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On Effects of the Hyogo Earthquake on Household Consumption: A Note*†

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Abstract. This paper empirically examines the effect on household consumption triggered by the Hyogo Earthquake, which took place in January 1995. We utilize the empirical specification of the full insurance hypothesis with the panel structure of *the Family Income and Expenditure Survey* from 1989 through 1997. The main finding is that the earthquake shock was not shared between the damaged area and the other areas, despite the fact that the insurance capability in this damaged area was above the national average.

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1. Introduction This paper, as a supplement to Kohara, Ohtake, and Saito [2002], empirically examines the effect on household consumption triggered by the earthquake that devastated Hyogo prefecture in January 1995. According to the 1998 report by the Fire and Disaster Management Agency, 6,430 people died, and 512,857 housings collapsed partially or completely. Among possible effects of the earthquake shock on the economy, it is important to analyze the household reaction to such a catastrophic shock. In particular, it is worth examining whether the households in the damaged area could insure such shocks on their consumption with those in the other areas.

In this paper, we apply the full insurance implication to measure the earthquake effect on household consumption. As Mace [1991] and others demonstrate, the full insurance hypothesis implies that if idiosyncratic shocks such as shocks specific to individuals and regions are perfectly shared in complete markets, then individual consumption moves similarly over time among consumers. From the rejection of the hypothesis, we may infer the extent that idiosyncratic shocks or region-specific shocks are uninsured. We take the Hyogo earthquake incidence as an example of a region-specific shock.

For this purpose, we utilize one of the most representative panel data on Japanese households, *the Family Income and Expenditure Survey* (hereafter referred to as FIES) conducted by the Japanese Bureau of Statistics.

Following Mace [1991], Section 2 summarizes empirical specifications to test the full insurance hypothesis, and applies it to examine the effect of the above earthquake event on household consumption. Section 3 reports data and estimation results. The last section offers discussions.

2. Empirical Specifications Mace [1991] and others derive the following implication as to the full insurance hypothesis from the complete markets setup with the constant relative risk aversion preference:

$$ln\frac{C^i_{t+1}}{C^i_t} = \alpha + \beta_1 ln\frac{C^a_{t+1}}{C^a_t} + \beta_2 ln\frac{y^i_{t+1}}{y^i_t} + \varepsilon^i_{t+1}, \tag{1}$$

where C_t^i is consumption of household i, y_t^i is per household disposable income, C_t^a is per household aggregate consumption, and ε_{t+1}^i is assumed to represent measurement errors. Under the null hypothesis of full insurance, a coefficient on a change in per household aggregate consumption (β_1) is one, while a coefficient on a change in per household income (β_2) is zero. In other words, we can test the full insurance hypothesis by examining the extent that individual consumption growth can be explained by common time-specific factors (aggregate consumption growth). As is well-known (for example, Deaton [1992]), if preference is additive and separable in not only time, but also goods, then equation (1) is applicable even to subcategories of household consumption. As shown in the appendix by Mace [1991], however, even if the period preference is inseparable in goods, equation (1) may hold for subcategories. Examples include the case where the period utility is characterized by $\frac{1}{\alpha}\sum_{i=1}^{M}[\theta_i c_i(\omega(t))^{1-\gamma}]^{\frac{\alpha}{1-\gamma}}$, where M is the number of subcategories, and α, θ_i, and γ are given as parameters[1] .

We extend the above specification to examine the effect of the earthquake shock on household consumption. A region specific catastrophic event such as the Hyogo Earthquake is likely to constitute non-diversifiable or aggregate components at the national level. Nevertheless, as long as catastrophic shocks are shared well between the damaged area and the other areas, we still expect the equality of consumption growth among households under our setup with homogeneous preferences and belief[2] .

For the above purpose, we construct a regional dummy variable Dis, which takes one if a household lives in the damaged cities including Itami, Kobe, and Nishinomiya, all of which are in Hyogo prefecture, and zero otherwise. Replacing a coefficient on per household disposable income β_2 in the equation (1) by $\beta_2 + \beta_3 Dis$, we specify the empirical model as

$$ln\frac{C_{t+1}^i}{C_t^i} = \alpha + \beta_1 ln\frac{C_{t+1}^a}{C_t^a} + (\beta_2 + \beta_3 Dis) ln\frac{y_{t+1}^i}{y_t^i} + \epsilon_{t+1}^i. \tag{2}$$

[1] If $\frac{\alpha}{1-\gamma} = 1$, then the period utility is additively separable in subcategories of the consumption. The intra-period elasticity of substitution is infinite for $\gamma = 0$, while it is zero for $\gamma = \infty$.

[2] Braun, Todd, and Wallace [2000] show that the allocation and pricing of such catastrophe risks depend on properties of preferences, individual assessments of the likelihood of catastrophe events, and so on.

A coefficient β_3 is expected to represent the degree to which the earthquake shock is allocated between the disaster area and the other areas. Finding $\beta_3 = 0$ suggests that the earthquake shock was effectively insured throughout the national economy by way of either the insurance markets, family insurance, self-insurance, or governmental help. A positive coefficient β_3, on the other hand, indicates that the earthquake shock was borne largely by the Hyogo area.

One subtle issue concerning the interpretation of β_3 is that this coefficient is also subject to the region-specific insurance availability. As found in Kohara [2001], the insurance availability is generically better in urban areas than in rural areas. Since the damaged area is urban, the coefficient β_3 reflects not only the insurance capability specific to the earthquake shock, but also specific to this urban area. To control for the two different kinds of the insurance capabilities, we split the full sample into three sub-samples: (i) the earthquake period, which includes January 1995 in defining growth rates for both consumption and income; (ii) the pre-earthquake period; and (iii) the post-earthquake period. We are also interested in F-tests for testing $\beta_2 + \beta_3 = 0$, to examine whether the perfect sharing of the earthquake shock works at the national level.

3. Data and Estimation Results

3.1. **Data** In this study, we use the *Family Income and Expenditure Survey* (FIES) for Japanese households from 1989 through 1997, conducted by the Japanese Bureau of Statistics. While it has been quite often regarded as cross-sectional micro household data, it indeed has panel data structure. The FIES interviews the randomly sampled households every month. The sample size is equal to around 4200 households. Replacing one sixth of the total sample (about 700 households) every month, the survey interviews the same households every month for six consecutive months.

The sample of the FIES consists of three major categories of households, the household of a proprietor, that with an employed head, and that with an unemployed head. While we attempt to make the estimation sample as large as possible, we exclude the first category

of households from the full sample because no information on household income is available for these households.

The categories of household consumption used in the empirical analysis are the total consumption, together with expenditure on services, nondurables, and durables, as broadly classified categories, and food, housing, utilities, furniture, clothes, medical expenses, transportation, education, and recreation, as finely classified categories. See the data appendix for more details on these categories of expenditure.

Exploiting the panel data structure of the FIES, we construct the growth in individual household consumption over nine years. Among possible constructions, we compute one-month changes, which are the shortest intervals we can take for each observation. We also compute five-month changes, the longest intervals we can take for each observation, which takes into consideration the slow adjustment of household consumption due to some frictions or habit formation. Since the implication of the result with five-month changes is not different from that with one-month changes, the paper only reports the results with one-month changes.

As a variable representing a person-specific shock, we use the household income, which consists of labor income, personal business income, property income, and social security benefits. We compute its growth rate for the estimation. If the full insurance hypothesis holds, the realized person-specific shocks do not have any effect on a change in the household consumption. Thus, we examine whether the coefficient on income growth is significantly different from zero[3] .

We exclude any household in which consumption or income data are missing. The sample size consequently amounts to around 3000 each month. Table 1 reports the descriptive statistics for basic variables of household consumption and income.

Before reporting the estimation results, we make two remarks here. First, the empirical

[3] Mace [1991] estimate with the first difference in consumption or income in addition to the growth specification, and with a change in the employment status (from employed to unemployed, and vice versa) instead of the income changes. We conducted the same estimation, and found the same implications as the results shown in this paper.

results may be subject to the heterogeneity of household members. To account for this possibility, we estimate the above specification using not only the variables defined per household, but also those adjusted by some household equivalence measures. The empirical results with due consideration for such heterogeneity do not differ substantially from those without one[4] . Throughout this paper, therefore, we assume that 'individuals' are interchangeable with 'households'.

Second, due to the Hyogo Earthquake that impacted the Kansai area in January 1995, the survey failed to interview a substantial fraction of the sample households in this area. After the earthquake, accordingly, the sample size was small in comparison with the usual size of 3000 households per month. It took six months for the sample size to return to the pre-disaster level. We refer to this point later.

3.2. **Estimation results** As shown in Kohara, Ohtake and Saito [2002], for the entire period between 1989 and 1997, the full insurance is strongly rejected for most of the expenditure categories, although idiosyncratic shocks are insured relatively well for the consumption of necessities such as food, housing, utilities and medical care.

Table 2 reports the empirical result of equation (2) based on the earthquake period or the sample period between August 1994 and June 1995. F-tests for both $\beta_1 = 1$ and $\beta_2 + \beta_3 = 0$ indicate that the perfect risk sharing implication is rejected for the total consumption, as well as for several expenditure categories. While this F-test is not significant for some expenditure categories, such as housing, utilities, medical expenses, transportation, education, and recreation, a closer look at the estimated coefficient β_3 indicates that β_3 is significantly positive, and that the households in the damaged area indeed suffered seriously from the earthquake shock.

The estimation result of equation (2) for the pre-earthquake period further highlights the above interpretation. As Table 3 shows, the estimated β_3 is negative for several items, thereby suggesting that the damaged area originally enjoyed better insurance capability.

[4] One reasonable interpretation of a low impact of the equivalent measure correction is that the household characteristics do not change substantially within a short period such as six months.

The estimation result for the post-earthquake period is quite similar to that for the pre-earthquake period. Hence, we do not report the post-earthquake results in this manuscript. These estimation results imply that the households in the damaged area failed to spread the earthquake shock to other regions, despite the regional advantage of the insurance availability. In other words, the damage of the earthquake shock overwhelmed high insurance capability observed in this damaged area.

Before concluding this subsection, we point out one data problem with the above estimation results. As mentioned above, as a result of the earthquake, the FIES failed to interview a substantial portion of the sample households living in the damaged area. About three quarters of the households in the earthquake area were out of the sample in January 1995, and it took six months for the sample size to return to the pre-disaster level. Considering this issue quite seriously, the above empirical results may undermine the impact of the earthquake shock because the FIES might have been forced to drop the households severely affected by the earthquake from the sample.

3.3. **Discussions** This paper empirically examines the effect of the Hyogo Earthquake on household consumption based on a test of the full insurance hypothesis. The results estimated from the panel structure of *the Family Income and Expenditure Survey* from 1989 through 1997 demonstrate that the earthquake shock was not shared effectively between the damaged area and the other area, despite the fact that the insurance capability was originally high in this damaged area. Due to the sample attrition problems caused by the earthquake, our empirical results are fairly likely to undermine the impact of the earthquake damage.

There might have been several factors responsible for serious failure of sharing the Hyogo Earthquake shock. First, while earthquake insurance was offered for households jointly by the central government and private insurance companies, the earthquake insurance had not been prevalent at all in Hyogo before the earthquake occurred. According to the Marine and Fire Insurance Association of Japan, partly reflecting that the Hyogo area had not experienced catastrophic earthquake for a long time, the average percentage of households

who purchased private earthquake insurance before the earthquake (in 1995) was only 3%; it was still 12% even after the earthquake (in 2000).

Second, financial assistance from central and local government might not have worked sufficiently. Akai and Nagamatsu [2000] point out that there was not enough financial assistance from the central government to the damaged area.

Third, households did not save so much in preparation for the occurrence of natural disasters. In this regard, our estimation result based on household panel data contrasts with Skidmore [2001] that claims that preparation for natural disaster including earthquake is responsible for high saving rates in Japan, and with Horwich [2000] that emphasizes the importance of self-insurance in protecting those in the damaged area from the Hyogo Earthquake shock.

REFERENCES

[1] Akai N. and S. Nagamatsu, 2000,"Natural Disaster Risk Management and Local Governments," (in Japanese) *unpublished manuscript*.

[2] Braun, R. A., R. M. Todd, and N. Wallace, 1999, "A General Equilibrium Interpretation of Damage-Contingent Securities," *Journal of Risk and Insurance* 66, 583-95.

[3] Deaton, A., 1992, *Understanding Consumption*, Oxford University Press.

[4] Horwich, G., 2000, "Economic Lessons of the Kobe Earthquake," *Economic Development and Cultural Change* 48, 521-542.

[5] Kohara, M., 2001, "Consumption Insurance in Japan: The Evidence from Individual Panel Data," *Applied Economics* 33, 791-800.

[6] Kohara, M., F. Ohtake, and M. Saito, 2002, "A Test of the Full Insurance Hypothesis: The Case of Japan," *Journal of the Japanese and International Economies* 16, 335-352.

[7] Mace, B. J., 1991, "Full Insurance in the Presence of Aggregate Uncertainty," *Journal of Political Economy* 99, 928-956.

[8] Skidmore, M., 2001, "Risk, Natural Disasters, and Household Savings in a Life Cycle Model," *Japan and the World Economy* 13, 15-34.

Table 1: Averages and Standard Deviations of Consumption and Income

	Level (Yen)	Difference (Yen)	Log Difference
Total consumption	356530.49 (24119.67)	-2615.43 (29497.86)	-0.007 (0.045)
Services	132802.88 (14387.47)	-729.26 (18240.74)	-0.010 (0.068)
Nondurables	126101.27 (4571.27)	-333.58 (4256.61)	-0.003 (0.029)
Durables	31059.96 (1335.36)	-1145.24 (19006.28)	-0.018 (0.202)
Food	84164.49 (3071.39)	-396.84 (2362.45)	-0.005 (0.027)
Housing	24419.15 (8554.40)	499.10 (12029.41)	-0.003 (0.117)
Utilities	20143.89 (1017.74)	71.55 (1115.19)	0.008 (0.059)
Furniture	16039.27 (3832.46)	-312.58 (5270.74)	-0.009 (0.128)
Clothes	23505.28 (3613.64)	-271.73 (4754.94)	-0.011 (0.127)
Medical Expenses	11539.94 (2407.74)	159.85 (3213.09)	-0.010 (0.118)
Transportation	43743.27 (13721.83)	-1263.75 (19526.98)	-0.013 (0.100)
Education	20278.80 (6245.58)	152.50 (9919.35)	-0.001 (0.111)
Recreation	38075.14 (5257.91)	-476.97 (6768.83)	-0.015 (0.097)
Others	74621.27 (9415.99)	-419.85 (11270.79)	-0.016 (0.084)
Disposable income	592599.47 (40536.15)	3112.11 (50941.20)	0.004 (0.070)

(1) The disposable income is defined in terms of the sum of labor income, personal business income, property income and social security benefits.
(2) Standard deviations are in parentheses.

Table 2: The Estimation Result for a Test of the Full Insurance Hypothesis with Disaster Dummies for the Earthquake Period (One-month Growth-Rate Specification)

Dependent Variables (Classified Items)	Coefficient on ΔC^a_t (β_1)	Coefficient on Δy^i_t (β_2)	Coefficient on Dis$\times\Delta y^i_t$ (β_3)	F-statistics For $\beta_1=1$, $\beta_2+\beta_3=0$	R-squared	Number of observations
Total consumption	0.7690*** (0.0563)	0.0588*** (0.0091)	0.2611*** (0.0653)	18.65***	0.0908	5540
Services	0.6532*** (0.2286)	0.0353* (0.0150)	0.1964 (0.1073)	3.19*	0.0065	5540
Nondurables	0.8681*** (0.0287)	0.0449*** (0.0063)	0.2341*** (0.0448)	27.43***	0.2643	5540
Durables	0.9641*** (0.1076)	0.0257 (0.0444)	-0.0897 (0.3179)	0.083	0.0234	5540
Food	0.9009*** (0.0314)	0.0308*** (0.0064)	0.2189*** (0.0459)	18.31***	0.2282	5540
Housing	0.3458 (0.4080)	0.1111** (0.0425)	-0.1976 (0.2947)	1.39	0.0057	2435
Utilities	1.1015*** (0.3295)	0.0093 (0.0142)	-0.1613 (0.1019)	1.22	0.0027	5356
Furniture	0.8572*** (0.0743)	0.0877** (0.0294)	0.4883** (0.2091)	5.17**	0.0514	5461
Clothes	0.9866* (0.3940)	-0.0076 (0.0323)	0.7255** (0.2382)	4.57**	0.0154	4979
Medical Expenses	1.0233 (0.7939)	-0.0056 (0.0277)	0.4153* (0.2050)	2.02	0.0007	5135
Transportation	0.2439 (0.4287)	0.0614** (0.0216)	0.1250 (0.1566)	2.08	0.0027	5448
Education	0.9955* (0.3876)	0.0026 (0.0445)	-0.3490 (0.3115)	0.62	0.0041	2371
Recreation	0.9775*** (0.0713)	0.0079 (0.0220)	0.2895 (0.1573)	1.80	0.0533	5488
Others	0.3407*** (0.1258)	0.1630*** (0.0193)	0.3593** (0.1380)	19.15***	0.0312	5509

(1) Standard errors are in parentheses.
(2) ***, **, and * indicate that the estimated coefficient is significant at the 0.1 percent, 1 percent and 5 percent levels respectively.

Table 3: The Estimation Result for a Test of the Full Insurance Hypothesis with Disaster Dummies for the Pre-Earthquake Period (One-month Growth-Rate Specification)

Dependent Variables (Classified Items)	Coefficient on ΔC^a_t (β_1)	Coefficient on Δy^i_t (β_2)	Coefficient on $Dis \times \Delta y^i_t$ (β_3)	F-statistics for $\beta_1=1$, $\beta_2+\beta_3=0$	R-squared	Number of observations (in thousands)
Total consumption	0.8695*** (0.0077)	0.0606*** (0.0016)	-0.0094 (0.0074)	158.11***	0.1129	177
Services	0.8936*** (0.0173)	0.0432*** (0.0024)	0.0267* (0.0119)	33.96***	0.0227	177
Nondurables	0.9422*** (0.0047)	0.0269*** (0.0010)	-0.0258*** (0.0045)	77.00***	0.2481	177
Durables	0.9363*** (0.0182)	0.0654*** (0.0073)	-0.0575 (0.0348)	6.13**	0.0203	177
Food	0.9553*** (0.0051)	0.0178*** (0.0009)	-0.0034 (0.0043)	41.67***	0.2156	177
Housing	0.9457*** (0.0600)	0.0206** (0.0068)	-0.1164*** (0.0296)	6.17**	0.0042	82
Utilities	0.9985*** (0.0191)	0.0083*** (0.0020)	0.0082 (0.0108)	1.21	0.0161	169
Furniture	0.9720*** (0.0124)	0.0226*** (0.0047)	0.0423 (0.0222)	6.32**	0.0438	175
Clothes	0.9676*** (0.0119)	0.0424*** (0.0047)	-0.0334 (0.0228)	3.74*	0.0461	163
Medical Expenses	0.9037*** (0.0334)	0.0300*** (0.0046)	0.0527* (0.0218)	10.56***	0.0070	160
Transportation	0.9556*** (0.0208)	0.0334*** (0.0035)	0.0093 (0.0178)	5.01**	0.0142	175
Education	1.0051*** (0.0299)	0.0202** (0.0068)	0.0795 (0.0370)	3.76*	0.0142	79
Recreation	0.9274*** (0.0118)	0.0536*** (0.0035)	-0.0008 (0.0168)	22.25***	0.0471	176
Others	0.8241*** (0.0097)	0.1295*** (0.0030)	-0.0601*** (0.0143)	167.43***	0.0768	176

(1) Standard errors are in parentheses.
(2) ***, **, and * indicate that the estimated coefficient is significant at the 0.1 percent, 1 percent and 5 percent levels respectively.

Data Appendix: Thirteen Items of Consumption Expenditures

Classified Items	Classification : "the *FIES* Classification Name" [Classification Code]
Food	"food"[1]
Housing	"housing"[2]
Utilities	"heating and water"[3]
Furniture	"furniture and household goods"[4]
Clothes	"clothes and footwear"[5]
Medical Expenses	"medical expenses"[6]
Transportation	"transportation and communication"[7]
Education	"education"[8]
Recreation	"recreation"[9]
Others	"others"[10] (excluding "entertainment expenses"[10.3] and "transfers to family members and others"[10.4])
Services	"eating out"[1.12] + "rent"[2.1] + "housing repairs and maintenance services"[2.2.2] + "household services"[4.6] + "services related to clothes"[5.8] + "medical services"[6.4] + "transportation"[7.1] + "automobile maintenance"[7.2.3] + "communication"[7.3] + "tuition"[8.1] + "supplementary education[8.3] + "recreational services"[9.4] + "services related to beauty"[10.1.1] + "other miscellaneous goods"[10.1.5] + "recreation included in entertainment expenses"[10.3.4] + "services included in entertainment expenses[10.3.5]
Nondurables	Food (excluding "eating out"[1.12]) + Utilities + "household nondurables"[4.5] + Clothes (excluding "services related to clothes"[5.8]) + Medical Expenses (excluding "medical equipment"[6.3] and "medical services"[6.4]) + "textbooks and educational materials"[8.2] + "recreational equipment"[9.2] + "books and other printed matters"[9.3] + "beauty aids"[10.1.2] + "cigarettes"[10.1.4] + "food included in entertainment expenses"[10.3.1] + "other entertainment expenses"[10.3.7]
Durables	"materials for housing repairs and maintenance"[2.2.1] + "household durables"[4.1] +"room ornaments"[4.2] +"medical equipment"[6.3] + "automobiles"[7.2.1] + "bicycles"[7.2.2] + "recreational durables"[9.1] + "furniture and household goods included in entertainment expenses"[10.3.2]

(1) See *the Report on the Family Income and Expenditure Survey* for more details on the above classification codes.