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Dynamic Consumption Behavior: Evidence from Japanese Household Panel Data

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Abstract

Household consumption and saving behavior have been the central theme of recent macroeconomic literature. Following the work of Robert Hall (1978) and a series of papers by Fumio Hayashi, the focus of the literature has been on dynamic consumption behavior. Using the Family Income and Expenditure Survey (FIES), we conducted a dynamic panel analysis of consumption behavior. We examined intertemporal smoothing and the durability of consumption behavior with or without liquidity constraints. Our results are summarized as follows: (1) households with debt as well as debt-free households with low annual incomes and net savings faced disposable income constraints; (2) for these types of households, parameter values of lagged dependent variables between MLE and GMM are very close and therefore statistically significant and the implications for each remain more or less the same; (3) debt-free households with high annual incomes and net savings also faced a disposable income constraint in MLE that is not expected in the permanent income-lifecycle hypothesis.

Key words: dynamic consumption, panel data, liquidity constraints.

JEL classifications: C23, D12, E21

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1 Introduction

The Family Income and Expenditure Survey (FIES) has a panel data element, which is a six monthly rotation panel. FIES is the primary source of information for investigating household consumption and saving behavior in a dynamic context. Indeed, Hayashi (1997, chapter 5) explores this aspect of FIES almost twenty years ago. Since the study of Hayashi, there have been no studies of which I am aware that have examined the FIES using a dynamic panel analysis framework.

Considering the rapid developments in computer technology, software, and data processing over the past twenty years, it is worthwhile reexamining household consumption using a rotation panel from the FIES. Such a study would be interesting because economic environments have changed since 1981–82, the years in which Hayashi analyzed the FIES. For example, macroeconomic conditions are different, as employment and wage systems have changed significantly.

For the sake of comparison, we followed Hayashi's (1997, chapter 5) framework and investigated the durability of consumption and liquidity constraints. The data we used were taken from the FIES, sampled from August 2001 to December 2002. We chose this period because the FIES and the Family Saving Survey (FSS) were combined into a newly unified FIES in January 2002, which allowed us to identify gross financial assets (savings), debt, and thus net financial assets (net savings), together with consumption expenditure patterns, household characteristics, status of homeownership, and employment status[1]. All the financial stock data were available at the end of survey (i.e., after the sixth month of the survey). The sample households surveyed in August 2001 were the first cohort to provide information on savings and debt in the last month of their survey, i.e., January 2002. Starting from this cohort, we considered 12 cohorts, the last cohort of which was surveyed between July and December 2002.

The advantage of our dataset over Hayashi's is that we can use debt information. It is now much easier to distinguish between households with or without debt, thus advancing research on consumption behavior under liquidity constraints.

The data have limitations in that they only span a six-month period. Because of this limitation, it was not possible to investigate annual changes in consumption patterns or the lifecycle patterns of individual households. The special features of monthly data are not usually discussed in economic theory, and we needed to accommodate these features in our empirical work.

The paper is organized as follows. Section 2 contains a review of recent literature on dynamic consumption behavior. Section 3 contains a discussion

[1] In January 2002, the sample was extended to include one-person household, which meant that its coverage rose from about 8,000 households to about 9,000 households. In addition, the survey method for households with two or more persons was revised as follows. The survey on the quantity of food was shortened from six months to the first month of the survey period, and a savings schedule was introduced to ascertain the amount of savings and liabilities held by households and their plans to purchase houses and land. After the FIES revision, the Survey for One-person Households and the FSS were abolished.

of the theoretical model. Section 4 contains a review of statistical issues inherent in the FIES. Empirical results are presented in Section 5. Section 6 contains the conclusion.

2 The Literature on Dynamic Consumption Behavior

Much research on consumption and saving was conducted in the 1950s and 1960s, when standard approaches such as the permanent income hypothesis and the lifecycle hypothesis were introduced. At that time, the main data sources were time series from national income accounts. In the 1980s and 1990s, research on this topic revived after microeconomic data became available. Using rich information from microeconomic data, researchers investigated the bequest motive vis-à-vis the lifecycle motive, the impact of social security on savings, and the impact of tax exemption of interest income on incentives, among other topics. The empirical results of these studies are found in, for example, Kotlikoff (1989, 2001), Hall (1990), and Hayashi (1997). A broad survey of this literature includes Deaton (1992, 1997), Gollier (2001), and Bagliano and Bertola (2004).

The recent direction of research in this field was set by Hall (1978), who proposed a statistical method to distinguish between a Keynesian consumption function and the permanent income–lifecycle consumption function. This method is used to estimate the now well-known Euler equation, which is derived from the first-order condition for intertemporal utility optimization. The null hypothesis is that household consumption follows a random walk. If this is the case, the permanent income hypothesis cannot be rejected. Hall (1978) shows that the permanent income hypothesis is not rejected by using consumption data from national income accounts. Flavin (1981) demonstrates that consumption is excessively sensitive to changes in disposable income. After this publication, a series of studies was conducted in which the excess sensitivity of consumption to disposable income was examined using macroeconomic time-series data. Two conclusions emerged from this debate: (1) consumption is sensitive to disposable income, albeit less than what the Keynesian consumption function predicts; and (2) macroeconomic time-series data contain a series of common and idiosyncratic shocks, which make it difficult to empirically distinguish between the effects of unexpected shocks and other shocks on income and consumption. It is, therefore, practically impossible to apply identification tests over the permanent income hypothesis[2].

Regarding the first point, disposable income is interpreted as affecting consumption either through liquidity constraints on a part of the population or through the precautionary motive due to uncertainty about future income.

[2] The debate over this issue is evident from publications by Campbell and Deaton (1989), Campbell and Mankiw (1991), Deaton (1991,1992), Shea (1995), and Bacchetta and Gerlach (1997), among others.

The liquidity constraint hypothesis was examined using micro data — in particular, panel data — by Hall and Mishkin (1982), Zeldes (1989), Hayashi (1997, chapters 4 and 5), and Runkle (1991)[3].

Following Flavin (1981), Hall and Mishkin (1982) decomposes income and consumption data from PSID into a long-run deterministic trend (the permanent component) and a short-run stochastic component and then examines the permanent income hypothesis. They found that consumption is more sensitive to the permanent component than the short-run component, but it is also affected by the short-run component. In this sense, the pure permanent income hypothesis is rejected. Hall and Mishkin argued that 80% of the population obey the permanent income hypothesis and 20% are affected by current disposable income.

Zeldes (1989) formulates the liquidity-constrained households hypothesis using the 1968–82 PSID and shows that liquidity constraints exist for households with smaller assets. Using the same PSID data for 1973–82, Runkle (1991) argues that there was no evidence of liquidity constraints, even for people with smaller assets, and that disposable income probably affects consumption because of data aggregation problems. As Deaton (1992) comments, these contradictory results deserve further investigation.

Using the 1982 Consumer Confidence Survey and the 1981–82 FIES, Hayashi (1997, chapters 4 and 5, respectively) [4] conducts Euler equation tests for the permanent income hypothesis. He concludes that 10–15% of households face liquidity constraints, while the rest of the population conform to the permanent income hypothesis. This paper is an extension of that of Hayashi (1997, chapter 5).

Research on the precautionary saving motive includes that of Zeldes (1989b), Carroll (1992, 1997, 2001), and Carroll, Hall, and Zeldes (1992). The model developed by Zeldes and Carroll explicitly takes risk-averse behavior into account so that households do not necessarily smooth their consumption over time. The model assumes a constant relative risk-averse (CRRA) utility function that yields risk-averse behavior. However, this functional form has analytical problems. Most studies in the literature have used a numerical solution via calibration[5].

An important topic in the literature has been the identification of how uncertainty regarding income emerges over time. Some studies have used opinion surveys of uncertainty in future life, such as uncertainty caused by unemployment, reduction of pension benefits, tax increases, and bankruptcies of firms.

[3] Microeconomic cross-section data was used by Maki (1983) for liquidity constraints due to housing purchases. Maki used the 1979 FIES for Japan.

[4] This survey seeks to gain a quick understanding of shifts in consumer perception, expenditure plans for services, and the possession and planned purchases of principle consumer durables as a tool for evaluating the state of the economy. The survey included 5,040 households in 230 cities, towns, and villages, which involved a three-level stratified random sampling of city/town/village, local unit, and household. The survey was conducted on 15 June, September, December, and March of the subsequent fiscal year.

[5] Recently, some studies have combined calibration with some empirical data. Gourinchas and Parker (2002) and Cagetti (2003) are cases in point.

Other studies have used historical changes in individual income obtained from panel data or semiaggregate time series data. Another method has been to use numerical values from previous studies. Because we only had six months' panel data, we were not able to estimate income uncertainty over the life cycle and decided not to consider this approach.

Studies on durable consumption were conducted by Bernanke (1984, 1985), Mankiw (1985), Bar-Ilan and Blinder (1992) and others. These studies are inconclusive as to whether durable consumption is more sensitive to permanent income than to transitory income. In the framework of intertemporal optimization, the discount rate plays an important role. A new research area focusing on the hyperbolic discount rate investigates how intertemporal optimization is altered when the discount rate becomes time variable. Brown and Lewis (1981), Laibson (1997), Harris and Laibson (2001), Gollier (2002), Diamond and Köszegi (2002), and Dasgupta and Mishkin (2002) have investigated this problem. At present, all arguments are made on the basis of theoretical models. In the long-run, this topic will have direct relevance to empirical studies of intertemporal choice that use panel data.

3 The Model

The model we use in this paper is a standard permanent income-lifecycle consumption model such that:

$$\begin{aligned} \max U_t &= E_t \left[\sum_{i=0}^{\infty} \left(\frac{1}{1+\rho} \right)^i u(c_{t+i}) \right] \\ \textit{subject to } A_{t+i+1} &= (1+r)A_{t+i} + y_{t+1} - c_{t+i}, \quad A_t \textit{ is given}, \end{aligned} \tag{1}$$

where ρ is the time preference, A_{t+i} is the stock of financial wealth (i.e., net savings = financial assets - debt) at the beginning of period t+i, r_{t+i} is the real rate of return on financial assets in period t+i, y_{t+i} is labor income earned at the end of the period, and c_{t+i} is consumption up to the end of the period.

In the above formula, we assume: (a) intertemporal separability (additivity over time) of the utility function; (b) time consistency (that is, utility is discounted in the future in a way that guarantees intertemporally consistent choices); (c) that expected utility is the objective function under uncertainty; (d) there is only one financial asset with a certain and constant rate of return r; and (e) there is no Ponzi game condition (the transversality condition).

Eq(1) can be rewritten such that:

$$\max U_t = E_t \left[\sum_{i=0}^{\infty} \left(\frac{1}{1+\rho} \right)^i u((1+r)A_{t+i} + y_{t+1} - A_{t+i+1}) \right]. \tag{2}$$

The first-order conditions are necessary and sufficient if utility is an increasing and concave function of consumption.

$$E_t u'(c_{t+i}) = \frac{1+r}{1+\rho} E_t u'(c_{t+i+1}). \tag{3}$$

The consumer knows his or her marginal utility in the first period (when $i = 0$). Therefore, we obtain the following Euler equation:

$$u'(c_t) = \frac{1+r}{1+\rho} E_t u'(c_{t+1}). \tag{4}$$

At the optimum, the consumer is indifferent between current consumption and future consumption. Generally, the Euler equation gives the dynamics of marginal utility in any two successive periods. In this formula, the change in marginal utility and consumption depends on the difference between the rate of return r and the intertemporal rate of time preference ρ. The consumer's degree of risk aversion depends on the concavity of the utility function. It is well known that there is a negative relationship between risk aversion and intertemporal substitutability in the case of the CRRA utility function.

So far, we have not considered the possibility of a liquidity constraint. According to Zeldes (1989a), a liquidity constraint can be expressed as follows:

$$A_{t+i+1} \geq 0, \quad i = 0, ..., T-t-1. \tag{5}$$

This constraint means that consumer cannot borrow to finance purchases when net assets are negative. In reality, most consumers can borrow to purchase goods and assets, but some consumers face liquidity constraints as defined above[6]. For those who face liquidity constraints, the Euler equation becomes:

$$u'(c_t) = \frac{1+r}{1+\rho} E_t u'(c_{t+1}) + \lambda_t, \tag{6}$$

where λ_t is the Lagrange multiplier associated with the constraint of Eq(5).

This term λ_t is interpreted as the increase in expected lifetime utility that would result if the current budget constraint were relaxed by one unit. If λ_t is greater than zero, making the current budget constraint binding, then the end-of-period financial assets must be equal to zero.

The combination of Eqs (4) and (6) is the basis of our empirical model. The empirical model depends on the specification of the utility function. In addition, we had to modify the model given the nature of our specific statistical data.

[6] To be more realistic, the need to borrow occurs from time to time over a lifecycle (not all at the same time). The liquidity constraint becomes binding when consumers have sufficient debts, such as mortgages.

4 Statistical Issues

The empirical data were selected if they met the following criteria: (1) households answered the survey for the entire six months; (2) households answered the survey on savings (financial assets and debt); (3) households remained either employed or unemployed for the entire six months; (4) household characteristics were classified according to the previous month's information; (5) savings, net savings, debt, and time deposits were derived from the previous month's information.

Because of the diary method used in the FIES, it is very unlikely that it contains measurement errors of significance. However, non-responses for certain items are common. In this instance, households may be deleted from the sample even if they satisfy the five criteria.

Hayashi (1997, chapter5) redefines consumption categories according to economic reasoning. For example, he subtracted 'eating out' from the food expenditure category, placing it in the service and entertainment expenditure category, and added tobacco to the food expenditure category. Although these adjustments are justifiable, we did not adjust the ten expenditure categories defined by the Statistics Bureau. Summary statistics are shown in Table 1.

This study included nonworking households, which were omitted from the study of Hayashi (1997, chapter 5). The number of elderly, retired households has increased because the proportion of elderly people in the population has increased. It is pertinent to include these households in our analysis because of the aging demographics of society. Unlike Hayashi, we did not make seasonal adjustments based on the bonus system, which enabled us to include non-working households in the sample without difficulty.

Table 1 Summary Statistics

The figures in Table 1 are nominal values. In the regression analysis, all variables are converted into real values by the respective consumer price indices. In addition, we exclude outliers (i.e., figures that exceed the mean±4standard deviations in disposable income, total consumption, and saving) in our regression.

Table 2 Monthly Averages of Consumption, Savings, and Disposable Income (nominal values)

Table 2 indicates that consumption is surprisingly stable. Although consumption may increase somewhat when bonuses are paid, in general the bonus is absorbed in savings — i.e., savings fluctuate from positive to negative as a residual between disposable income and consumption.

A stationarity check is a prerequisite in time series analysis. Panel data may require a stationarity check when the time series are long enough. The six-months' data we use may not exhibit a non-stationary trend. Nevertheless, in the empirical analysis below, we use the first-difference consumption model. Even if stationarity is not a serious problem, the seasonality problem remains. We will consider this issue in the next subsection.

4.1 Seasonal adjustment

It is well known that consumption exhibits seasonality. Income in the employees' households fluctuates in the bonus periods[7]. The analysis of consumption behavior has to accommodate these seasonality effects.

There are several methods of seasonal adjustment in macroeconomic time series data[8]. In fact, if data are available over multiple years, we can eliminate seasonality by using a month-to-month (or quarter-to-quarter) growth rate or moving average over several months. The available data is too limited to employ conventional seasonality adjustment methods.

In order to overcome this problem, Hayashi (1997, chapter 5) proposes the following method. He divides monthly expenditure and income by the monthly average of expenditure and income, then takes the first difference, such that:

$$\frac{X_{i,t+1}}{\bar{X}_{t+1}} - \frac{X_{i,t}}{\bar{X}_t}, \tag{7}$$

where $\bar{X}_t$ is a cross-section average of month t.

This method implies that each household's expenditure and income are evaluated cross-sectionally (i.e., based on a ranking of the household's economic position in society) and are checked monthly for changes of ranking. The rationale for this seasonal adjustment is to remove the bonus effects, as most working households receive bonuses twice a year. If the bonus amount is proportional to regular monthly income, then the relative ranking of households in expenditure and income might not change in the bonus periods. Provided this method of standardization (ranking) by mean division removes seasonal fluctuations in absolute values in expenditure and income, it functions as a seasonal adjustment.

Indeed, this method is appropriate when all working households receive a bonuses that are of equal proportion to their regular incomes. After the burst of the bubble economy in Japan in the 1990s, substantial corporate renewals took place with the result that bonus payments are no longer guaranteed and the amount of bonus varies from firm to firm. The wage system has also changed recently. Some firms have adopted annual salary contracts in which one twelfth of the annual salary is paid out monthly. Suppose some households

[7] Usually, the bonus periods are June, July, and December.

[8] For macroeconomic aspects of seasonality, see Miron (1996).

accept the annual salary system, while others follow the bonus system and that those under the annual salary system exhibit a consumption pattern based on the permanent income-lifecycle hypothesis. Using Hayashi's ranking method, the relative ranking of those under the annual salary system may fall during the bonus periods when those under the bonus system receive substantially higher incomes than they do in other periods. If we adopt Hayashi's method in this case, the permanent income consumers could be classified as Keynesian consumers. Furthermore, this data transformation may alter the nature of utility. Instead of being based on consumption per se, utility may be based upon the relative ranking in society.

Thus, we avoid adopting the Hayashi method of seasonal adjustment for the 2000–2001 data because this may induce additional statistical errors. Instead, we simply add monthly dummies to remove seasonality, as most time series analyses for seasonally unadjusted data do[9]. This is rather a naïve way of adjusting seasonality, but it is neutral in the sense that it avoids any specific and strong assumptions about the income and expenditure behavior of households.

4.2 The durability of consumption

Another important point made by Hayashi (1997, chapter 5) is that the consumption of nondurable items reveals some durability. This is a genuinely empirical finding. Hayashi's main point is to distinguish consumption from expenditure. Although this is reasonable, economic theory completely ignores this.

For example, although we consume shampoo, soap, and toothpaste everyday, we only purchase them once in a while, with the result that expenditures on these items occur at intervals. This expenditure is not equivalent to consumption because consumption is a process of using up items that were purchased previously.

In economic theory, consumption is the focus of argument. FIES deals with expenditure and not consumption per se. Monthly data may reveal discrepancies between expenditure and consumption, while annual data on consumption and expenditure may coincide more or less[10].

This finding is not new. In the field of marketing, Ehrenberg (1959) investigated the pattern of purchases of nondurable consumer goods such as bread, breakfast cereals, canned vegetables, coffee, detergents, soaps, shampoos, and soft drinks over 26 weeks. He found that the pattern fitted well with the negative binomial distribution. That is, purchases of certain goods are observed k times and nonpurchases x times, yielding a total observation of $n = k + x$. The

[9] Initially, dummies were used for every month, but only the statistically significant dummies (June, July, August, November, December, and January) were retained for the regression analysis.

[10] The National Income Accounts consider durables to be goods that are consumable over a period of more than one year, whereas nondurables are goods that are consumable in less than one year. It is a trivial point that nondurables may not necessarily be consumed in a month.

frequency of purchases obeys the following formula: $f(x) = \begin{pmatrix} n-1 \\ x \end{pmatrix} p^k q^x$, where $x = 0, 1, 2, ..., p > 0,\ \ p+q = 1$. According to Ehrenberg (1959), $p = 0.806$ and this function fits well with the observed data overall. This result implies that the same goods are not purchased frequently. A frequency distribution of individual purchases follows a negatrive binominal or Poisson distribution, with average purchases varying among households. Looking at the marketing data, over 26-week period, nondurable goods are purchased in 0-4 times[11].

To be more specific, Hayashi (1997, chapter 5) shows that the relationship between expenditure x_{ijt} and consumption c_{ijt} is such that consumption is a flow from accumulated expenditure in the past:

$$c_{ijt} = \rho_{j0}x_{ijt} + \rho_{j1}x_{ijt-1} + \rho_{j2}x_{ijt-2} + \rho_{j3}x_{ijt-3} + ... + \rho_{jM}x_{ijt-M}, \tag{8}$$

where i is the agent, j is the consumption item, t is time, and M is a certain time dimension.

This formula shows that consumption is a weighted average of past expenditures. Although this formula is correct, it needs further elaboration. Eq(8), in fact, shows that this relation is valid for a consumption basket (such as food and housing). However, expenditures on individual goods x_{ijt}, such as rice, soy sauce, coffee, detergents, and pencils, must be expressed as the flow of current and future consumption c_{ijt+n} such that:

$$x_{ijt} = \delta_{j0}c_{ijt} + \delta_{j1}c_{ijt+1} + \delta_{j2}c_{ijt+2} + \delta_{j3}c_{ijt+3} + ... + \delta_{jM}c_{ijt+N}. \tag{9}$$

Rational consumers use individual goods until they are used up and do not purchase the same goods until then. Eq(8) does not hold for individual goods. As mentioned above, Eq(9) expresses a consumption basket of individual goods that are purchased in different periods of the past expenditure. For example, food consumption is a combination of seasoning and soybean paste purchased last month, fish purchased today, vegetables purchased last week, and rice purchased two months ago.

This fact induces us to convert our consumption model into an expenditure model with a reasonable lag structure, reflecting the durability of consumption.

4.3 Liquidity constraints

Prior to January 2002, the FIES asked sample households commencing the survey between October and December to participate in the FSS as well. For this period, the samples in FIES and FSS are identical. However, we needed to make additional efforts to match the two surveys even though the samples were known to coincide. After January 2002, the FIES and the FSS were

[11] It would be interesting to investigate whether the frequency of individual nondurable goods purchases in the FIES follows a negative binomial distribution.

combined into a new FIES. In this paper, we explore this improved survey and shed new light on the issue of liquidity constraints. Until FIES was revised, the magnitude of liquidity constraints could not be identified in a convincing way[12].

We divided the households into three groups according to the degree of liquidity constraints. (1) Households with debt. Although these households may not borrow as much as they wish, they have not been faced with liquidity constraints in the past. (2) Households without debt and seemingly without liquidity constraints. Although households in this group can borrow as much as they like, they do not borrow. (3) Households without debt and seemingly with liquidity constraints.

Group (1) can be distinguished on the basis of available debt information. The distinction between groups (2) and (3) requires some assumptions to separate these groups according to annual incomes and net savings. Strictly speaking, the degree of liquidity constraints should be obtained from the credit line manual of the financial institutions or be estimated by analyzing the characteristics of the households with debt. We impose strict assumptions regarding households without liquidity constraints and loosely define those with constraints.[13] We set debtinc = 1 for households with debt. Then, we assume those households earning in the top 25% of annual incomes (i.e., households earning 8.2 million yen per annum and above) do not have liquidity constraints, and set debtinc = 0 for this group. Finally, we set debtinc = 2 for households that potentially face liquidity constraints, which we assume are those with an annual income below 8.2 million yen. By the same token, we set debtass = 1 for households with debt. Then, debtass = 0 for households without constraints, which we assume are those in the top 25% of net savings (i.e., those saving 18.6 million yen and above). Finally, debtass = 2 for households that potentially face liquidity constraints, which are those with net savings below 18.6 million yen.

Summary statistics are shown in Table3.

Table 3 Summary Statistics for Indebted and Nonindebted Households

Panel A shows disposable income, annual incomes, net savings, consumption, surplus (the flow of savings), and the age of the household head for three categories (i.e., debtinc = 0, 1, and 2). Compared with debtinc = 1 (households with debt), the debtinc = 0 group (10.7% of the total households) has a higher disposable income and net savings 100 times higher. Judging from annual incomes and net savings, the debtinc = 0 group do not need to borrow. Nevertheless, if they wish, they can borrow without constraints. Debtinc = 2

[12] Net savings and debt information help us to identify those who have debt and the extent of their debt and those who have net savings and the extent of their savings. Such information makes empirical trials much easier to conduct and makes the results more accurate.

[13] Zeldes (1989a) divided PSID data into groups of poor and non poor households to examine liquidity constraints.

(47.2% of the total) has higher net savings than debtinc = 1, despite the fact that their annual and disposable incomes are much lower than debtinc = 1. It is not necessarily the case that all households in debtinc = 2 are liquidity constrained, but it is certain that some of these households face constraints. Households in debtinc = 1 hold virtually zero net savings and thus do not have sufficient buffers for uncertain events.

Panel B classifies households according to net savings. Households without debt and net savings exceeding 18.6 million yen (debtass = 0) make up 21.4% of the total. Average net savings exceed 40 million for this group, thus making liquidity constraints out of the question. Nonetheless, disposable income and annual incomes are not that high compared with debtass = 2, and are even slightly lower than those of the debtass = 1 group. Thus, consumption and surplus (the flow of savings) are not high for debtass = 0. An average age of 63 years for this group implies that the amount of net savings may reflect lump-sum retirement income.

The average age of households without debt and lower net savings (debtass = 2) is 53 years. Thus, this group, which accounts for 36.5% of the total, consists of people who are still working. Some, but not all households may face liquidity constraints.

5 Empirical Results

Taking into account the statistical issues raised in Section 4, the theoretical model in Section 3 is now transformed into the empirical model.

The utility function takes a CRRA form such that:

$$u(c_t) = \frac{c_t^{1-\gamma} - 1}{1-\gamma}, \quad \gamma > 0, \tag{10}$$

with $u'(c_t) = c^{-\gamma}$.

Using Eq(10), Eq(4) becomes:

$$\triangle c_{it} = \frac{1}{\gamma} \ln(\frac{1+r}{1+\rho}) \simeq \frac{1}{\gamma}(r-\rho). \tag{11}$$

Eq(6) includes the budget constraint, e.g., the disposable income constraint. In addition, we need to control seasonality. The consumption function is a combination of nonliquidity-constrained households (Eq(4)) and liquidity-constrained households (Eq(6)). Let us define our consumption function in empirical analysis such that[14],

$$\triangle c_{it} = \alpha + \beta \triangle disp_{it-1} + \mu_i + \nu_t + u_{it}, \tag{12}$$

[14] This formula corresponds to Hall's (1978) consumption function, which tests that $\beta = 0$ to ascertain if the permanent income–lifecycle hypothesis holds.

where c = the log of real consumption, disp = the log of real disposable income,

ν_t = the monthly dummy for November and December, 2001, and for January, May, June, July, November, and December 2002.

Replacing the log of real consumption with the log of real expenditure x_{it} yields our basic empirical model:

$$\triangle x_{it} = \alpha + \gamma \triangle x_{it-1} + \beta \triangle disp_{it-1} + \mu_i + \nu_t + u_{it}. \quad (13)$$

We employ two competing estimation methods of dynamic panel analysis, i.e., maximum likelihood (MLE) and generalized method of moments (GMM one-step)[15].

Table 4 The Autoregression Model

Table 4 corresponds to Table 5.5 in Hayashi (1997, chapter 5). We estimate AR(1) and AR(4) of real expenditure by means of maximum likelihood. For the results of the AR(1) regression, the coefficients of food, housing, traffic and telecommunications, and recreation exceed 0.5. Habit formation or sticky expenditure seems to exist. On the other hand, the coefficients of furniture, clothes, medical expenditure, and education are less than 0.2, indicating that habit formation does not exist for these items. Compared with AR(1), the AR(4) process indicates smaller but stable coefficients over four lags. The differences in coefficients across goods are smaller and the coefficients do not drop sharply after lags. This implies that nondurable expenditure shows some durability. The coefficients of energy take low values for x_{t-1} and x_{t-3}, and high values for x_{t-2} and x_{t-4}. These parameter shifts may reflect the collection pattern of a user fee by public utilities.

Table 5 Expenditure Behavior by Items

Table 5 reports the expenditure regression of Eq(13). This table roughly corresponds to Table 5.6 of Hayashi (1997, chapter 5). Hayashi used a Minimum Distance Estimator (MDE), which is a special case of GMM. Panel A of Table 5 shows all coefficients of own lag are negative. Their values fall into a

[15] In addition, the Instrumental Variable Method, GMM two-step, and system GMM are estimated. Stable parameters could not be obtained for these methods. Thus, we do not report the results here. No diagnostic test is available for a direct comparison of MLE and GMM. Nevertheless, each estimation result can be evaluated by diagnostic tests. For MLE, the likelihood ratio chi-squared test is used such that the unconstrained and constrained maxima of the log-likelihood function should be the same. As to GMM, the Sargan chi-squared test is used for overidentifying restrictions such that the GMM estimator is consistent with the population moment conditions. If this test rejects the null hypothesis, then the GMM estimator is inconsistent. In addition, we report the Arellano–Bond tests for first- and second-order autocorrelation in the first-differenced residuals.

narrow range from -0.42 to -0.68. The coefficients of lagged disposable income are significant except for housing, energy, medical expenditure, education, and recreation. Panel B of Table 5 shows all negative coefficients of own lag. Their values fall in a narrow range from -0.35 to -0.62. The coefficients of lagged disposable income are insignificant for housing, furniture, medical expenditure, and for other categories. One annoying fact is that the coefficients of lagged disposable income for food and recreation are significantly negative.

These results imply that: (1) expenditure has a very robust durability. This is consistent with the fact that the coefficients of own lag in the level estimation are positive whereas those in the difference estimation are negative;[16] (2) Coefficients of disposable income are significant in some cases. At least some consumers face disposable income constraints. We will investigate this issue next.

The empirical results for liquidity constraints are shown in Tables 6–7. In order to focus on liquidity constraints on expenditure in general, we do not report the results by individual expenditure items.

Table 6 Expenditure Behavior by Annual Incomes
Table 7 Expenditure Behavior by Net Savings

The research strategies here are first, to divide households into three groups according to the degree of liquidity constraints. To distinguish these groups, we use annual income as a flow indicator and net savings as a stock indicator. Second, dynamic panel estimations are made by MLE and GMM, and third, we combine three groups, two separation criteria and two estimation methods to yield 12 equations of dynamic expenditure and identify some common trends.

The results are quite clear regardless of model specifications. Let us review the results.

First, the coefficients of own lag are significantly negative in all cases. Hall's (1978) random walk hypothesis implies that a coefficient of lagged consumption is to be zero. The expenditure data at hand do not follow the random walk process, i.e., the Euler equation does not hold in a strict sense. As we have mentioned above, expenditure has a durability.

Second, the coefficients of lagged disposable income are significantly positive in the case of MLE, regardless of debt and net savings conditions. In the case of GMM, they are moderately negatively significant for debtinc = 1, debtinc = 2, debtass = 1, and debtass = 2. Judging from diagnostic tests, MLE satisfies the likelihood ratio chi-squared tests, as the explanatory variables as a whole are significantly different from zero. In the case of GMM, the Sargan test rejects the null hypothesis of valid overidentifying restrictions. To take the results

[16] Suppose the following level model, $x_t = (1+\gamma)x_{t-1} - \gamma x_{t-2} + u_{it}$. Transform this level model into the difference model, $(x_t - x_{t-1}) = \gamma(x_{t-1} - x_{t-2}) + \varepsilon_{it}$. If the coefficient of own lag in the level model is positive, this implies $1+\gamma > 0$, whereas if the coefficient in the difference model is negative, this implies $\gamma < 0$. If both results are to be consistent, the value of γ needs to be $-1 < \gamma < 0$. This condition can be met in most cases.

literally, the GMM estimator is inconsistent with the population moment conditions. However, this could be due to heteroskedasticity because the Sargan test is defined only in the case of a one-step homoskedastic estimator. Alternatively, this could be due to the misspecification of a functional form or to inadequate instruments[17]. Except for the case of debtinc = 0, the Arellano–Bond tests of residual autocorrelation indicate signs of first- and second-order autocorrelations. Negative coefficients of lagged disposable income also contradict what the theory of consumer behavior predicts.

Given these shortfalls of the GMM estimator, if we accept the results of MLE, disposable income influences expenditure even for those households without debt and with high incomes and large net savings. Again, this fact leads to a violation of the Euler equation in particular and the permanent income–life cycle hypothesis in general. Those who are significantly influenced by disposable income must follow alternative behavioral assumptions[18]. In addition, it is interesting to see that those who already have debt (i.e., debtinc = 1 and debtass = 1) face disposable income constraints. Recall that at the end of Section 3, we assumed that the current budget constraint is binding for the households with nonnegative net savings, i.e., $A \geqslant 0$. The results here show that the current budget constraint is binding for those who have negative net savings, i.e., $A < 0$.

Interpreting this result, indebted households, which make up 42.1% of the total sample, usually have a large mortgage outstanding. They pay about 100000 yen per month to pay off their debt and consume the rest of their disposable income. As indebted household heads tend to be in their 40s, it is likely that they incur education expenses for their children, leaving little room for discretionary consumption. These facts may explain why consumption is so sensitive to disposable income for indebted households.

Third, households without debt but with low annual incomes and net savings (i.e., debtinc = 2 and debtass = 2) are also sensitive to disposable income, although not as much as indebted households are. This group includes liquidity constrained households, as pointed out by Zeldes (1989a). However, as Table 3 shows, the net savings of this group are much larger than those of indebted households. Because this group could withdraw savings, liquidity constraints do not restrict consumption behavior as much as they do for indebted households.

The above results can be summarized as follows. First, both households with debt (debtinc = 1, debtass = 1) and households without debt and with low annual incomes and net savings (debtinc = 2, debtass = 2) face disposable income constraints, regardless of the estimation methods employed. Second, for these households, the parameter values of lagged dependent variables are very similar for MLE and GMM. Therefore, the statistical significance and implications remain more or less the same regardless of the estimation method.

[17] At this stage, we cannot improve the model specifications because this model is well established. Nor can we add other instrumental variables, as the available data are limited.

[18] As noted in Section 2, alternative explanations include the precautionary saving motive to cope with uncertainty regarding future income, Keynesian consumers whose activities are myopic, and hyperbolic discounting behavior.

Third, households without debt and with high annual incomes and net savings have significantly positive coefficients of disposable income in case of MLE.

These results can be interpreted in the light of Japan's historical context. Financial market liberalization made consumer credit much more widely available in 2001–02 compared with the 1981–82 period on which Hayashi's analysis was based. In general, the availability of credit has relaxed liquidity constraints for households, but it has also increased the number of indebted households. These households must pay back debt and thus, their consumption is constrained by their disposable income. Japanese firms increased their debt levels in the bubble period in the late 1980s but found it difficult to pay back debt after the bubble economy burst in the 1990s. These firms could not allocate their resources to more productive purposes such as investment and increases in employment. Therefore, their profitability dropped. The household sector may experience the same pattern, namely, that the increase in debt in the 1990s may cause financial distress in the 2000s. Hayashi argued that over 90% of the households followed the permanent income hypothesis during the early 1980s. Based on the 2001–02 data, it is unlikely that this will be the case in the 2000s.

The sensitivity of consumption to disposable income differs according to annual income and net savings. However, it turns out to be significant in many cases. This result implies that policy variables such as taxes and social security contributions could affect consumption, at least in the short run. Policies such as income tax reductions against the amount of mortgages, interest payment deductions, and property tax reductions against the amount of mortgages might be used to relax the liquidity constraints faced by indebted households.

Finally, it is difficult to identify the liquidity-constrained households even with the panel data. If one has answers to such questions as "have you been rejected by financial institutions when you apply for loans?", "from which financial institutions do you want to borrow?", or "how much is your interest rate when you borrow?", one would be able to grasp the degree of liquidity constraints for each household. However, FIES does not include such questions. How then can we identify the liquidity-constrained households?

Hall and Mishkin (1982) and Hayashi (1985) conduct an identification by assuming the following conditions: (1) the households can be classified into two groups, namely, permanent-income households and liquidity-constrained households; (2) the behavior of each type of household is well understood; (3) the combination of the two types of households represents the observed statistics; (4) given the behavioral assumptions, the theoretical conditions to identify the two households can be obtained; (5) these conditions can be applied to the statistical data to estimate the ratio between the two types[19].

Manski (1995) shows how to identify individuals when he attempted to make conditional predictions based on "what if?" questions. Even with microeconomic data, it turns out to be very difficult to match conditions when conditional predictions are made. This paper, in fact, finds plural behavioral patterns of

[19] Hall and Mishkin (1982) and Hayashi (1985) followed the traditional identification problem discussed by Koopmans (1949) and Fisher (1966). Their method makes sense when the theory they rely upon is justifiable or acceptable.

households. As a result, it would be inappropriate to apply the Hall-and-Mishkin-type identification method. Therefore, this paper does not intend to identify the number of liquidity-constrained households, but simply estimates the expenditure function after the households are classified into three groups according to a priori information about the degree of liquidity constraints. In so doing, we find that the indebted households also face liquidity constraints and that households without debt and with high annual incomes and net savings might experience disposable income constraints. Hence, an alternative behavioral hypothesis to the permanent income-lifecycle hypothesis is required.

6 Conclusion

This paper examined the consumption behavior of Japanese households in 2001–02, taking into account savings and debt information available after January 2002. The methodology followed Hayashi (1997, chapter 5).

Economic circumstances differ between 2001–02 and Hayashi's period of analysis, which was 1981–82. In 1981–82, the economy had not yet entered the bubble economy period, Japanese products were dominating world markets, and the Japanese management style — the main bank system, the lifetime employment system, and the seniority system — were accepted as the keys to economic success. In 2001–02, the bubble economy had burst and financial institutions and firms were reaching the final stage of debt payouts in the aftermath of "the lost decade" of the 1990s.

Even if the FIES we used had been the same as in Hayashi's period of analysis,the households faced completely different economic environments in the two periods. Thus, the results from this paper differ from those of Hayashi because a substantially greater number of households faced liquidity constraints or disposable income constraints in 2001–02. In addition, even some of those households who have no debt, high annual incomes, and net savings might face disposable income constraints. This possibility requires further theoretical and empirical investigations.

In contrast to the pure sciences, the social sciences are not able to conduct controlled experiments. The relationship that holds in a certain period may not hold in another period or may be replaced by another relationship. Therefore, we need to examine the same behavioral relationship over different periods. Furthermore, we have not obtained an overwhelmingly successful estimation method for dynamic panel estimation. For the time being, we need to apply alternative estimation methods and select the most reasonable results ex post. The improvement of estimation methods remains a topic for future research.

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Table 1 Summary Statistics

Variable	Average	Standard Deviation	Minimum	Maximum
Annual Income（10 thousand yen）	651	361	43	4452
Savings （10 thousand yen）	1581	1925	0	31526
Net Savings (10 thousand yen)	1152	2230	-13812	31526
Debt (10 thousand yen)	429	911	0	15607
Time Deposit (10 thousand yen)	755	1194	0	26518
Expenditure (yen)	318056	277692	20704	7875677
Food (yen)	69967	31601	10052	771573
Housing (yen)	22688	116282	0	7503265
Energy (yen)	20556	11753	0	143981
Furniture (yen)	10665	29254	0	2852161
Cloth (yen)	14578	30471	0	2154551
Medical expenditure (yen)	11815	27835	0	1420700
Traffic and Telecommunications (yen)	38535	126675	0	4522514
Education (yen)	12975	53954	0	1581127
Recreation (yen)	31913	5167	0	2001873
Others (yen)	84365	145232	0	5839834
Educational Expenditure (yen)	23265	84440	0	4502768
Recreation and Leisure (yen)	37143	55907	0	2010767
Current Consumption Expenditure (yen)	243561	148987	20704	6025569
Net Income (yen)	473653	486315	0	3.45E+07
Current Income of Household Head (yen)	265410	238970	0	3355000
Disposable Income (yen)	401773	438385	-987983	3.24E+07
Surplus (yen)	83717	453471	-7293695	3.17E+07
Net Saving Increase (flow) (yen)	54753	507095	-3.52E+07	3.22E+07

Table 2 Monthly Average of Consumption, Savings and Disposable Income (nominal)

mm-yy	Consumption	Savings	Disposable Income
Aug-01	315689	105266	420955
	(224102)	(265559)	(232935)
Sep-01	297266	-13697	283569
	(213742)	(242082)	(230170)
Oct-01	325753	95134	420888
	(259924)	(296309)	(235281)
Nov-01	310017	-23204	286813
	(281378)	(300455)	(249265)
Dec-01	386782	418379	805161
	(306382)	(667695)	(718318)
Jan-02	306844	-18568	288276
	(224146)	(325567)	(313676)
Feb-02	280703	127744	408447
	(231930)	(282414)	(235774)
Mar-02	337028	-27596	309431
	(313492)	(363705)	(308223)
Apr-02	329453	76944	406396
	(302933)	(558200)	(515590)
May-02	303988	-45794	258193
	(241995)	(578021)	(559703)
Jun-02	302183	291667	593650
	(280206)	(531551)	(547812)
Jul-02	327803	26510	354313
	(308427)	(444426)	(413022)
Aug-02	317823	107355	425178
	(279047)	(327768)	(254345)
Sep-02	304840	-33883	270957
	(297904)	(312172)	(239933)
Oct-02	310884	98381	409264
	(287468)	(312482)	(238194)
Nov-02	299168	-17715	281453
	(258881)	(299383)	(236731)
Dec-02	373603	429198	802801
	(303563)	(571104)	(628828)
Average	318056	83717	401773
	(277692)	(453471)	(438385)

Note: Figures in brackets are standard deviations.
Shadowed figures are in bonus season.

Table 3 Summary Statistics for Indebted and Non-Indebted Household

Panel A: Annual Income

		Debtinc = 0	Debinc = 1	Debtinc = 2
Numbers of households (%)		6470(10.7)	25399(42.1)	28451(47.2)
Disposable Income	mean	575428	455380	280982
(yen)	sd	390013	331113	268534
Annual Income	mean	1118	739	452
(10 thousand yen)	sd	336	356	171
Net Savings	mean	2835	28	1749
(10 thousand yen)	sd	2641	1707	2025
Consumption	mean	412453	323322	249323
(Expenditure)	sd	214013	182676	143806
Surplus (yen)	mean	162975	132058	31659
	sd	393089	312784	272335
Age of	mean	52	48	57
household head	sd	10	12	16

Note: Debtinc = 0: without debt, annual income of 8.2 million yen or more, debtinc = 1: with debt, debtinc = 2: without debt, annual income of less than 8.2 million yen.

Panel B: Net Savings

		Debtass = 0	Debtass = 1	Debtass = 2
Numbers of households (%)		12892(21.4)	25399(42.1)	22029(36.5)
Disposable Income	mean	371674	455380	314385
(yen)	sd	373684	331113	274991
Annual Income	mean	676	739	517
(10 thousand yen)	sd	393	356	279
Net Savings	mean	4006	28	747
(10 thousand yen)	sd	2421	1707	527
Consumption	mean	320549	323322	255551
(Expenditure)	sd	193863	182676	151573
Surplus (yen)	mean	51127	132058	58834
	sd	368672	312784	256378
Age of	mean	63	48	53
household head	sd	12	12	16

Note: Debtass = 0: without debt, net savings of 18.6 million yen or more, debtass = 1: with debt, debtass = 2: without debt, net savings less than 18.6 million yen.

Table 4 Autoregression Model

Dependent variable: x_t	AR(1)		AR(4)							
	x_{t-1}		x_{t-1}		x_{t-2}		x_{t-3}		x_{t-4}	
	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics
Expenditure（all）	0.6265	4094.23	0.2474	34.64	0.2107	34.57	0.1952	31.13	0.1917	30.89
Food	0.7766	431.77	0.3238	48.28	0.2372	34.69	0.2213	32.58	0.1459	22.27
Housing	0.6079	1271.40	0.2892	21.80	0.2076	14.69	0.2127	14.79	0.1898	14.23
Energy	0.3556	1271.40	0.0991	11.40	0.3945	57.40	0.0576	7.83	0.2053	30.50
Furniture	0.0982	15.31	0.1716	23.93	0.1469	20.16	0.1249	17.15	0.1338	18.72
Clothes	0.1168	15.48	0.1850	21.09	0.1389	15.69	0.1459	16.64	0.1513	17.40
Medical expenditure	0.1800	22.70	0.2548	32.00	0.1807	22.35	0.1280	15.82	0.1527	19.26
Traffic and Telecommunication	0.5250	1285.10	0.2329	36.19	0.1934	29.88	0.1966	30.05	0.1788	27.50
Education	0.1422	10.35	0.2452	12.98	0.2073	13.57	0.2296	15.31	0.1716	11.64
Recreation	0.5244	1196.91	0.2476	35.84	0.1978	28.19	0.1554	22.21	0.1916	27.41
Others	0.6249	177.90	0.2688	39.68	0.2109	30.60	0.1995	28.40	0.1925	27.68

Table 5 Expenditure Behavior by Items

Panel A: Maximum Likelihood Method

Dependent Variable △x	**Explanatory variables**			
	own lag		disposable income $_{t-1}$	
	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics
Expenditure (all)	-0.478	-106.78	0.011	6.11
food	-0.421	-88.36	0.006	5.14
housing	-0.498	-59.24	-0.008	-0.91
energy	-0.678	-164.03	0.002	1.08
furniture	-0.478	-95.82	0.026	4.46
clothes	-0.487	-87.64	0.059	8.07
medical expenditure	-0.471	-85.96	0.008	1.49
transportation and telecommunication	-0.495	-105.96	0.019	4.89
education	-0.474	-54.19	0.023	1.37
recreation	-0.480	-97.27	0.007	1.65
others	-0.477	-97.40	0.009	2.28

Note: Other explanatory variables include monthly dummy for November, December, January, May, July.

Panel B: GMM (one step)

Dependent Variable △x	**Explanatory variables**			
	own lag		disposable income $_{t-1}$	
	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics
Expenditure (all)	-0.347	-55.69	-0.004	-1.91
food	-0.375	-59.47	-0.012	-8.56
housing	-0.344	-28.43	-0.006	-0.64
energy	-0.617	-120.11	0.009	3.69
furniture	-0.375	-57.52	-0.006	-0.78
clothes	-0.381	-51.83	0.052	5.69
medical expenditure	-0.362	-49.93	-0.006	-0.83
transportation and telecommunication	-0.377	-60.10	0.015	3.20
education	-0.386	-33.84	0.053	2.63
recreation	-0.380	-59.77	-0.022	-4.45
others	-0.372	-58.54	-0.005	-0.94

Note: Additional instrumental variables are numbers of household members, numbers of workers, age of household head.

Table 6 Expenditure Behavior by Annual Income

Panel A: Maximum Likelihood Method

Dependent Variable: Δx	debtinc = 0 Estimated Coefficient	debtinc = 0 z-statistics	debtinc = 1 Estimated Coefficient	debtinc = 1 z-statistics	debtinc = 2 Estimated Coefficient	debtinc = 2 z-statistics
△x_1	-0.461	-36.89	-0.476	-74.04	-0.491	-67.89
△disp_1	0.038	4.73	0.020	5.45	0.006	2.69
Nov2001	-0.049	-1.51	-0.002	-0.13	0.014	0.77
Dec2001	0.248	8.76	0.246	18.87	0.214	14.78
Jan2002	-0.111	-4.36	-0.070	-5.81	-0.069	-5.19
May2002	-0.050	-2.10	-0.048	-4.28	-0.020	-1.58
Jun2002	-0.044	-1.79	-0.012	-1.07	-0.023	-1.80
Jul2002	0.035	1.38	0.067	5.76	0.038	2.86
Nov2002	-0.089	-2.78	0.006	0.40	0.001	0.04
Dec2002	0.122	2.68	0.243	11.21	0.228	9.51
_cons	-0.036	-3.96	-0.054	-12.49	-0.042	-8.69
Diagnostic Test						
Number of observation	4015		15491		12399	
Number of groups	1076		4066		3552	
LR Chi2(10)	1336.42		5383.53		4328.46	
Prob>Chi2	0.000		0.000		0.000	
LR test of sigma_u = 0 Chi2(1)	0.00		0.00		0.00	
Prob>Chi2	1.000		1.000		1.000	

Panel B： GMM (one-step)

Dependent Variable: Δx	debtinc = 0 Estimated Coefficient	debtinc = 0 z-statistics	debtinc = 1 Estimated Coefficient	debtinc = 1 z-statistics	debtinc = 2 Estimated Coefficient	debtinc = 2 z-statistics
△x_1	-0.2958	-16.05	-0.3498	-39.48	-0.3651	-36.65
△disp_1	0.0074	0.79	-0.0067	-1.49	-0.0038	-1.57
_cons	0.0035	0.49	-0.0023	-0.70	-0.0049	-1.30
Diagnostic Test						
Number of observation	2749		11093		8706	
Number of groups	995		3903		3225	
Sargan Test						
Chi2(42)	120.6		267.49		188.43	
Prob>Chi2	0.000		0.000		0.000	
Wald Test Chi2(2)	259.77		1615.78		1366.33	
Arellano-Bond Test for residual AR(1)=z	-24.41		-47.48		-40.87	
Prob>z	0.000		0.000		0.000	
Arellano-Bond Test for residual AR(2)=z	-1.05		-6.07		-5.38	
Prob>z	0.2923		0.000		0.0000	

Note: Additional instrumental variables are numbers of household members, numbers of workers, age of household head, squares of age of household head.

Table 7 Expenditure Behavior by Net Savings

Panel A: Maximum Likelihood Method

Dependent Variable: Δx	debtass = 0		debtass = 1		debtass = 2	
	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics
△x_1	-0.483	-45.08	-0.476	-74.04	-0.479	-62.01
△disp_1	0.009	2.65	0.020	5.45	0.008	3.09
Nov2001	-0.046	-1.51	-0.002	-0.13	0.021	1.18
Dec2001	0.253	9.88	0.246	18.87	0.207	14.21
Jan2002	-0.095	-4.15	-0.070	-5.81	-0.062	-4.68
May2002	-0.060	-2.62	-0.048	-4.28	-0.013	-1.08
Jun2002	-0.036	-1.56	-0.012	-1.07	-0.023	-1.84
Jul2002	0.048	2.00	0.067	5.76	0.038	2.90
Nov2002	-0.042	-1.39	0.006	0.40	-0.011	-0.62
Dec2002	0.173	4.40	0.243	11.21	0.222	8.90
_cons	-0.042	-4.87	-0.054	-12.49	-0.042	-8.57
Diagnostic Test						
Number of observation	5387		15491		11027	
Number of groups	1622		4066		3006	
LR Chi2(10)	1917.97		5383.53		3679.43	
Prob>Chi2	0.000		0.000		0.000	
LR test of sigma_u = 0 Chi2(1)	0.00		0.00		0.00	
Prob>Chi2	1.000		1.000		1.000	

Panel B： GMM (one-step)

Dependent Variable: Δx	debtass = 0		debtass = 1		debtass = 2	
	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics	Estimated Coefficient	z-statistics
△x_1	-0.3286	-20.73	-0.3498	-39.48	-0.3572	-33.95
△disp_1	-0.0021	-0.57	-0.0067	-1.49	-0.0048	-1.46
_cons	0.0061	0.88	-0.0023	-0.70	-0.0062	-1.67
Diagnostic Test						
Number of observation	3573		11093		7885	
Number of groups	1396		3903		2824	
Sargan Test						
LR Chi2(42)	112.48		267.49		175.62	
Prob>Chi2	0.000		0.000		0.000	
Wald Test Chi2(2)	434.18		1615.78		1178.93	
Arellano-Bond Test for residual AR(1)=z	-25.93		-47.48		-40.19	
Prob>z	0.000		0.000		0.000	
Arellano-Bond Test for residual AR(2)=z	-3.27		-6.07		-3.79	
Prob>z	0.0011		0.000		0.0002	

Note: Additional instrumental variables are numbers of household members, numbers of workers, age of household head, squares of age of household head.