	1.00
65+	0.18	0.38	0.00	1.00
Education level				
Junior high school	0.11	0.31	0.00	1.00
High school	0.49	0.50	0.00	1.00
Some college	0.16	0.36	0.00	1.00
University/College	0.25	0.43	0.00	1.00
Income				
GY(1): Family's total annual income change rate	–0.02	0.41	–3.91	3.40
GY(2): Sum of respondent's and spouse's monthly income change rate	–0.03	0.32	–2.71	2.40
Expenditure				
GC: Family's expenditure change rate without durables	–0.02	0.68	–3.87	4.25
GTC: Family's total expenditure change rate	0.01	0.05	–0.11	0.11
Expectation variable				
EGY: Family's expected total income change rate	–0.01	0.04	–0.11	0.11
EGTC: Family's expected total expenditure change rate	0.01	0.05	–0.11	0.11
ΔFAMILY: Change in family size	–0.04	0.59	–6.00	5.00
ΔWORKER: Change in number of workers	–0.01	0.36	–1.00	1.00
VAR: Variance of EGTC×100	0.21	0.26	0.00	2.53
Liquidity-constraint dummy	0.07	0.26	0.00	1.00

Note: Number of observations is 7,128 except for GY(2), with 2,859 observations.

Table 2. The REH test

Dependent variable	GY(1)		GY(2)	
	(1)	(2)	(3)	(4)
EGY	1.15***	1.16***	0.98***	1.02***
	(0.13)	(0.13)	(0.15)	(0.15)
YD2006		–0.03		
		(0.02)		
YD2007		–0.01		
		(0.02)		
YD2008		–0.05**		
		(0.02)		
YD2009		–0.06***		–0.03
		(0.02)		(0.02)
YD2010		–0.03*		0.01
		(0.02)		(0.01)
Constant	–0.01***	0.02	–0.02***	–0.01
	(0.00)	(0.02)	(0.01)	(0.01)
F-test statistics	0.66	0.67	0.91	0.91
Wu–Hausman test statistics	0.67	2.58	5.83	7.96
Wald test statistics	6.32	4.26	5.95	4.82

Note: The numbers of observations (households) in models (1) and (2) are 7,128 (2,857) and those in models (3) and (4) are 2,859 (1,934). All models are estimated using OLS because the results of the specification test indicate that OLS is sufficient for estimation against the fixed effects model and the random effects model. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. The null hypothesis of the F-test is that the individual fixed effects are all zero. The null hypothesis of the Wu–Hausman test is that individual effects are not correlated with explanatory variables. The null hypothesis of the Wald test is that the coefficient of EGY is equal to one, the coefficients of indicator variables for each year are equal to zero, and the constant term is equal to zero.

Table 3. The REH test allowing for heterogeneous macroeconomic shocks and measurement errors

Dependent variable	GY(1)		GY(2)	
	(1)	(2)	(3)	(4)
EGY	1.17***		0.88***	
	(0.12)		(0.14)	
EGY without top and bottom categories		0.90***		0.52**
		(0.20)		(0.23)
Dummy variable for top category of EGY		0.09**		0.07**
		(0.03)		(0.04)
Dummy variable for bottom category of EGY		–0.17***		–0.14***
		(0.02)		(0.03)
Year dummies × Age dummies	Yes	Yes	Yes	Yes
Year dummies × Education level dummies	Yes	Yes	Yes	Yes
Year dummies × 1st lag of family income	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
F-test statistics	2.10	2.10	2.64	2.65
Wu–Hausman test statistics	2591.37	2354.40	942.64	945.40
Wald test statistics	69.75	71.72	24.69	25.11

Note: The numbers of observations (households) in models (1) and (2) are 7,128 (2,857) and those in models (3) and (4) are 2,859 (1,934). All models are estimated using OLS because the results of the specification test indicate that OLS is sufficient for estimation against the fixed effects model and the random effects model. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. The null hypothesis of the F-test is that the individual fixed effects are all zero. The null hypothesis of the Wu–Hausman test is that individual effects are not correlated with explanatory variables. The null hypothesis of the Wald test is that the coefficient of EGY is equal to one, the coefficients of indicator variables for each year are equal to zero, and the constant term is equal to zero.

Table 4. The REH test by proxies for forward-looking behavior

	(A) *Always plan*		(B) *Retirement plan*	
	Yes	No	Yes	No
	(1)	(2)	(3)	(4)
EGY without top and bottom categories	1.01***	0.62*	0.87***	0.91***
	(0.24)	(0.35)	(0.29)	(0.27)
Dummy variable for top category of EGY	0.11***	–0.01	0.10***	0.06
	(0.04)	(0.07)	(0.04)	(0.06)
Dummy variable for bottom category of EGY	–0.17***	–0.17***	–0.20***	–0.15***
	(0.02)	(0.04)	(0.03)	(0.03)
Year dummies	Yes	Yes	Yes	Yes
Year dummies × Age dummies	Yes	Yes	Yes	Yes
Year dummies × Education level dummies	Yes	Yes	Yes	Yes
Year dummies × 1st lag of family income	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Number of observations	5089	2039	3121	4007
Number of households (clusters)	2036	821	1240	1617
Proportion of observations	29%	71%	56%	44%

Note: All models are estimated using OLS because the results of the specification test indicate that OLS is sufficient for estimation against the fixed effects model and the random effects model. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. The null hypothesis of the F-test is that the individual fixed effects are all zero. The null hypothesis of the Wu-Hausman test is that individual effects are not correlated with explanatory variables. The null hypothesis of the Wald test is that the coefficient of EGY is equal to one, the coefficients of indicator variables for each year are equal to zero, and the coefficient of the constant term is equal to zero.

Table 5. The excess sensitivity test

	Whole sample			Liquidity-unconstrained households		
	(1)	(2)	(3)	(4)	(5)	(6)
EGY	0.36**	0.38**		0.37**	0.39**	
	(0.16)	(0.16)		(0.17)	(0.17)	
EGY_up			0.63**			0.54
			(0.32)			(0.33)
EGY_down			0.25			0.32
			(0.23)			(0.24)
ERROR×YD2005		–0.59	–0.58		–0.43	–0.43
		(0.45)	(0.45)		(0.46)	(0.46)
ERROR×YD2006		–0.49	–0.49		–0.56	–0.55
		(0.42)	(0.42)		(0.43)	(0.43)
ERROR×YD2007		0.48	0.48		0.66	0.67
		(0.42)	(0.42)		(0.44)	(0.44)
ERROR×YD2008		0.70**	0.70**		0.57	0.57
		(0.35)	(0.35)		(0.37)	(0.37)
ERROR×YD2009		0.23	0.24		0.36	0.36
		(0.31)	(0.31)		(0.32)	(0.32)
ERROR×YD2010		0.45**	0.46**		0.36	0.36
		(0.23)	(0.23)		(0.24)	(0.24)
ΔFAMILY	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ΔWORKER	0.00	0.00	0.00	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
VAR	–0.03	–0.04	–0.04	–0.01	–0.01	–0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
F-test statistics	0.61	0.61	0.61	0.62	0.62	0.62
Wu-Hausman test statistics	3.04	6.84	7.15	2.69	6.04	6.72

Note: The numbers of observations (households) in models (1) and (2) are 7,128 (2,857) and those in models (3) and (4) are 6,609 (2,690). The dependent variable is GC. All models are estimated using OLS because the results of the specification test indicate that OLS is sufficient for estimation against the fixed effects model and the random effects model. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. The null hypothesis of

the F-test is that the individual fixed effects are all zero. The null hypothesis of the Hausman test is that individual effects are not correlated with explanatory variables.

Table 6. Excess sensitivity test according to proxies for forward-looking behavior

	(A) *Always plan*		(B) *Retirement plan*	
	Yes	No	Yes	No
	(1)	(2)	(3)	(4)
Panel A. Whole sample (Obs.: 7,128)				
EGY	0.37*	0.44*	0.33	0.45*
	(0.20)	(0.25)	(0.23)	(0.23)
Observations	5089	2039	3121	4007
Proportion of observations	71%	29%	44%	56%
Panel B. Liquidity unconstrained (Obs.: 6,609)				
EGY	0.35	0.53**	0.34	0.46*
	(0.22)	(0.27)	(0.24)	(0.25)
Observations	4734	1875	2952	3657
Proportion of observations	72%	28%	45%	55%

Note: All estimates also include interaction of ERROR with year dummies, ΔFAMILY, ΔWORKER, VAR, age dummies, year dummies, and constant term. All models are estimated using OLS because the results of the specification test indicate that OLS is sufficient for estimation against the fixed effects model and the random effects model. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 7. Excess sensitivity test by proxies for self-control problems

	(I) *Cannot bear not buying*		(II) *End up procrastinating*		(III) *Cannot execute plan*		
	No	Yes	No	Yes	No	Yes	Not plan
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Whole sample (Obs.: 7,128)							
EGY	0.26	0.67*	0.17	0.81***	–0.05	0.67***	–0.09
	(0.18)	(0.37)	(0.19)	(0.29)	(0.28)	(0.21)	(0.66)
Observations	5654	1474	4829	2299	2476	4130	522
Proportion of obs.	79%	21%	68%	32%	35%	58%	7%
Panel B. Liquidity unconstrained (Obs.: 6,609)							
EGY	0.26	0.73*	0.18	0.85***	–0.10	0.69***	0.13
	(0.19)	(0.39)	(0.21)	(0.31)	(0.29)	(0.22)	(0.68)
Observations	5253	1356	4519	2090	2302	3824	483
Proportion of obs.	79%	21%	68%	32%	35%	58%	7%

Note: All estimates are OLS for the results of the specification test. All estimates also include interaction of ERROR with year dummies, ΔFAMILY, ΔWORKER, VAR, age dummies, year dummies, and constant term. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 8. Excess sensitivity test by proxies for forward-looking behavior and self-control problems (excluding liquidity-constrained households)

	(A) *Always plan*		(B) *Retirement plan*	
	Yes	No	Yes	No
(I) *Cannot bear not buying*				
No	0.18	0.50	0.19	0.38
	(0.24)	(0.31)	(0.25)	(0.28)
	[3812, 58%]	[1441, 22%]	[2462, 37%]	[2791, 42%]
Yes	0.78	0.53	0.81	0.65
	(0.49)	(0.61)	(0.65)	(0.50)
	[922, 14%]	[434, 7%]	[490, 7%]	[866, 13%]
(II) *End up procrastinating*				
No	0.23	0.06	–0.01	0.50*
	(0.25)	(0.35)	(0.28)	(0.30)
	[3497, 53%]	[1022, 15%]	[2130, 32%]	[2389, 36%]
Yes	0.60	1.18***	1.27***	0.55
	(0.43)	(0.40)	(0.45)	(0.45)
	[1237, 19%]	[853, 13%]	[822, 12%]	[1268, 19%]
(III) *Cannot execute plan*				
No	–0.28	0.27	–0.45	0.31
	(0.34)	(0.54)	(0.39)	(0.43)
	[1793, 29%]	[509, 8%]	[1116, 18%]	[1186, 19%]
Yes	0.87***	0.42	1.02***	0.39
	(0.29)	(0.32)	(0.32)	(0.32)
	[2607, 23%]	[1217, 20%]	[1620, 26%]	[2204, 36%]

Note: All estimates also include interaction of ERROR with year dummies, ΔFAMILY, ΔWORKER, VAR, age dummies, year dummies, and constant term. All estimates are OLS for the results of the specification test. Clustered robust standard errors are in parentheses. The numbers of observations and the proportions of observations are in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table 9. Sophisticated vs. naïve households (excluding liquidity-constrained households)

	Whole sample	(I) *Cannot bear not buying*		(II) *End up procrastinating*		(III) *Cannot execute plan*		
		No	Yes	No	Yes	No	Yes	Not plan
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. *Not have cash*								
Naïve (Obs.: 1,714)								
EGY	0.83***	0.60*	1.09	0.55	1.46**	0.14	1.20***	5.24*
	(0.32)	(0.33)	(0.84)	(0.36)	(0.63)	(0.55)	(0.39)	(2.80)
Proportion of obs.	100%	79%	21%	69%	31%	36%	60%	5%
Sophisticated (Obs.: 4,895)								
EGY	0.23	0.14	0.52	0.05	0.65*	–0.19	0.53**	–0.25
	(0.20)	(0.23)	(0.44)	(0.25)	(0.36)	(0.34)	(0.27)	(0.71)
Proportion of obs.	100%	80%	20%	68%	32%	35%	57%	8%
Panel B. *Not use incentives to finish assignments*								
Naïve (Obs.: 4,127)								
EGY	0.54**	0.39	0.84*	0.40	0.85**	0.12	0.77***	0.14
	(0.21)	(0.24)	(0.46)	(0.26)	(0.38)	(0.37)	(0.28)	(0.71)
Proportion of obs.	100%	78%	22%	66%	34%	29%	60%	11%
Sophisticated (Obs.: 2,482)								
EGY	0.09	0.04	0.22	–0.23	0.84	–0.35	0.42	-
	(0.29)	(0.31)	(0.77)	(0.34)	(0.55)	(0.44)	(0.38)	-
Proportion of obs.	100%	82%	18%	72%	28%	44%	55%	1%

Note: All estimates also include interaction of ERROR with year dummies, ΔFAMILY, ΔWORKER, VAR, age dummies, year dummies, and constant term. All estimates are OLS for the results of the specification test. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Results are omitted for the sophisticated group for (III) in Panel B because the sample size was not large enough to obtain robust estimates.

Table A. Distribution of observations by year

	04–05	05–06	06–07	07–08	08–09	09–10	Total	Total obs.
Our sample	10%	10%	15%	16%	16%	33%	100%	7,128
Total sample	16%	12%	16%	14%	13%	28%	100%	19,052

Note: Total sample indicates the number of households that responded in at least two consecutive periods.

Table B. Excess sensitivity test by forward-looking behavior and self-control problems (whole sample)

	(A) *Always plan*		(B) *Retirement plan*	
	Yes	No	Yes	No
(I) *Cannot bear not buying*				
No	0.23	0.40	0.18	0.38
	(0.22)	(0.29)	(0.24)	(0.27)
	[4103, 58%]	[1551, 22%]	[2593, 36%]	[3061, 43%]
Yes	0.69	0.59	0.73	0.63
	(0.47)	(0.55)	(0.61)	(0.46)
	[986, 14%]	[488, 7%]	[528, 7%]	[946, 13%]
(II) *End up procrastinating*				
No	0.23	0.05	–0.03	0.47*
	(0.23)	(0.33)	(0.27)	(0.28)
	[3749, 53%]	[1080, 15%]	[2235, 31%]	[2594, 36%]
Yes	0.66	0.93**	1.26***	0.54
	(0.42)	(0.38)	(0.42)	(0.42)
	[1340, 19%]	[959, 13%]	[886, 12%]	[1413, 20%]
(III) *Cannot execute plan*				
No	–0.22	0.30	–0.31	0.25
	(0.33)	(0.52)	(0.36)	(0.43)
	[1932, 29%]	[544, 8%]	[1189, 18%]	[1287, 19%]
Yes	0.84***	0.37	0.97***	0.41
	(0.27)	(0.30)	(0.31)	(0.29)
	[2804, 42%]	[1326, 20%]	[1709, 26%]	[2421, 37%]

Note: All estimates also include interaction of ERROR with year dummies, ΔFAMILY, ΔWORKER, VAR, age dummies, year dummies, and constant term. All estimates are OLS for the results of the specification test. Clustered robust standard errors are in parentheses. The numbers of observations and the proportion of observations are in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Table C. *Cannot execute plan* and *Types of incentives*

Types of incentives		
1. I did my homework with my friends and made it a competition to see who could do a better job.	–0.002	(0.044)
2. I asked my parents to give me a reward for completing my homework.	0.086	(0.192)
3. I put a homework schedule in a place where I would see it.	0.113	(0.035)***
4. I tried to sit at my desk at the same time each day.	0.190	(0.034)***
5. I used other creative methods for completing my homework.	–0.034	(0.071)
6. I did not follow any specific regimen.	Reference	
Female dummy	0.008	(0.028)
Age dummies	Yes	
Observations	1275	
Log likelihood	–796	

Note: Dependent variable is *Cannot execute plan*, which takes a value of one if the response is “Yes” and zero if “No”. The coefficients are marginal effects estimated by the probit model. Robust standard errors are in parentheses. *** indicates significance at the 1% level.

Table D. Sophisticated vs. naïve households (whole sample)

	Whole sample	(I) *Cannot bear not buying*		(I) *End up procrastinating*		(III) *Cannot execute plan*		
		No	Yes	No	Yes	No	Yes	Not plan
Panel A. *Not have cash*								
Naïve (Obs.: 1,849)								
EGY	0.96***	0.80**	0.89	0.65*	1.59**	0.56	1.13***	3.89
	(0.32)	(0.34)	(0.83)	(0.35)	(0.65)	(0.60)	(0.36)	(2.71)
Proportion of obs.	100%	79%	21%	69%	31%	36%	60%	5%
Sophisticated (Obs.: 5,279)								
EGY	0.18	0.08	0.49	0.02	0.56*	–0.25	0.50**	–0.25
	(0.19)	(0.22)	(0.40)	(0.23)	(0.32)	(0.32)	(0.25)	(0.68)
Proportion of obs.	100%	79%	21%	67%	33%	34%	57%	8%
Panel B. *Not use incentives to finish assignments*								
Naïve (Obs.: 4,454)								
EGY	0.52**	0.39*	0.81*	0.33	0.89**	0.24	0.71***	–0.16
	(0.20)	(0.24)	(0.43)	(0.25)	(0.36)	(0.38)	(0.26)	(0.69)
Proportion of obs.	100%	77%	23%	65%	35%	29%	60%	11%
Sophisticated (Obs.: 2,674)								
EGY	0.11	0.07	0.21	–0.11	0.55	–0.41	0.49	16.59***
	(0.27)	(0.29)	(0.69)	(0.32)	(0.51)	(0.42)	(0.35)	(1.63)
Proportion of obs.	100%	82%	18%	72%	28%	44%	55%	1%

Note: All estimates also include interaction of ERROR with year dummies, ΔFAMILY, ΔWORKER, VAR, age dummies, year dummies, and constant term. All estimates are OLS for the results of the specification test. Clustered robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

Figure 1. Distribution of expectation of income growth rate (EGY)

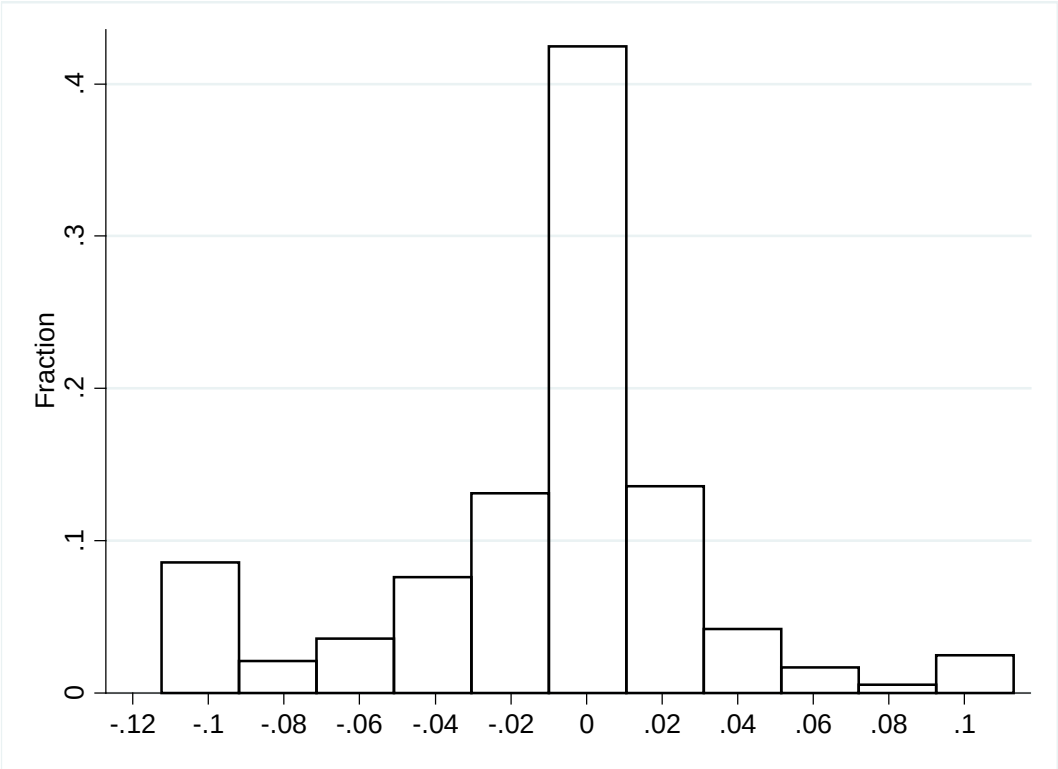

Figure 2. Means of GY(1), GY(2), and EGY

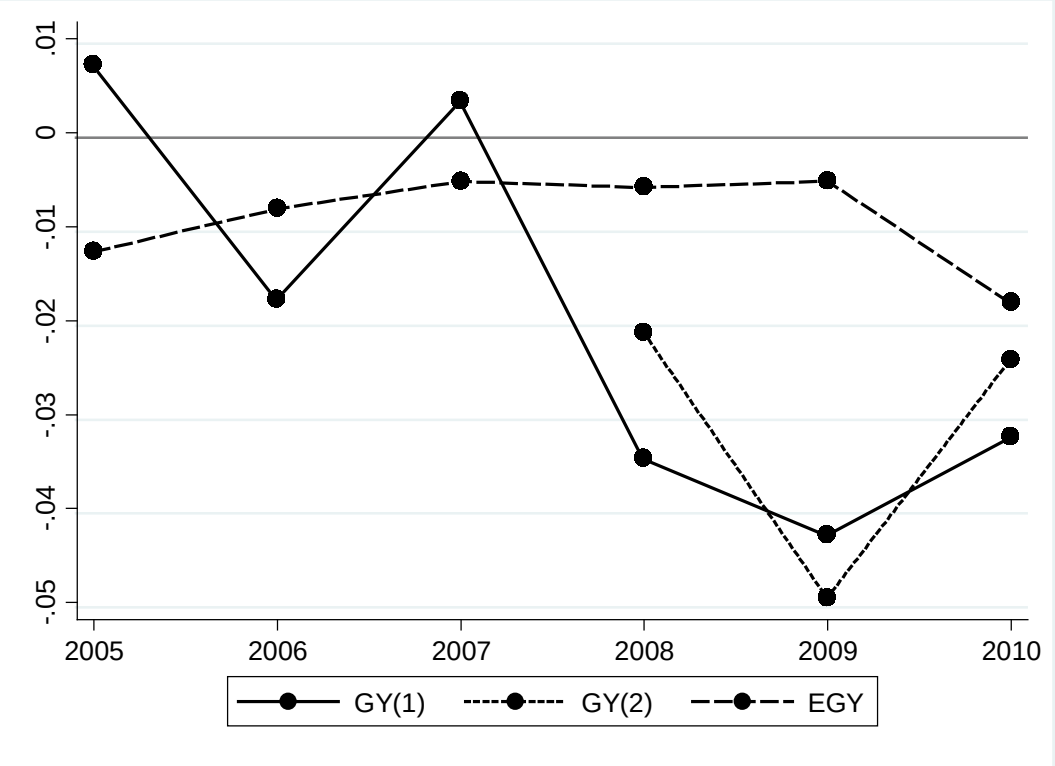

Figure 3. Forecast error of family income change

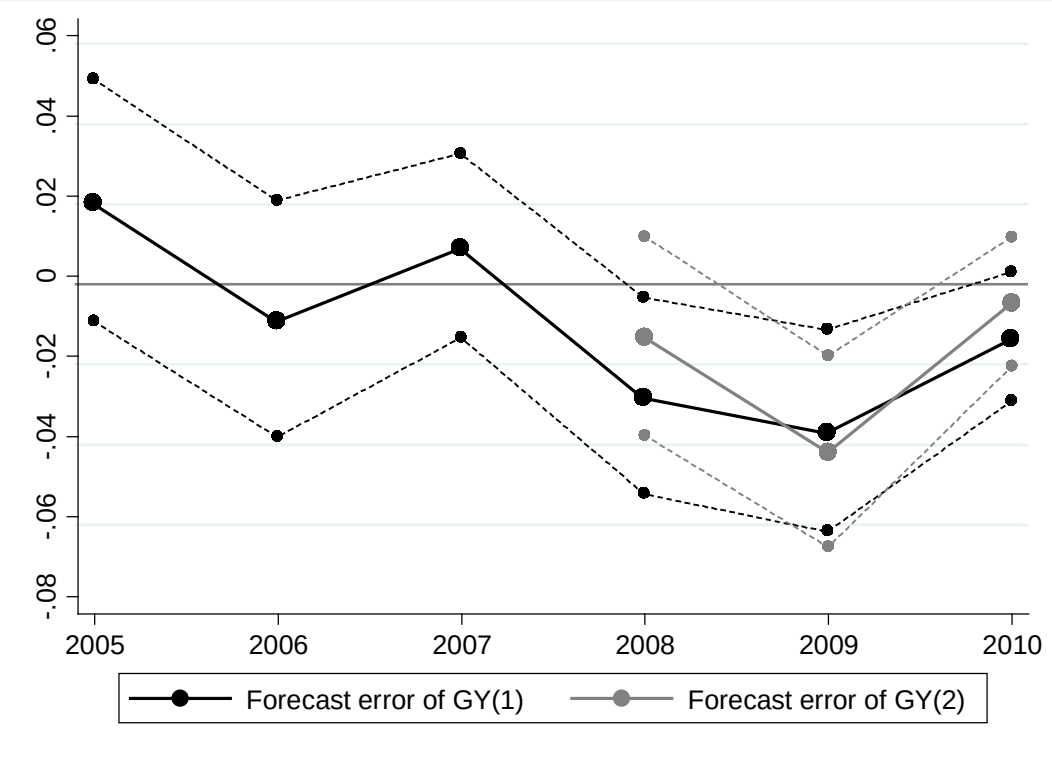

Figure 4. Distribution of proxy for forward-looking (*Always plan*)

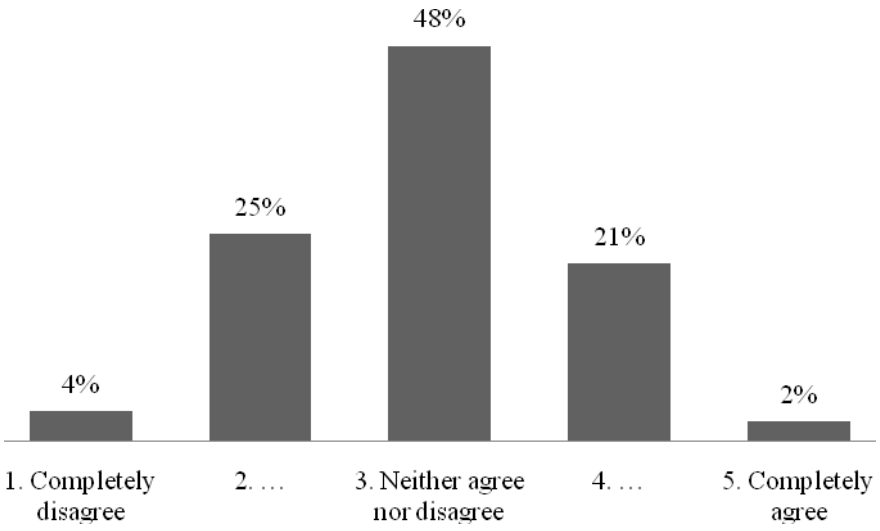

Figure 5. Distribution of proxy for forward-looking (*Retirement plan*)

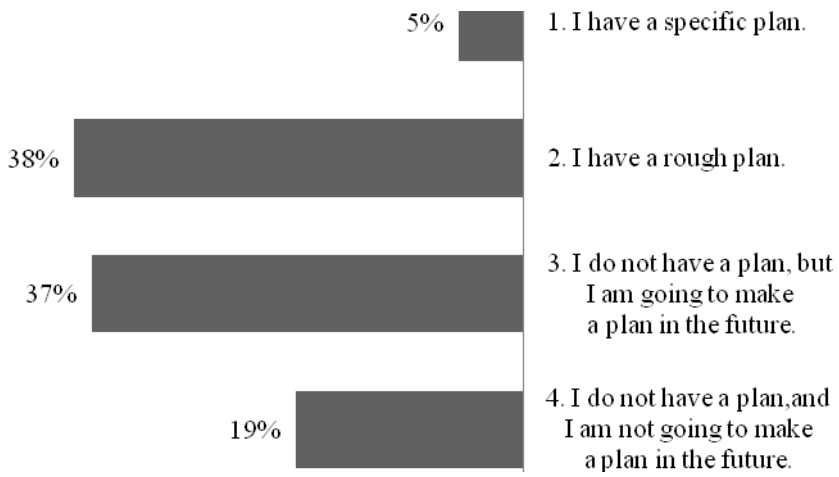

Figure 6. Distribution of proxy for self-control problems (*Cannot bear not buying*)

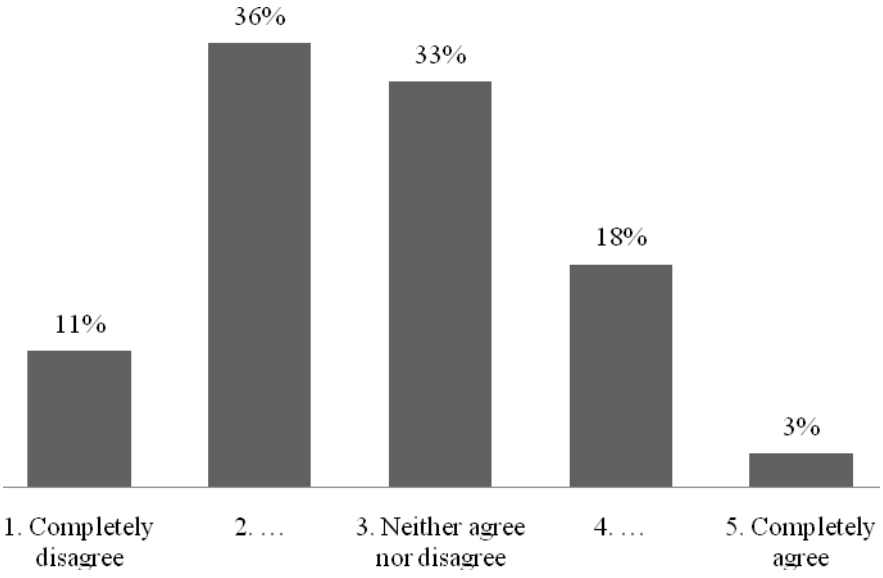

Figure 7. Distribution of proxy for self-control problems (*End up procrastinating*)

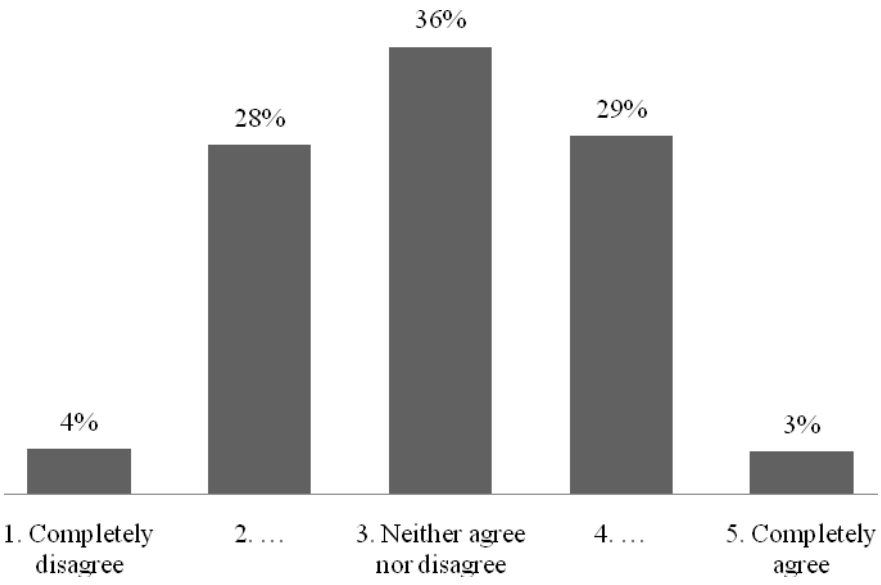

Figure 8. Distribution of proxy for self-control problems (*Assignment plans and their execution*)

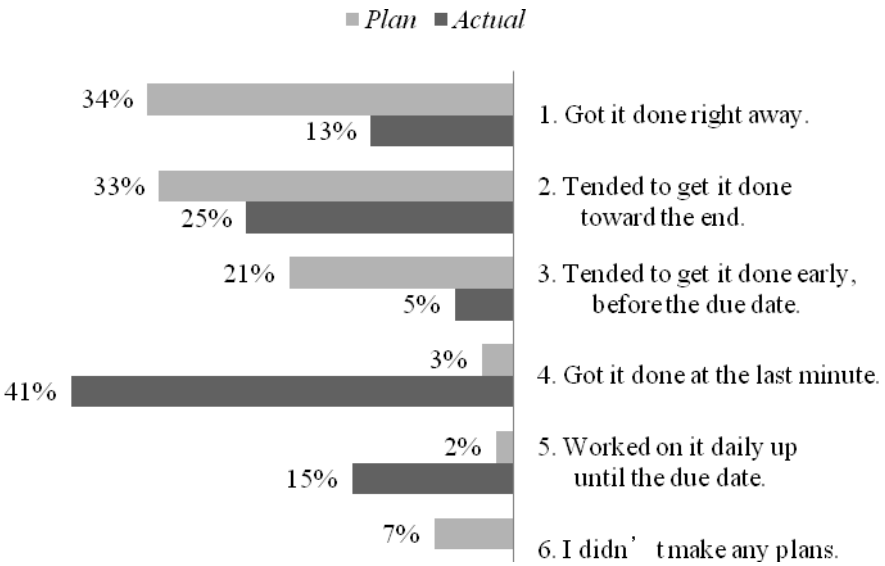

Figure 9. Distribution of using commitment devices (*Use of incentives to finish homework*)

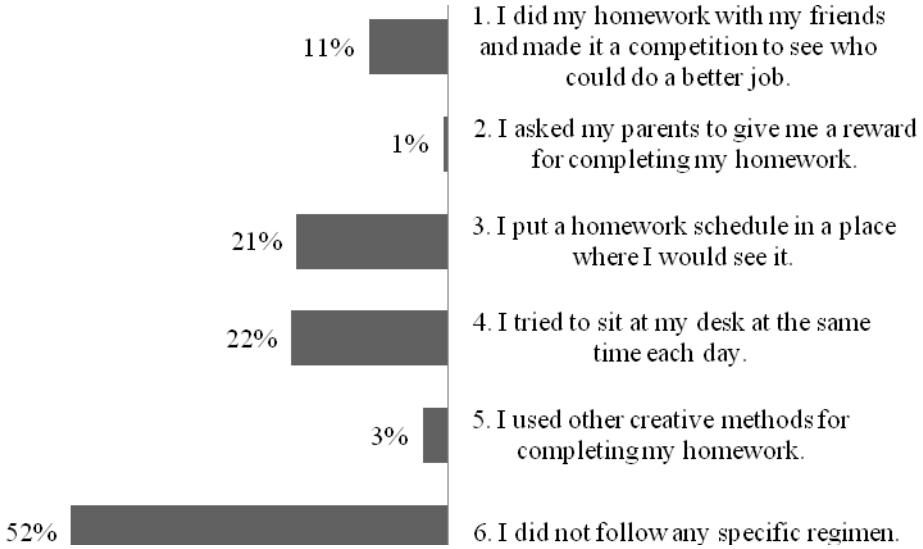

Figure A-1. Distribution of income growth rate (GY(1))

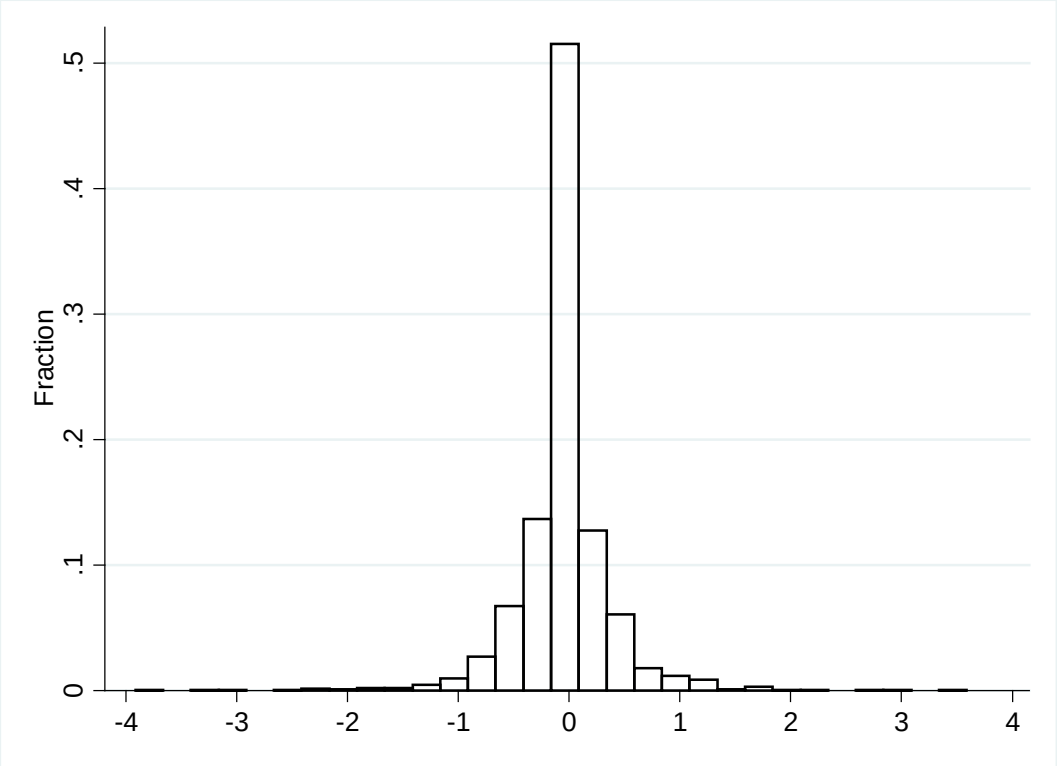

Figure A-2. Distribution of income growth rate (GY(2))

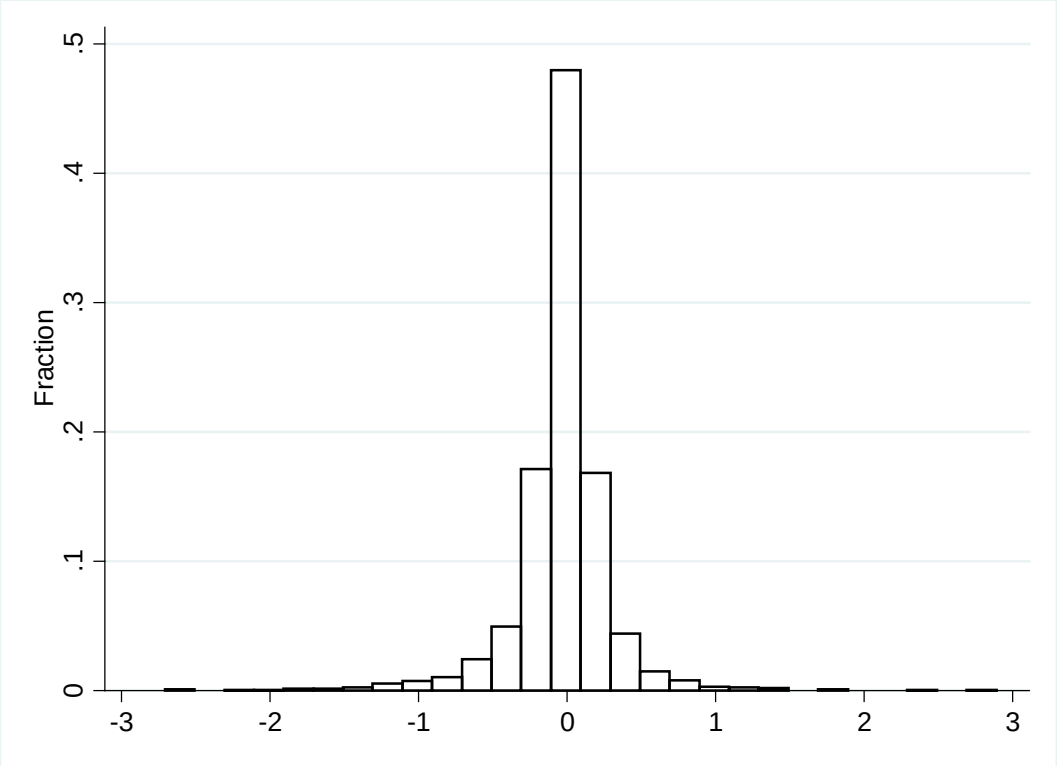

Figure B. Distribution of consumption growth rate (GC)

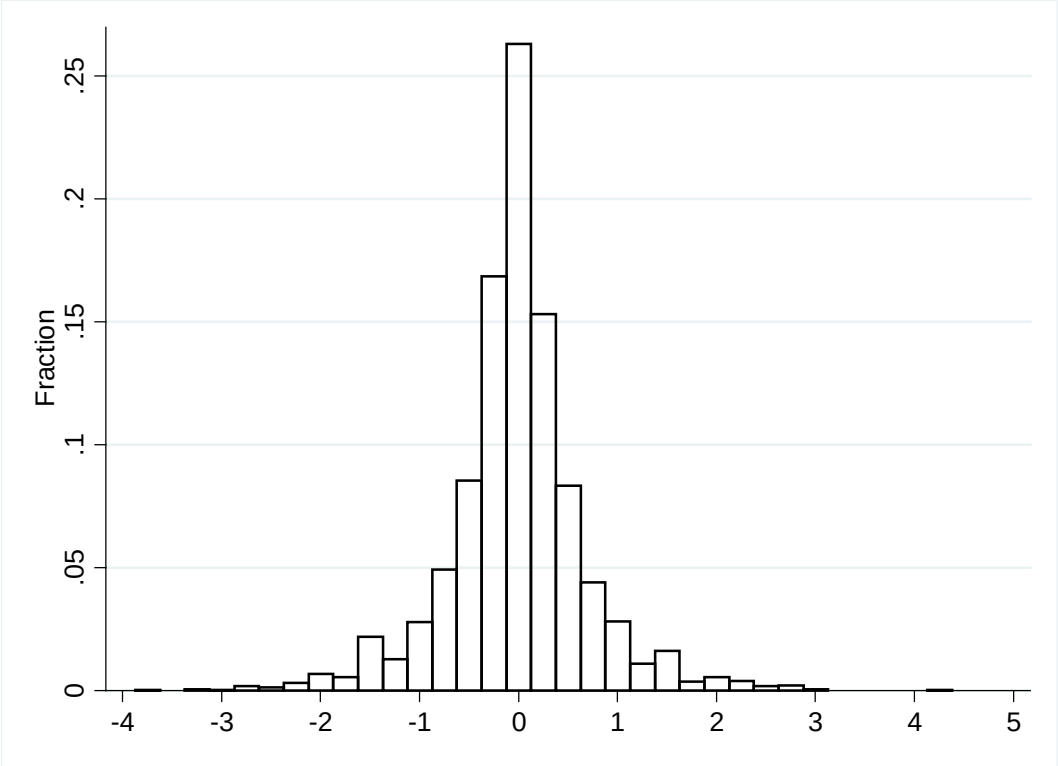

Figure C-1. Distribution of total consumption growth rate (GTC)

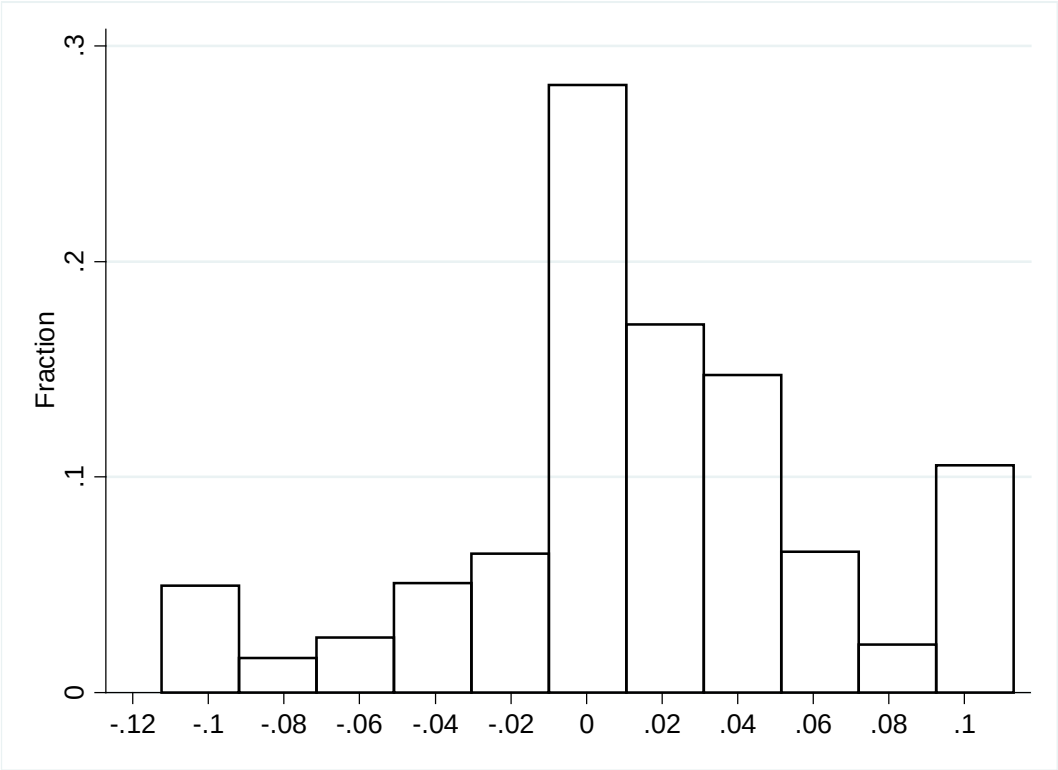

Figure C-2. Distribution of expectation of consumption growth rate (EGTC)