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Food Consumption Expenditure and Habit Formation
: Evidence from Japanese Household Panel Data

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Abstract

Because habit formation among consumers preference has strong influence on policy effects, it is crucially important for public policy management. In this article, I estimate the Euler equation allowing habit formation based on Dynan (2000), using data from the Japanese Panel Survey of Consumers (JPSC) for the period 2000-2004, and compare my estimation results with those of previous studies. Like Dynan (2000) and Guariglia and Rossi (2002), my estimation results yield no evidence of habit formation. And as Guariglia and Rossi (2002), my results are consistent with the durability of consumption.

JEL Classification Codes: D12

Key Words: household consumption, habit formation, panel data

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I. Introduction

Since the 1980s, Hall (1978)'s life-cycle/permanent-income hypothesis (LCPIH) has become a standard hypothesis of household consumption and savings behavior. But even today, some "puzzles" —inconsistencies between predictions of the LCPIH and observed household data— persist.[1] "Excess smoothness" is one of those puzzles.[2] This excess smoothness is the phenomenon that real observed consumption is too smooth relative to the implications of the LCPIH. Since Deaton (1987), many empirical studies, for example Campbell and Deaton (1989), Carroll and Weil (1994), Shintani (1996), have showed the existence of excess smoothness.

In some works, the consumption habit was thought as a key to the excess smoothness puzzle. The consumption habit refers to the idea of accepting time non-separable preference in a consumer's utility function; this concept is called "habit formation" in the context of economics.[3] Since the late 1980s, particularly in Europe and the United States, consistency between the implications of a household consumption behavior model with habit formation and real consumption data has been tested actively. It's easy to assume that the existence or nonexistence (and effectiveness level) of the excess smoothness based on habit formation should have strong influence to policy effects, for example at the case of commodity tax rate change or benefits for consumption stimulating. So, an empirical analysis for consumption habits has been considered a very important issue, not only for economists but also for public policy makers. And recently, habit formation has come to play an important role in the macroeconomic model grounded in micro-foundations like DSGE, and has attracted new attention among many researchers. Therefore, in the real economy, more rigorous tests for habit formation, especially at the micro-level, are needed.

As for Japanese household consumption, there are some analyses involving habit formation (e.g. Maki (1983), Braun et al. (1993), Iwata and Shimotsu (1996), Pagano (2004)), and their results basically showed that habit formation played an important role in Japanese household consumption. But most of them were analyses of macro-data; analyses using micro-data were very few. One reason for that would be a delay in building a panel data set. But, fortunately, today we can use the data of the Japanese

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[1] The most famous puzzle is the "excess sensitivity," explored in Flavin (1981), Hall and Mishkin (1982), and many other studies.

[2] Otherwise known as "Deaton's Paradox."

[3] Habit formation used in household consumption analysis has a long history. In the 1960~70s, Houthakker and Taylor (1966,1970), Pollak and Wales (1969) and other many empirical studies used the concept of "myopic habit formation" (Spinnewyn (1981)). Recently, however, most works use the concept of "rational habit formation," as opposed to a myopic one. In the framework of rational habit formation, the level of current consumption would influence marginal utility of future consumption. In this article, I consider rational (and internal) habit formation.

Panel Survey of Consumers (JPSC), which is a continuing panel investigation for Japanese households from 1993 to today. In this article, by the household food expenditure data from the JPSC and Dynan (2000)'s consumption Euler equation allowing habit formation, I try to analyze empirically the relationship between Japanese household consumption and habit formation. From my estimation, I see two key implications: 1) like Dynan (2000), my results yield no evidence of habit formation in Japanese household consumption, and 2) my results are consistent with the durability of consumption as found by Guariglia and Rossi (2002).

The remainder of this article proceeds as follows: Section II describes a small literature survey and theoretical model; Section III discusses data; Section IV presents the results of my estimation; and Section V concludes.

II. Theoretical Framework

From the late 1980s to the early 1990s, the role of habit formation in the household consumption had been tested actively by macro time-series data. But, no test could reach a decisive conclusion about that role. Some researchers suspected the influence of the bias with data aggregation (e.g. Goodfriend (1992), Attanasio and Weber (1993), Cherry and List (2002), Garrett (2002), Blundell and Stoker (2005)). Perhaps most researchers would deny the perfect homogeneity among households. Actually, many works implied that the analysis ignoring heterogeneity among households might produce a biased result (e.g. Constantinides and Duffie (1996), Pesaran (2003), Jones and Labeaga (2003)).

Of course, micro-data would be more suitable for the heterogeneity adjusted analysis than would macro-data. Since the early 2000s, the starting time for using panel data, micro-data analysis about habit formation began to be reported. Dynan (2000) and Guariglia and Rossi (2002) were pioneers and representative of this trend.[4] One of my objectives in this article is to compare my estimation results with those of these two previous studies. Dynan (2000) used food expenditure data from the Panel Study of Income Dynamics (PSID), which was a panel survey of American households, and estimated the Euler equation including habit formation by the method of GMM. But her estimation yielded no evidence for habit formation in American household consumption[5]. Guariglia and Rossi (2002) estimated the Euler equation accepting habit formation and

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[4] Naik and Moore (1996) analyzed habit formation using the PSID earlier than Dynan (2000). They got a consistent result for habit formation, unlike Dynan (2000). But their results were from level estimation (during about 10 years), not from differential estimation. Considering the possibility of unit root in long time panel data, perhaps their conclusion should be interpreted more cautiously.

[5] Kuismanen and Pistaferri (2006) is a more recent work using PSID compared to Dynan (2000). They estimated a dynamic consumption function. Their result also yielded no evidence for habit formation.

precautionary motive by food expenditure data of the British Household Panel Survey (BHPS), which was a panel survey of British households and had a similar survey design to that of the PSID. They concluded that past consumption changes and labor income risk played important roles in current consumption changes. But their results were consistent with durability of consumption, not habit formation. In addition, there are many studies for testing habit formation by micro data, and some of their results are consistent with habit formation (e.g. Alessie and Teppa (2002), Carrasco et al. (2005), Browning and Collado (2007)[6]), unlike Dynan (2000) or Guariglia and Rossi (2002). Actually, a final conclusion or consensus on this issue has yet to be drawn. The test for habit formation has been ongoing.

The targets of these studies presented here are Western households. But, there are few micro-data analyses about Japanese households' habit formation.[7] Perhaps, the accumulation of micro-level empirical analyses is not yet sufficient. So, in this article, I try to analyze the role of habit formation in Japanese household consumption by Japanese household panel data. For my estimation, I use Dynan (2000)'s Euler equation allowing habit formation. Dynan (2000) thinks Household i's consumption at time t, C_{it} should look like the following:

$$C_{it} = CE_{it} - a\,CE_{it-1} \tag{1}$$

where CE_{it} represents this household's consumption expenditure, parameter a is "habit formation parameter," which measures the strength of habit formation. And the consumer's utility function is settled as follows, in isoelastic form:

$$u(C_{it};T_{it}) = T_{it}\,\frac{C_{it}^{1-\rho}}{1-\rho} \tag{2}$$

where T_{it} corresponds to taste shifters of utility function, and $-\rho$ is the elasticity of marginal utility of consumption. This framework shows that a part of past consumption expenditure has become a habit and is expended preferentially at the current time (in other words, "consumption is committed"), but has no influence on current utility. From a utility maximization problem of the household whose utility function is like formulation (2), Dynan (2000) derives the loglinearized Euler equation for her estimation[8]. Her estimation model is as follows:

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[6] Alessie and Teppa (2002) used Dutch household panel data. Carrasco et al. (2005) and Browning and Collado (2007) used Spanish household panel data.

[7] Perhaps, Hayashi (1985, 1986) and Kitamura (2005), which is an additional test for Hayashi (1986), are rare exceptions. But their targeting issue is durability of consumption, not habit formation, and their results are consistent with durability.

[8] See Dynan (2000)'s Section I and Appendix A for details of deriving processes.

$$\Delta \ln CE_{it} = a_0 + a_1 \Delta \ln CE_{it-1} + a_2 \Delta \ln T_{it} + e_{it} \quad (3)$$

where e_{it} represents a stochastic error term with mean zero and constant variance, and $a_0 \sim a_2$ are estimating parameters. Especially, a_1 is the habit formation parameter, and equals parameter a in formulation (1). If the estimated a_1 is positive and less than one, that result would be consistent with habit formation.

III. Data

In this article, as mentioned above, I estimate formulation (3) using data from the JPSC. Originally, the JPSC published an annual survey of 1,500 married and unmarried women about their social and family lives. But, because the JPSC contains information about the whole family, the data of the JPSC is often used to analyze Japanese households. Since 1998, the JPSC has started to research household expenditures by item category for September every year. Categories correspond approximately to the ten major classifications of the Family Income and Expenditure Survey (FIES).[9] Of course, food expenditure is one of the JPSC's expenditure items, and, therefore, I can compare my estimation result using food data directly with the results of Dynan (2000) or Guariglia and Rossi (2002).

Though I use JPSC data from 1998 to 2004, for the purpose of omitting outliers I eliminate observations and households as follows: monthly food expenditure is zero or more than 170,000 yen, and last annual household income (before tax and public dues) is less than one million yen or more than 22.8 million yen.[10] I also omitted the unmarried sample, except single-person households because the JPSC has not researched cohabitating family members' expenditure for the unmarried sample. The JPSC doesn't have information for whole family expenditure of the unmarried sample (except women living solo). These omissions bring the sample size of my data set to 7,107 observations.

[9] The FIES is the Japanese government's main source of information on household consumption.
[10] These threshold values are 1 percentile or 99 percentile of food expenditure and family income, which are calculated in preliminary analysis using a full-sample data set.

Table 1. Basic Statistics of My Data Set

numerical variables	obs	mean	Std.Dev.	min	max
food expenditure (nominal, thousand yen)	7,107	62.5	30.22	1.0	170.0
age of wives or live-alone women	7,107	35.0	4.83	25.0	45.0
number of family menbers	7,107	4.0	1.61	1.0	11.0
family annual income (not exclude tax and public charge, nominal, ten thousand yen)	7,107	667.4	322.42	100.0	2,271.0
(about marriage sample)					
food expenditure (nominal, thousand yen)	6,640	64.6	29.89	2.0	170.0
age of wives or live-alone women	6,640	35.2	4.74	25.0	45.0
number of family menbers	6,640	4.3	1.45	1.0	11.0
family annual income (not exclude tax and public charge, nominal, ten thousand yen)	6,640	688.9	320.06	100.0	2,271.0

dummy variables	obs		Freq.	Percent
husbands at work (at work = 1)	7,107	1:	6,235	87.7
		0:	872	12.3
wives or live-alone women at work (at work = 1)	7,107	1:	1,645	23.2
		0:	5,462	76.9
other family members at work (at work = 1)	7,107	1:	1,645	23.2
		0:	5,462	76.9
(about marriage sample)				
husbands at work (at work = 1)	6,640	1:	6,235	93.9
		0:	405	6.1
wives or live-alone women at work (at work = 1)	6,640	1:	3,541	53.3
		0:	3,099	46.7
other family members at work (at work = 1)	6,640	1:	1,640	24.7
		0:	5,000	75.3

Table 1 presents basic statistics of selected variables for my estimation. Food expenditure is for the whole family and in September. Family annual income is the sum of annual pretax earnings of husband, wife, and other family members. Of course, for a household in the unmarried sample group, the investigated woman's income equals family income. In my estimation, these food expenditures and family income are deflated by the CPI. As taste shifters, I chose investigated woman's age[11] and family size in accordance with Dynan (2000). And I define three dummy variables: Dummy for husband working, Dummy for investigated woman working, Dummy for other family member working. These dummies take the value 1 if husband, wife (investigated woman) or other family member is either employed or self-employed.

[11] Dynan (2000) used the age of household head.

IV. Results of Estimation

In this section, I estimate formulation (3) and compare my results with previous works. Formulation (3) has the lagged dependent variable as one of the independent variables. It means my estimation is the dynamic panel estimation. So I chose the system GMM, not the fixed effects model or random effects model, as my estimation method.

In all estimations, the dependent variable is the log difference in real food expenditure and the independent variables are the lagged change in food expenditure, the investigated woman's age and that square, the log difference in household size, year dummies, and a constant term.

Table 2. Estimation Results

Estimation results by System GMM : Respectively, *,**,*** indicate significance at the 10,5,1% levels.

	(i)		(ii)		(iii)	
Δlog(C(−1))	−0.3162	***	−0.2356	**	−0.3046	***
	(0.033)		(0.099)		(0.027)	
age	2.203	**	−0.908		0.371	
	(1.062)		(0.862)		(0.408)	
$age^2/1000$	−29.104	**	11.932		−4.794	
	(14.150)		(12.390)		(5.814)	
Δlog(family size)	2.581	**	0.189		0.933	***
	(1.180)		(0.227)		(0.302)	
constant	−40.751	**	17.484		−6.474	
	(19.737)		(15.046)		(6.961)	
joint significance of year dummies (p-value)	0.142		0.407		0.003	
Arellano-Bond test for AR(2) in first differences (p-value)	0.065		0.650		0.010	
Hansen test of overidentifying restrictions (p-value)	0.062		0.714		0.080	
Wald test (p-value)	0.00		0.01		0.00	
number of obs.	3,910		242		4,152	
95% confidence interval for HF parameter	(−0.3816, −0.2507)		(−0.4298, −0.0415)		(−0.3582, −0.2509)	

notes: Δ represents the first difference. Standard errors are in parentheses. Instruments in all columns : Δlog(C(−2)) and Δof husband at work, wife at work, other family members at work, lagged real family income, and lagged family size for the difference estimation; ΔΔlog(C(−1)), husband at work, wife at work, other family members at work, lagged real family income, lagged family size, and constant term for the level estimation.

Table 2 reports the results of my estimation: Column (i) refers to married women (= family) sub-sample estimation, Column (ii) refers to unmarried and live-alone women (= single household) sub-sample estimation, and Column (iii) refers to the full-sample (= i

+ ii) estimation. At the estimation of (i) ~ (iii), I use the same set of instrument variables (see Table 2's note).

All p-values for the Hansen test of overidentifying restriction are over 0.05, providing no evidence of a significant correlation between instruments and error term at the 5% level. The (i) and (ii)'s p-values for the Arellano-Bond test of second order serial correlation of the residual are over 0.05, providing no signs of the serial correlation at the 5% level. But the (iii)'s p-value for the Arellano-Bond test is 0.010. It means that, in (iii), there is no sign of the second order serial correlation of the 1% level, nor that 5% level. And for the Wald test, whose null hypothesis is "all estimated parameters equal zero", all p-values are over 0.05, indicating that I can reject the null hypothesis at the 5% level. From these facts, I conclude that my specification is essentially correct.

In the all of (i) ~ (iii), the estimated coefficient a_1 is negatively significant at the 5% level.[12] The upper bound for 95% confidence interval is negative, too. These facts suggest that the lagged change in food expenditure has a negative and statistically significant effect on the current change. This result is consistent with the durability of consumption, not habit formation.

In Column (i), the family sub-sample, aging has a positive and significant effect. This result would be valid because the highest age of wife is 45 years old (in Table 1) and it means that all families would be in the younger stage of the family life-cycle. And the change in family size has a positive and significant effect on the change in food expenditure. This result would also be valid and commonsensical. But in Column (ii), the single- household sub-sample, aging and family size have no significant effects. Considering that this sample has only single-households, the result on family size wouldn't be invalid. But it's rather unexpected that aging has no significant effect. And surprisingly, aging also has no effect in Column (iii), the full sample estimation. However, the effect of family size is significantly positive in Column (iii). It would be a valid result.

[12] In (i)~(iii), standard errors are transformed to heteroskedasticity robust standard errors.

Table 3. Comparison with the Results of Previous Works: Parameters of the Lagged Change on Food Expenditure

		COEF	p-value	95% confidence interval		Method
Table 2	(i)	−0.316	0.00	−0.382	−0.251	System GMM
	(ii)	−0.236	0.02	−0.430	−0.042	System GMM
	(iii)	−0.305	0.00	−0.358	−0.251	System GMM
Dynan (2000), Table 2	(1)	−0.039	0.57	−0.180	0.100	GMM
	(2)	−0.046	0.51	−0.190	0.090	GMM
	(3)	−0.038	0.63	−0.190	0.120	GMM
Guariglia and Rossi (2002), Table 2	(1)	−0.382	0.00	−0.418	−0.346	OLS
	(2)	−0.470	0.00	−0.504	−0.436	Fixed Effrcts
	(3)	−0.262	0.00	−0.305	−0.219	GMM
	(4)	−0.272	0.00	−0.314	−0.230	System GMM

note: The (2) of Dynan (2000) : Race and sex are added to (1) as independent variables.
The (3) of Dynan (2000) : The real after-tax interst rate is added to (2).

Table 3 presents the results of comparing my estimated parameter of the lagged change on food expenditure, a_1 in formulation (3), with those of earlier works. As with those earlier works, I chose Dynan (2000) and Guariglia and Rossi (2002), which are representative studies that estimate the Euler equation by the panel data of food expenditure. This table shows the following two facts: the results of Dynan (2000), Guariglia and Rossi (2002), and mine yield no evidence for habit formation, and the results of Guariglia and Rossi (2002) and mine are very similar and consistent with the durability of consumption.

V. Conclusion

In this article, I estimate the Euler equation allowing habit formation by Japanese household panel data, and compare that estimation results with previous studies' ones. But my estimation results yield no evidence of habit formation like Dynan (2000) and Guariglia and Rossi (2002), and are consistent with the durability of consumption, not habit formation, like Guariglia and Rossi (2002). These facts suggest that habit formation plays no role in Japanese household consumption, don't they?

As above mentioned, there are several studies that are consistent with habit formation, like Alessie and Teppa (2002), Carrasco et al. (2005), and Browning and Collado (2007). Today, among a lot of empirical analyses using micro-data to study the role of habit formation on consumption, there are both results, accepted and rejected.

For the inconsistent result with habit formation of previous works, the influences of some factors that bias the results have been suspected (see Iwamoto (2010)). Nowadays, the three main candidates of those factors are as follows: 1)measurement errors contained in data, 2)durability of consumption goods and research intervals, and 3)heterogeneity among households. But, of course, it would be difficult to analyze household consumption by controlling all these factors. Many researchers have been trying to address these difficulties. It is, in fact, too early to draw final conclusions.

The degree of strength of habit formation has strong influence on policy effects, as I noted at the introduction. This issue is crucially important for public policy management, and should continue to be analyzed empirically. I also shall try an expansive analysis for the relationship between habit formation and Japanese household consumption.

Appendix Results of Estimation by the JPSC Expenditure Category Data

A1. Habit Formation and Durability of Consumption Goods

In the main article, I estimate the Euler equation allowing for habit formation, which is based on Dynan (2000), by the household food expenditure data (1998~2004) of the JPSC. Because one of my goals in this article is to compare my estimation results with those of important previous studies, e.g. Dynan (2000) or Guariglia and Rossi (2002), my analysis is concentrated on food expenditure. Constraints on data are Dynan (2000) or Guariglia and Rossi (2002)'s major reasons for using food expenditure data almost exclusively. They use only food data by assuming separability for the utility of food consumption. And perhaps, they would think that using food data was an advantage, because food is by definition not durable. According to Ferson and Constantinides (1991), durability of consumption goods cancels out the effect of habit formation. If durability were stronger than habit, the results of habit formation test would be consistent with durability. For the strict analysis of habit formation, the effects of durability should be removed from the result.

In the estimation of Dynan (2000), Guariglia and Rossi (2002), and in my own estimation, are estimated parameters of lagged consumption change influenced by durability? Are the effects of habit formation canceled out? To identify the effects of durability or habit formation directly is difficult because both effects are mixed in estimated parameters. But, comparing estimation results by data of expenditures, whose durability differ from one another, we could get some hints to answers for these questions.

Unfortunately, for the results of Dynan (2000) and Guariglia and Rossi (2002) —both are representative earlier studies— it's very hard to compare estimation results by multi- consumption goods because of limitations of data[13]. However, for this article, it's not so difficult for this comparison, because the JPSC surveys household expenditure by category of expense items, whose classification is based on the FIES or National Survey of Family Income and Expenditure (NSFIE).[14] Table A1 shows a list of surveyed

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[13] Dynan (2000) estimates her model by expenditure data of non-durable goods and services. But the PSID originally had no research items of "non-durable goods and services." At first, using data from the Consumer Expenditure Survey (CEX), she did her estimation as follows: Regresand is expenditure of non-durable goods and services; Regressors are market value of one's own house and mobiles, payments of public fees, and so on. Because PSID has similar variables with these regressors, she can estimate the theoretical value of "non-durable goods and services" using PSID variables and estimated parameters. She treats this value as a proxy for expenditure of "non-durable goods and services".

[14] The NSFIE is an also representative Japanese household economy survey. It's a cross-sectional survey (not panel one) done every five years for about 50,000 households.

expense items in the JPSC.

Table A1. List of JPSC Expenditure Items

0	Total expenditure	7	Transportation
1	Food	8	Communication
2	House and land rents	9	Education
3	Fuel, light and water	10	Reading and recreation
4	Furniture and household utensils	11	Social expenses
5	Clothes and footwear	12	Pocket money
6	Medical care	13	Other living expenditure

Sorce: JPSC survey sheet (1998)

In this appendix, I estimate formulation (2), which is the extended Euler equation based on Dynan (2000), by the data of JPSC expenditure items and compare these estimation results to each other for the consideration about the effect of durability.

A2. Data

Since 1998, the JPSC has surveyed household consumption expenditures by category of expense items every September, they are based on the FIES's and the NSFIE's 10 major expense items. In this appendix, though the JPSC has 13 expense items (see Table A1), I transform these 13 items to 10 based on the FIES's and the NSFIE's classification.

Table A2. Basic Statistics of JPSC's expense items

Expenditure items (nominal, thousand yen)	Obs	Mean	Std. Dev.	Min	Max	(Zero Obs)	(Overflow Obs)
Food	7,107	62.5	30.22	1	170	0	
House and land rents	7,107	25.4	44.94	0	998	3,647	2
Fuel, light and water	7,107	20.1	12.53	0	280	407	
Furniture and household utensils	7,107	5.5	17.89	0	620	3,728	
Clothes and footwear	7,107	10.3	14.34	0	320	2,116	
Medical care	7,107	7.2	17.25	0	550	2,517	
Transportation and communication	7,107	30.3	52.99	0	1,010	240	11
Education	7,107	19.9	38.76	0	931	2,379	
Reading and recreation	7,107	11.2	22.08	0	811	2,790	
Other living expenditure	7,107	59.6	67.65	0	1,090	661	2
(Married sample)							
Food	6,640	64.6	29.89	2	170		
House and land rents	6,640	23.9	45.55	0	998		
Fuel, light and water	6,640	20.8	12.54	0	280		
Furniture and household utensils	6,640	5.6	18.17	0	620		
Clothes and footwear	6,640	10.2	14.06	0	320		
Medical care	6,640	7.3	17.56	0	550		
Transportation and communication	6,640	31.1	54.58	0	1,010		
Education	6,640	21.1	39.74	0	931		
Reading and recreation	6,640	11.2	21.81	0	811		
Other living expenditure	6,640	61.9	69.11	0	1,090		

Table A2 reports basic statistics of the JPSC's transformed expense items. Several expense items have overflow observations, which means that expenditure amount is more than 998,000 yen.[15] On the overflows of transportation and communication, influences of purchasing automobiles are suspected. And, the existence of many zero values, which are not missing values, is more remarkable. Perhaps this is one influence of a short-period (one month) survey.

Table A3. Component Percentages of Consumption Expenditure

	JPSC	FIES	NSFIE
Food	24.0%	22.2%	23.2%
House and land rents	8.9%	8.6%	8.1%
Fuel, light and water	7.7%	6.5%	6.0%
Furniture and household utensils	2.1%	3.2%	3.0%
Clothes and footwear	3.8%	4.9%	4.9%
Medical care	2.7%	3.5%	3.5%
Transportation and communication	11.5%	14.6%	14.5%
Education	7.8%	5.7%	6.5%
Reading and recreation	4.2%	10.7%	10.0%
Other living expenditure	23.0%	19.8%	20.3%

notes:
JPSC : Married sample (Wife's age 25-45), 1998-2004
FIES : 2-or-more-person Households (Household head's age 25-49), 2000-2004
NSFIE : 2-or-more-person Households (Household head's age 25-49), 1999 and 2004

Table A3 presents the list of expenditure component ratios using data from the JPSC, the FIES, and the NSFIE. These ratios are not exactly same; for example, the JPSC's ratios of "reading and recreation" and "transportation and communication" are lower than those of the FIES and the NSFIE's. However, on the whole, those ratios have only very small differences. This result of comparison means that the JPSC, which is a recall-based (from memory) survey, could have the same accuracy as the FIES or the NSFIE, which are diary-based surveys.

A3. Estimation Results

In this appendix, I estimate the Euler equation allowing habit formation by the data shown in Table A2, except for food and other living expenditures.[16] Estimation method, dependent variables except for the lagged consumption change,[17] and instruments are the same as those in the main article.

[15] Amount of JPSC's expense items are recorded as 3-digit number. And for each items, 997 thousand yen is the highest recordable amount, because 998 means overflow and 999 means a missing value.
[16] Regarding food, I estimated it already in the main article. Other living expenditure includes too many kind of consumption goods and services, whose properties are very different from one another other. So it's doubtful to treat it as an expense item.
[17] Because these eight expense items have a lot of zero value observations (see Table A2), I use simple differences of current and lagged consumption as dependent and independent variables, instead of log-differences ones.

Table A4. Results of Estimations

Method : System GMM		Full sample (4,152 obs)		Married sample (3,190 obs)	
House and land rents	COEF of a_1	−0.388	***	−0.380	***
	S.D.	(0.041)		(0.041)	
	Arellano–Bond test for AR(2) *p–value*	0.514		0.684	
	Hansen test of overid. Restrictions *p–value*	0.667		0.771	
Fuel, light and water	COEF of a_1	−0.381	***	−0.385	***
	S.D.	(0.039)		(0.038)	
	Arellano–Bond test for AR(2) *p–value*	0.171		0.114	
	Hansen test of overid. Restrictions *p–value*	0.462		0.722	
Furniture and house-hold utensils	COEF of a_1	−0.424	***	−0.431	***
	S.D.	(0.047)		(0.052)	
	Arellano–Bond test for AR(2) *p–value*	0.293		0.226	
	Hansen test of overid. Restrictions *p–value*	0.367		0.184	
Clothes and footwear	COEF of a_1	−0.349	***	−0.344	***
	S.D.	(0.052)		(0.041)	
	Arellano–Bond test for AR(2) *p–value*	0.437		0.110	
	Hansen test of overid. Restrictions *p–value*	0.234		0.084	
Medical care	COEF of a_1	−0.346	***	−0.355	***
	S.D.	(0.099)		(0.103)	
	Arellano–Bond test for AR(2) *p–value*	0.533		0.399	
	Hansen test of overid. Restrictions *p–value*	0.270		0.300	
Transportation and communication	COEF of a_1	−0.252	***	−0.266	***
	S.D.	(0.085)		(0.055)	
	Arellano–Bond test for AR(2) *p–value*	0.068		0.140	
	Hansen test of overid. Restrictions *p–value*	0.733		0.343	
Education	COEF of a_1	−0.335	***	−0.316	***
	S.D.	(0.124)		(0.116)	
	Arellano–Bond test for AR(2) *p–value*	0.265		0.460	
	Hansen test of overid. Restrictions *p–value*	0.542		0.536	
Reading and recreation	COEF of a_1	−0.466	***	−0.491	***
	S.D.	(0.045)		(0.056)	
	Arellano–Bond test for AR(2) *p–value*	0.563		0.814	
	Hansen test of overid. Restrictions *p–value*	0.125		0.196	

Respectively, *,**,*** indicate significance at the 10,5,1% levels.

Table A4 reports the estimation results of habit formation parameters, which is the a_1 of formulation (2). This table shows that all habit formation parameters are negatively significant at the 1% level.[18] And all 95% confidence intervals are also within negative zone. Therefore, all of my estimation results are consistent with durability, as are the main article's results.

From comparison among expense items, we can observe the following facts about absolute values of estimated parameters: "Furniture and household utensils" and "Reading and recreation," which contain durable goods, are closest to value 1; "Education," which doesn't contain durable goods, are far from 1; "Fuel, light and

[18] For tests of significance, I transform standard errors to heteroskedasticity robust ones.

water," which doesn't contain durable goods, is close to 1; "Transportation and communication," which contains durable goods, is farthest from 1. The former two facts are consistent with the vision that durability cancels out the effect of habit formation. But the latter two facts are inconsistent with this vision. I must say that my results are difficult to explain. Finally, there are few differences between the full-sample's estimation results and those of married sample.

A4. Conclusion

From Table A4, I conclude as follows: All results are consistent with durability of consumption goods, not habit formation; From comparison among expense items, I can get results that are both consistent and inconsistent with the vision that durability cancels out the effects of habit formation.

Table A5. Estimation Results by Monthly Macro-data

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Food	−0.274	***	Medical care	−0.501	***
	(0.09)			(0.08)	
House and land rents	−0.581	***	Transportation and communication	−0.497	***
	(0.07)			(0.08)	
Fuel, light and water	−0.188	**	Education	−0.350	***
	(0.09)			(0.09)	
Furniture and house-hold utensils	−0.435	***	Reading and recreation	−0.512	***
	(0.08)			(0.09)	
Clothes and footwear	−0.489	***			
	(0.08)				

notes : Respectively, *,**,*** indicate significance at the 10,5,1% levels.
Standard Deviations are in parentheses.

Table A5 shows the results of my estimation using the formulation (A1)[19] and macro-data. This table is made for comparison with Table A4. I use the FIES's monthly macro-data (2-or-more persons and workers' households, January2000-April2010, Deflated by CPI, Seasonally adjusted by X12ARIMA).

All of my results of macro-data estimations are consistent with durability as well as Table A4 and Hayashi (1986), which showed that durability was detected in not only durable goods but also non-durable goods. But unlike Table A4, there is a strong tendency that absolute values of estimated parameters of "Food," "Fuel," and

[19] I estimate the formulation (A1), which is based on Hayashi (1986), by OLS. The (A1) is written as,

$$\Delta CE_t = a_0 + a_1 \Delta CE_{t-1} + \varepsilon_t \qquad \text{(A1)}$$

where CE_t means Consumption Expenditure at time t; ε_t is an error term; a_0—a_1 are parameters. By Hayashi (1986), the parameter a_1 of a durable goods becomes negatively significant. And if the goods have strong durability, the absolute value of the a_1 would be close to value 1.

"Education," which don't contain durable goods, are relatively smaller than ones of expense items that do contain durable goods. This fact is consistent with Hayashi (1986)'s vision that differences of durability of consumption goods have influence on household activities, and this influence is reflected in the value of parameters of lagged consumption changes.

On the whole, Tables A4 and A5 yield no evidence of habit formation. But they could show two possibilities: 1)durability, which cancels out the effect of habit formation, influences household consumption, and 2)at the micro level, other some factors have impacts on the results of estimations. So, for the exact analysis, these factors should be controlled. Further empirical analyses to identify these factors may be needed.

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