Discussion Paper Series

No.109

Did Japanese Consumers Become More Prudent During 1998-1999? Evidence From Household Level Data

Masahiro Hori and Satoshi Shimizutani

August 2005

Hitotsubashi University Research Unit
for Statistical Analysis in Social Sciences
A 21st-Century COE Program

Institute of Economic Research
Hitotsubashi University
Kunitachi, Tokyo, 186-8603 Japan
http://hi-stat.ier.hit-u.ac.jp/

Did Japanese Consumers Become More Prudent During 1998-1999? Evidence From Household Level Data*

Masahiro Hori and Satoshi Shimizutani†

Abstract:

This paper explores empirically whether Japanese consumers became more prudent in the second half of the 1990s, a decade in which Japan registered historically low economic growth. Employing the methodology developed by Dynan (1993), this study uses micro-level data from the *Family Savings Survey* and the *Family Income and Expenditure Survey* to estimate the coefficient of prudence for Japanese households in the second half of the 1990s. The estimates reveal that the coefficient of prudence is positive and statistically significant in the 1998-1999 period. The obtained value for the coefficient of prudence is four, which is much higher than those estimated for U.S. households (not significantly different from zero) or U.K. households (around 2). The estimated coefficient for young households is higher still, which is consistent with simulation studies conducted by Gourinchas and Parker (2002) showing that precaution is the most important saving motive for younger households.

JEL Classification Code; D12

Key words: Precautionary saving, Coefficient of Prudence, Euler equation, Household Data.

* An earlier version of this paper was published as part of Hori and Shimizutani (2002). We are grateful to the Ministry of Internal Affairs and Communications for providing the micro-data from the FIES. The views expressed in this paper are our own.

† Masahiro Hori; Research Fellow at the Economic and Social Research Institute, Cabinet Office, Government of Japan; Address : 3-1-1, Kasumigaseki, Chiyoda-ku, Tokyo, Japan; E-mail: masahiro.hori@cao.go.jp

Satoshi Shimizutani (corresponding author); Associate Professor, Institute of Economic Research, Hitotsubashi University, 2-1 Naka, Kunitachi-shi, Tokyo, Japan; Tel: +81-42-580-8369, E-mail: sshimizu@ier.hit-u.ac.jp.

1. Introduction

The 1990s were a period of historically low growth for the Japanese economy. After showing signs of recovery during the middle of the decade, the economy plunged into recession again in the spring of 1997, triggering the failure of a string of financial institutions. The troubles in the financial sector further exacerbated the economic downturn and Japan was gripped by a severe sense of crisis. The sense of crisis, in turn, led households to take a more pessimistic view of the future as income uncertainty increased, contributing to the weakness of private consumption that has plagued the Japanese economy until this day. It is against this background that the present paper aims to take a closer look at the saving behavior of Japanese households, focusing especially on the critical period of 1998-99.

Several studies have shown that the precautionary motive is a major factor in determining Japanese households' saving behavior: households accumulate savings in order to prepare for an uncertain future (Horioka and Watanabe (1997)). A survey conducted by the Central Council for Financial Services Information provides further detail, suggesting that about 70% of Japanese households save to prepare for sickness and unforeseen disasters. Such precautionary saving is followed by saving for living expenses after retirement (cited by 60%), a finding that is consistent with the life cycle model. [1] These two are by far the most frequently cited motives, ahead of saving for children's education or marriage, the purchase of a residence, for traveling or leisure, or for bequests.

[1] The survey allowed for multiple answers so that the sum of responses for each choice exceeds 100 percent.

However, empirical studies have not reached a consensus on how important the motive of precautionary saving is in explaining household saving behavior. Theoretically, the importance of the precautionary motive is measured by the gap between marginal household utility of consumption when the future is certain and the expected value of marginal utility (Leland (1968), Sandmo (1970), Dreze and Modigliani (1972)). A representative methodology to measure the extent of precautionary saving is to estimate the coefficient of prudence, which is derived from the Euler equation (Kimball (1990)). Applying Kimball's approach to household level data for the U.S., Dynan (1993) found a small precautionary motive, which, however, was "too small to be consistent with widely accepted beliefs about risk aversion."(ibid.: 1104) In contrast, Merrigan and Normandin (1996), applying the same methodology to a U.K household survey, showed that the estimated coefficients took a value of about two, which is consistent with conventional values of risk aversion.

Given the sluggishness of private consumption, it seems clear that in Japan precautionary saving has increased during the late 1990s. Yet, although several studies have examined the importance of the precautionary saving motive in Japan, few have examined empirically the growing prudence of consumers in this period.[2] Moreover, few studies have attempted to estimate the prudence coefficient for Japanese households. One exception is a study by the Economic Planning Agency (1999), which used micro-level

[2] Interested readers are referred to Ishihara and Doi (2003). In addition to prudence coefficients, several studies estimated a saving function that includes demographic variables as well as several proxies for uncertainty among the independent variables. Several studies found that the precautionary motive is large (Dardanoni (1991), Kazarosian (1997)) while others came to the conclusion that it is weak (Guiso et.al. (1992), Lussardi (1996)). For Japan, Ogawa (1991) confirmed that greater income risk leads to a rise in the personal saving rate. Ishihara and Doi (2003) showed that the risk of unemployment increased the savings/GDP ratio by 1 percentage point. See Murata (2003) for a survey of recent empirical studies on precautionary saving in Japan.

data from the *Japanese Panel Surveys of Consumption*, but the sample size and objective of that study were very limited.

The purpose of this paper therefore is to explore empirically if consumers became more prudent during the recession of 1998-1999. The analysis uses micro-level data from the *Family Savings Survey* (henceforth: FSS) and the *Family Income and Expenditure Survey* (henceforth: FIES), which are representative national surveys on households compiled by the Japanese government. Since the samples of the two surveys overlap, combining the datasets makes it possible to construct data on the annual change in consumption. Our estimates show that the coefficient of prudence is positive and statistically significant in the 1998-1999 period. What is more, the estimated value of the implied coefficient of prudence of about 4 is much higher than the equivalent values for the U.S or the U.K. The estimates produce a particularly high coefficient for young households, which is consistent with simulation studies conducted by Gourinchas and Parker (2002), which show that up until a household head is 40 years old precautionary saving is the most important household saving motive.

The remainder of this paper is organized as follows. Section 2 briefly describes the approach to measuring the coefficient of prudence developed by Dynan (1993), which underpins our analysis. Section 3 provides a description of the micro-level data set used in this paper. Section 4 presents the estimation of the coefficients of prudence. The final section concludes and discusses the policy implications of the findings.

2. Measuring the coefficient of prudence: Dynan's (1993) approach and related research

This section briefly describes the technique developed by Dynan (1993) to measure the coefficient of prudence that we will employ in this study. She derived a tractable specification from the Euler equation using a second-order Taylor approximation. The underlying idea is based on Kimball (1990), who defined the coefficient of relative prudence as $\rho = -C_{it}(U'''/U'')$ where C_{it} is consumption by consumer *i* at time *t* and *U* is his utility. This relationship holds for the constant relative risk aversion (CRRA) utility function and there is no room for precautionary saving in quadratic utility for which $U''' = 0$.

Assume consumers maximize the following discounted utility function:[3]

$$\max E_t\left[\sum_{j=0}^{T-t}(1+\delta)^{-j}U(C_{i,t+j})\right] \tag{1}$$

subject to the budget constraint $A_{i,t+j+1} = (1+r_i)A_{i,t+j} + Y_{i,t+j} - C_{i,t+j}$ where E_t represents the expectation operator; δ represents the time preference rate; *T* is the time of death of the consumer; and *i* refers to the *i*th consumer. C_{it} is consumption by consumer *i* at time t; Y_{it} is consumer *i*'s labor income at time *t*; A_{it} is his nonhuman wealth at time *t*; and r_i is the real after-tax interest rate consumers earn on their assets.

The following first-order condition is obtained using the Keynes-Ramsey rule:

$$\left(\frac{1+r_i}{1+\rho}\right)E_t\left[U'(C_{i.t+1})\right] = U'(C_{it}) \tag{2}$$

Applying a second-order Taylor approximation yields the following:

[3] This description closely follows Dynan (1993).

$$E_t\left[\frac{C_{i,t+1}-C_{it}}{C_{it}}\right]=\frac{1}{\xi}\left(\frac{r_i-\delta}{1+r_i}\right)+\frac{\rho}{2}E_t\left[\left(\frac{C_{i,t+1}-C_{it}}{C_{it}}\right)^2\right] \quad (3)$$

where $\xi=-C_{it}(U''/U')$ is the coefficient of relative risk aversion and $\rho=-C_{it}(U'''/U'')$ is the coefficient of relative prudence.

The empirical specification can be rewritten as

$$avg(GC)_i=\frac{1}{\xi}\left(\frac{r_i-\delta}{1+r_i}\right)+\frac{\rho}{2}avg(GC^2)_i+\varepsilon_i \quad (4)$$

where $(GC)_i$ is the growth in consumption by consumer *i* in period *t* and ε_i is the error term. Since the error term is correlated with $avg(GC^2)_i$, two stage least squares estimation is used to obtain consistent estimates of the coefficient on $avg(GC^2)_i$.

Under the CRRA utility function, $U(C)_i=(1-\gamma)^{-1}C^{1-\gamma}$, we obtain the relationship $\rho=1+\gamma$. In theoretical studies, γ is usually chosen to be between one and four and ρ thus ranges from two to five. Dynan's empirical results, however, were much smaller than these values predicted by theory: the highest estimate of ρ she obtained was 0.312 with a large standard error, and the null hypothesis that ρ is zero could not be rejected. Discussing her results, Dynan observed that "[t]he presence of liquidity-constrained household does not appear to explain this finding, and there is some evidence that self-selection of households into risky environment also cannot explain the results" (ibid.: 1104). On the other hand, Merrigan and Normandin (1996), applying the same methodology to a U.K. household survey, found that the estimated coefficients were about two.

To our knowledge, other than the study by the Economic Planning Agency (1999), no research based on micro-level data estimating the coefficient of relative prudence for Japanese households is available. One of the reasons for this is the unavailability of micro-level data on consumption in Japan. The Economic Planning Agency (1999) used the micro-level data of the *Japanese Panel Surveys of Consumption* compiled by the Institute of Household Economy and arrived at an estimate for ρ of a statistically insignificant 0.877 for the 1994 –1999 period and a marginally significant 1.720 for the 1998-1999 period.

3. Data

The data used in this paper are micro-level data from the *Family Income and Expenditure Survey* (FIES) and the *Family Saving Survey* (FSS) from 1995 to 1999. The sampled households of both surveys overlap and can be matched completely. The FIES is the Japanese Government's main source of information on aggregate consumption. The survey covers approximately 8,000 households which are randomly chosen from all areas of Japan. Single households and households employed in agriculture and fisheries are not surveyed.[4] The FIES provides monthly consumption data based on the diaries of survey participants which are collected twice a month and contain detailed information on the income and expenditure of individual households as well as on the characteristics of these households.

[4] The FIES began to cover agricultural and fishery households in July 1999. Hayashi (1997, Chapter 5) used the FIES in his test of the permanent income hypothesis. Hori et. al. (2002) also used the FIES to examine the effect of the shopping coupons program on household consumption.

The households surveyed for the FSS are a subset of the FIES sample. Households which enter the sample for the August, September and October FIES are also surveyed for the FSS in December of that year and the next. The FSS contains detailed information on individual households' financial assets and liabilities both on a stock and a flow basis.[5] The information on financial assets on a stock basis is available as of the end of year *t-1* and year *t* for households surveyed in year *t.* The FSS also contains information on the amount of gross annual income in year *t*. Data on households surveyed first for the FSS in year *t* is matched with data for the same household surveyed again for the FSS in year *t+1*. Then data on households in the FSS for year *t* are matched with data for the same household in the FIES. Thus, what is available for households surveyed first in year *t* is (1) the stock of financial assets as of the end of year *t-1*, *t* and *t+1* (from the FSS), (2) the flow of gross annual income in year *t* and *t+1* (from the FSS), and (3) the monthly income and expenditure from August of year *t* to January of year *t+1* or from September of year *t* to February of year *t+1* or from October of year *t* to March of year *t+1* (from the FIES). Our estimates of annual consumption mainly use the FSS data, while our estimates of tax payments primarily rely on the FIES data.

Neither survey contains explicit data on annual consumption. We therefore obtained it using the following relationship:[6]

$$A_{i,t+j+1} = (1 + r_i) A_{i,t+j} + (YG_{i,t+j} - TAX_{i,t+j}) - C_{i,t+j} \qquad (5)$$

where A_{it} is nonhuman wealth; YG_{it} is gross labor income; r_i is the real after-tax interest rate; TAX_{it} is tax payments and C_{it} is consumption. In all cases, *i* refers to the household.

[5] The FSS was merged with the FIES in 2001.

[6] Our approach to calculating annual household consumption opens the door to substantial measurement error, but unfortunately, this is the only way consumption data can be calculated using the FIES and the FSS. Moreover, while Dynan (1993) used non-durable to estimate the coefficient of

Data on nonhuman income and gross labor income are available in the FSS. On the other hand, no data on real assets are available in the FSS and it is therefore necessary to assume that the value of real assets remains unchanged during the period a household is surveyed. What remains to be taken into account in order to estimate annual consumption is tax payments. While the FSS does not contain data on tax payments, the FIES has detailed information on household demographics and monthly payments of national income tax, local inhabitant tax and other taxes, which allow us to estimate annual tax payments. Details on the construction of tax payments data for each household are provided in the Appendix.

Since it is likely that our calculations of tax payments contains a degree of error stemming from insufficient information, we eliminate households whose annual consumption shows extreme fluctuations, which we define as an increase or decrease by more than 50%. Eliminating such outliers is also justified by the fact that the mean consumption growth rate during the 1995-1999 period was close to zero, as shown in Table 1. [7] In addition, a household is excluded if the number of family members is greater than ten because the consumption patterns of large extended households are likely to be significantly different from those of the smaller households that are the norm in Japan.[8] Also, a household in which the reported age of the head of household decreases or increases by more than one year during the 6 month survey period or in which the household's tenancy status changes from owner to renter (or from renter to owner) are

---

prudence, our data do not allow us to exclude durable consumption

[7] On a national accounts basis, the average annual growth rate of real private consumption (excluding imputed rents) for the 1995-1999 period was 0.28 percent. The rate of change for individual years is as follows: 1995-1996: 2.5 percent; 1996-1997: 0.5 percent; 1997-1998: minus 1.0 percent; 1998-1999: minus 0.6 percent.

[8] The number of households removed from the sample due to this criterion is very small.

also excluded, because these changes are likely to be due to large shocks that may also have large effects on the household's consumption.

Summary statistics are reported in Table 1. They show that annual consumption growth was close to zero. The average number of family members was 3.3, while the average number of employed household members was 1.1. The average age of head of household was about 50 and the assets/annual income ratio, which measures the degree of households' liquidity constraints, was about 1.9.

4. Estimation of the coefficient of prudence

The specification used to estimate the coefficient of prudence is as follows:

$$GC_i = \alpha_0 + \alpha_1 * (GC^2)_i + \varepsilon_i \qquad (6)$$

where GC_i is consumption growth in household *i* and ε_i is the error term. The dependent variable is the growth rate of consumption in each household. α_1 is the coefficient on the main independent variable, the squared consumption growth rate, and is equal to half of the coefficient of prudence $\rho = -C_{it}(U'''/U'')$. As discussed in the previous section, two stage least squares estimation is adopted to obtain consistent estimates of the coefficient on $avg(GC^2)_i$, since the error term is correlated with $avg(GC^2)_i$. In this paper, $avg(GC^2)_i$ is instrumented by the number of household members, the number of employed household members, the change in the number of family members, the change in the number of employed household members, the size of the firm where the head of household is employed (if employed), a dummy variable

indicating whether the head of household is employed, and households' liquidity condition defined as the ratio of total financial assets to pre-tax annual income. The occupation of the household head is not included as an instrument since a risk averse household head is more likely to choose a safer occupation and to increase savings.[9] In the second stage estimation, we include the age of the head of household to control for any shift in a household's preferences.[10] The coefficient on the main variable is expected to be greater than zero.

Table 2 reports the results, showing that the coefficients are positive but not significantly different from zero for the period 1995-1998. The results are broadly comparable to the ones obtained by the Economic Planning Agency (1999). However, the coefficient for the period 1998-1999 is positive and significant, and the implied coefficient of prudence is 3.6. This value is much larger than that estimated by Dynan (1993) for the U.S or Merrigan and Normandin (1996) for the U.K. The jump in the coefficient and its size indicate that Japanese households became very prudent during the severe economic downturn in 1998.

Next, we focus on those households whose head of household is employed. Table 3 shows that the coefficients for 1995-1996 and 1996-1997 are large but not statistically significant. The coefficient for 1998-1999 is slightly larger than that for all households.[11] The estimate of the coefficient of prudence for these households is as high as 3.9.

---

[9] We did not include the occupation of a household head as an instrument since the occupation is likely to be endogenous, as suggested by a referee.

[10] Recent empirical studies on consumption often assume a felicity function with a preference shifter (see, e.g., Attanasio and Low (2001) and Gourinchas and Parker (2002)). The shifter is assumed to depend on household characteristics. Dynan (1993) used the age of a household head as a representative demographic variable and included this when estimating the Euler equation.

[11] We omit the results for the case where the head of household is not employed because the sample size is too small to obtain reliable statistical results.

Finally, in order to discover what factors determine the coefficient of prudence, the above specification is applied to subsamples by age of the head of household. The results are displayed in Table 4. If the sample is split at age 50, the coefficient of prudence during the 1998-1999 period is positive and significant for the younger households whose age is less than 50 in the 1998-1999 period, but insignificant for older households. Moreover, if the sample is divided at age 40, the coefficient for households with a younger head is large and significant.[12] Our finding that households with a head aged below 40 have a larger estimated coefficient of prudence than those with an older head is consistent with simulation studies such as Carroll's (1992, 1997) and Gourinchas and Parker's (2002). These studies show that precaution is a dominant saving motive for younger households for whom retirement is not imminent.

This prediction is also confirmed if we consider the results in Tables 2 and 3 again. Table 3 showed that focusing only on households whose head is employed, these were found to be more prudent than the sample as a whole (Table 2). Given that the households left out in the estimation in Table 3, i.e. those with an unemployed head, in most cases are in fact households headed by retirees, the higher estimate for the coefficient of prudence for households with an employed household head again confirms that younger households are more prudent than older households.

[12] An alternative hypothesis to explain the increase in the prudence coefficient, pointed out by a referee of this journal, is that the risk exposure of households increased in the 1998-99 period. For instance, it may be labor income uncertainty, not the structural prudence coefficient, that jumped up in this period. However, looking at employment and household income statistics for the second half of the 1990s, we find that, according to national accounts data, both labor compensation and the number of employees already started to decline in the 1997-1998 period and did not register a substantial further deterioration in the 1998-1999 period. As a robustness check, we pooled all data and ran the same regression with time dummies indicating each period in order to see whether the time dummy for 1998-1999 was significant. We found that the coefficients on the time dummies were not significant.

In sum, the coefficient of prudence is positive and significant in the 1998-1999 period and the estimated coefficient is almost four, no matter whether households with an unemployed head are included in the sample or not .The coefficient of prudence is slightly larger for the subsample with employed household heads than for the entire sample. Moreover, the coefficient is substantially larger for households with a household head aged under 40. This result is consistent with the theoretical prediction that the precautionary saving motive is more important for younger households for whom retirement lies in the distant future.

5. Conclusion

This paper explored empirically how Japanese consumers became more prudent in the second half of the 1990s, a period of historically low economic growth. Using the methodology developed by Dynan (1993), this study used micro-level data from the FIES and the FSS to estimate the coefficient of prudence for Japanese households in the late 1990s. The estimates reveal that the coefficient of prudence is positive and statistically significant in the 1998-1999 period and, with a value of almost 4 much higher than those estimated for U.S. households (not significantly different from zero) or U.K. households (around 2).

The jump in the coefficient of prudence coincides with what was one of the most critical periods in Japanese postwar economic history: economic growth came to a halt in the spring of 1997 following an increase in consumption tax rates, turning into outright recession in 1998 that was exacerbated by the crisis in Japan's banking sector. Against

this background, Japanese households took an increasingly pessimistic view of the future, resulting in the large coefficient of prudence. The high estimated coefficient for young households is consistent with simulation studies with structural parameters estimated from consumption data presented by Gourinchas and Parker (2002), which show that up until a household head is 40 years old precaution is the most important household saving motive. Therefore, one way in which the government could try to lower households' precautionary saving and boost consumption would be to provide a solid social safety net for the younger generation.

References

Attanasio, Orazio P. and Hamish Low (2000), "Estimating Euler Equations," *NBER Technical Working Paper* 253.

Carroll, Christopher D. (1992). "The Buffer Stock Theory of Saving: Some Macroeconomic Evidence," Brookings Papers on Economic Activity, 1992(2): 61-156.

– – – (1997). "Buffer Stock Saving and the Life Cycle/Permanent Income Hypothesis," Quarterly Journal of Economics, vol.112(1): 1-55.

Dardanoni, Valentino (1991). "Precautionary Savings under Income Uncertainty: A Cross-Sectional Analysis," *Applied Economics*, vol.23(1), pp.153-160.

Dreze, Jacques and Franco Modigliani (1972). "Consumption Decisions Under Uncertainty," *Journal of Economic Theory*, vol.5(2), pp.308-335.

Dynan, Karen E. (1993). "How Prudent Are Consumers?" *Journal of Political Economy*, vol.101(6), pp.1104-1113.

Economic Planning Agency (1999). *Nihon Keizai no Genkyo* [Annual Report on the Japanese Economy (1999)], (in Japanese).

Gourinchas, Pierre-Olivier and Jonathan A. Parker (2002), "Consumption Over the Life Cycle," *Econometrica*, vol.70 (1):47-89.

Guiso, Luigi, Tullio Jappeli and Daniele Terlizzese (1992). "Earning Uncertainty and Precautionary Saving," *Journal of Monetary Economics*, vol.30 (2), pp. 307-337.

Hayashi, Fumio (1997). *Understanding Saving: Evidence from the United States and Japan*. MIT press.

Hori, Masahiro and Satoshi Shimizutani (2002). "Micro Data Studies on Japanese Household Consumption," *ESRI Discussion Paper Series*, no.15. Government of Japan.

Hori, Masahiro, Chang-tai Hsieh, Keiko Murata and Satoshi Shimizutani (2002). "Did the Shopping Coupon Program Stimulate Consumption? Evidence from Japanese Micro Data," *ESRI Discussion Paper Series*, no.12. Government of Japan.

Horioka, Charles and Wako Watanabe (1997). "Why do People Save? A Micro-Analysis of Motives for Household Savings in Japan," *Economic Journal*, vol.107 (442), pp.537-552.

Horioka, Charles, Hideki Fujisaki, Wako Watanabe and Takatsugu Kouno (2000). "Are Americans More Altruistic than the Japanese? A U.S.- Japan Comparison of

Saving and Bequest Motives," *International Economic Journal*, vol.14(1), pp.1-31.

Ishihara, Hidehiko and Takero Doi (2003). "1990 Nendai no Nihon ni Okeru Shohi Chochiku Kodo ni tsuite (Consumption and Saving Behavior of the Japanese in the 1990s: Theoretical Results and Empirical Studies on the Precautionary Saving Motive" *Keizai Bunseki (Economic Analysis),* no.174, (in Japanese).

Kazarosian, Mark (1997). "Precautionary Savings – A Panel Study," *Review of Economics and Statistics*, vol.79(2), pp.241-247.

Kimball, Miles (1990). "Precautionary Saving in the Small and in the Large." *Econometrica,* vol.58(1), pp.53-73.

Leland, Hayne (1968). "Saving and Uncertainty: The Precautionary Demand for Saving," *Quarterly Journal of Economics*, vol.82(3), pp.465-473.

Lusardi, Annamaria (1998). "On the Importance of the Precautionary Saving Motive," *American Economic Review*, vol.88(2), pp.449-453.

Merrigan, Philip and Normandin, Michel (1996). "Precautionary Saving Motives: An Assessment From UK Time Series of Cross-Sections." *Economic Journal* vol.106(438), pp.1193-1208.

Ministry of Internal Affairs and Communications. *Annual Report on the Family Income and Expenditure Survey*, various years.

Murata, Keiko (2003). "Precautionary Savings and Income Uncertainty: Evidence from Japanese Micro Data," *Monetary and Economic Studies*, Institute of Monetary and Economic Studies, Bank of Japan, vol.21(3), pp.21-32.

Ogawa, Kazuo (1991). "Shotoku Risuku to Yobiteki Chotiku (Income Risks and Precautionary Saving)," *Keizai Kenkyu (Economic Studies),* vol.42 (2), pp.139-152.

Sandmo, Agnar (1970). "The Effect of Uncertainty on Saving Decisions," *Review of Economic Studies*, vol.37(3), pp.353-360.

Zeldes, Stephen. "Consumption and Liquidity Constraints: An Empirical Investigation." *Journal of Political Economy*, 1989, vol.97(2), pp.305-346.

Appendix

This appendix explains how we calculated individual households' annual consumption. As discussed in the text, the FIES contains income data for all household members, the head of household, and the spouse, as well as data on the payment of three tax categories: national income tax, local inhabitant tax and other taxes. A household is surveyed over a period of six months. However, the amount of tax payments is available only for the total household and is not disaggregated. In order to be able to estimate individual household members' tax payments as precisely as possible, we eliminate some households from the sample using the following criteria. A household is dropped if there are more than three persons employed or if there are two persons employed and the spouse's income is greater than 1.03 million yen, which would disqualify the spouse for tax exemption. A spouse's annual income is calculated by doubling her total income during the six-month period of the survey. If a spouse's annual income is less than 1.03 million yen, she is counted as a dependant. We also excluded households with a complex family member composition, such as households with live-in relatives, because it is difficult to identify who is whose dependant. The number of households removed from our sample due to this criterion is very small. Moreover, a household is dropped if the head of household is self-employed, since that makes it impossible to calculate the precise amount of tax payments. As a result, the sample contains worker households whose (head is the only taxpayer in the household and households whose income comes from pension benefits. After these adjustments to the data set, total tax payments for each household are obtained as the sum of national income tax, local inhabitant tax and other taxes.

National income tax payments are calculated based on the gross annual income in each year as reported in the FSS. First, non-taxable income is subtracted. Since data on non-taxable income are not available in the FIES or the FSS, the amount is assumed to be 20,000 for individual households with more than one person with a job. Then tax exemptions from salary income or official pension receipts are calculated. The total amount of tax exemptions is calculated as the sum of these exemptions as well as social security contributions, spouse and special spouse exemptions, exemptions for dependants,

insurance exemptions (50,000 yen), accident insurance (15,000 yen for (own-house owners only) and exemptions for widows or the elderly. The annual amount of social security contributions is calculated by doubling the amount for the six month survey period available in the FIES. The tax base for individual households is obtained by subtracting these exemptions from taxable income; actual tax payments are then calculated by applying the appropriate tax rate to this tax base.

The inhabitant tax is calculated based on annual salary in the previous year. The inhabitant tax is calculated with June as the beginning of the tax year. That is, the inhabitant tax payment from January to May in year *t* is based on the annual salary in year *t*-2 and that after June is based on the annual salary in year *t*-1. Because the FIES collected in year *t* lacks information from year *t*-2, the inhabitant tax amount had to be determined by information beyond that available in the FIES. In this paper, the growth rate of annual wage data from the *Basic Survey on Wage Structure* compiled by Ministry of Health, Labour and Welfare by industry, age, sex and firm size were matched with individual household heads to estimate wages.

The total tax reduction calculated for each year is based on these national income and local inhabitant tax payments.

Table 1: Summary Statistics

	Mean	**S. D.**
1995-1996 sample (N=748)		
Annual consumption growth	0.02	0.23
Annual consumption (1995)	5,262,949	2,283,478
Annual consumption (1996)	5,212,726	2,295,875
Annual income (pre-tax) (1995)	6,367,219	2,758,212
Annual income (pre-tax) (1996)	6,469,773	2,955,917
Number of family members	3.37	1.17
Number of employees	1.13	0.62
Age of household head	46.8	13.2
Assets/Annual Income	1.85	2.50
1996-1997 sample (N=749)		
Annual consumption growth	0.00	0.23
Annual consumption (1996)	5,442,215	2,765,408
Annual consumption (1997)	5,229,028	2,703,237
Annual income (pre-tax) (1996)	6,626,008	3,039,277
Annual income (pre-tax) (1997)	6,686,662	3,158,300
Number of family members	3.31	1.19
Number of employees	1.06	0.64
Age of household head	48.8	13.9
Assets/Annual income	1.94	2.35
1997-1998 sample (N=751)		
Annual consumption growth	0.01	0.24
Annual consumption (1997)	5,333,610	2,360,254
Annual consumption (1998)	5,163,809	2,213,831
Annual income (pre-tax) (1997)	6,467,137	3,003,720
Annual income (pre-tax) (1998)	6,472,250	3,172,710
Number of family members	3.32	1.23
Number of employees	1.09	0.68
Age of household head	48.0	14.4
Assets/Annual income	1.88	2.31
1998-1999 sample (N=678)		
Annual consumption growth	0.01	0.25
Annual consumption (1995)	5,686,167	2,582,999
Annual consumption (1996)	5,610,219	2,497,051
Annual income (pre-tax) (1995)	6,585,280	3,062,134
Annual income (pre-tax) (1996)	6,450,959	3,055,439
Number of family members	3.31	1.14
Number of employees	1.08	0.63
Age of household head	49.2	15.0
Assets/Annual income	1.93	2.41

Table 2 : Estimation of the Coefficient of Prudence

	α_1	Implied ρ	No. of Obs.
1995-1996	0.16 (1.10)	0.37 (2.21)	748
1996-1997	0.53 (1.14)	1.06 (2.28)	749
1997-1998	0.51 (0.68)	1.02 (1.36)	751
1998-1999	1.80 (1.03)	3.60 (2.06)	678

Notes: Standard errors in parenthesis. The dependent variable is the growth rate of consumption for each household. α_1 is the coefficient on the main independent variable, the squared consumption growth rate, which is instrumented by the number of family members, the number of employed household members , the change in the number of family members, the change in the number of employed household members, the size of the firm at which the head of household is employed (if employed), a dummy variable taking one if the head of household is employed and the liquidity condition of the household defined as the ratio of total financial assets to pre-tax annual income.

Table 3 : Estimation of the Coefficient of Prudence for the Employed

	α_1	Implied ρ	No. of Obs.
1995-1996	1.36 (1.03)	2.71 (2.06)	644
1996-1997	2.39 (1.48)	4.78 (2.96)	618
1997-1998	0.48 (0.81)	0.96 (1.62)	612
1998-1999	1.95 (1.04)	3.90 (2.08)	570

Notes: Standard errors in parenthesis. The dependent variable is the growth rate of consumption for each household. α_1 is the coefficient on the main independent variable, the squared consumption growth rate, which is instrumented by the number of family members, the number of employed household members , the change in the number of family members, the change in the number of employed household members, the size of the firm at which the head of household is employed, and the liquidity condition of the household defined as the ratio of total financial assets to pre-tax annual income.

Table 4: Estimation of the Coefficient of Prudence by Age

Head of household	<50			>=50		
	α_1	Implied ρ	No. of Obs.	α_1	Implied ρ	No. of Obs.
1995-1996	1.70 (1.09)	3.40 (2.18)	486	0.09 (1.81)	0.18 (3.62)	262
1996-1997	2.93 (1.88)	5.86 (3.76)	436	0.38 (1.50)	0.76 (3.00)	313
1997-1998	1.01 (0.84)	2.02 (1.68)	458	0.02 (0.86)	-0.04 (1.72)	293
1998-1999	1.66 (0.86)	3.32 (1.72)	386	1.90 (1.54)	3.80 (3.08)	292

Head of household	<40			>=40		
	α_1	Implied ρ	No. of Obs.	α_1	Implied ρ	No. of Obs.
1995-1996	3.39 (2.08)	6.78 (4.16)	252	0.34 (1.29)	0.68 (2.58)	496
1996-1997	2.82 (1.90)	5.64 (3.80)	203	-0.10 (1.25)	-0.20 (2.50)	546
1997-1998	0.49 (1.33)	0.98 (2.66)	248	0.05 (0.72)	0.10 (1.44)	503
1998-1999	3.19 (1.57)	6.38 (3.14)	211	1.77 (0.99)	3.54 (1.98)	467

Notes: Standard errors in parenthesis. The dependent variable is the growth rate of consumption for each household. α_1 is the coefficient on the main independent variable, the squared consumption growth rate, which is instrumented by the number of family members, the number of employed household members , the change in the number of family members, the change in the number of employed household members, the size of the firm at which the head of household is employed (if employed), a dummy variable taking one if the head of household is employed and the liquidity condition of the household defined as the ratio of total financial assets to pre-tax annual income.