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POPULATION AGING AND CONSUMPTION INEQUALITY IN JAPAN

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This paper analyses how consumption inequality within a fixed cohort grows with age using Japanese household microdata. Following the method developed by Deaton and Paxson (1994), we obtain the following results. First, consumption inequality starts to increase at the age of 40. Second, younger generations face a more unequal distribution from the beginning of their life-cycle. Third, half of the rapid increase in the economy-wide consumption inequality during the 1980s was caused by population aging, while one-third was due to the increasing cohort effect. The paper compares the above results with those of Deaton and Paxson.

1. INTRODUCTION

Older households are not uniform in terms of economic welfare; individual history up to old age is idiosyncratic, thereby generating a dispersion of individual economic status. For example, the wealth of older households reflects their history of health, opportunities of human capital formation, employment relations within firms, family background, human network, individual luck, and so forth.

Some sorts of individual risks can be avoided by either purchasing insurance or arranging implicit contracts within a family or a community. However, insurance markets may be absent for some kinds of risks due to either moral hazard or adverse selection, while the ability of implicit family (community) contracts may be imperfect in pooling individual risks. If uninsured idiosyncratic events have persistent or permanent impacts on individual income, or if uninsured idiosyncratic shocks are accumulated throughout life, the cross-sectional dispersion of income within a fixed cohort will grow with age. Under the permanent income hypothesis, so does within-cohort consumption.

Several empirical studies examine how the cross-sectional dispersion of both income and consumption changes with age. For example, Deaton and Paxson (1994) find that both income and consumption inequality within a fixed cohort increase with age using household microdata of the U.S., the U.K., and Taiwan. Takayama *et al.* (1989) and Takayama and Arita (1996) find that income distribution is more uneven among older households than among younger ones using Japanese household microdata.

Note: We are grateful to Professor Christina Paxson for providing us with the statistics used in Deaton and Paxson (1994). We would like to thank two anonymous referees, Melvyn Coles, Motoshige Fukushige, Yutaka Kosai, Kazuo Ogawa, Hiroko Ota, Atushi Seike, Toshiaki Tachibanaki and seminar participants at various institutes for valuable comments and Henrietta Cole for research assistance. We also acknowledge a Grant-in-Aid from the Ministry of Education of the Government of Japan (10113206) for financial support.

These empirical findings have important implications. That is, population aging may enhance within-cohort effects on inequality by raising the share of older households characterized by a large dispersion. Deaton and Paxson (1995) show that the effect of population aging on inequality is significant in Taiwan. Examining the increase in income inequality during the 1980s, Ohtake (1994) finds that the same effect is present in Japan.

One of the most important implications in Deaton and Paxson (1994) is that they measure the within-cohort inequality of economic welfare not only by income, but also by consumption.[1] This paper (Section 2) shows that the consumption inequality measure proposed by Deaton and Paxson (1994) (the within-cohort inequality measured in terms of log-consumption variance) has a well-defined theoretical content under the permanent income hypothesis with incomplete insurance. In this context, consumption inequality is more desirable than income inequality as the measurement of the dispersion of individual economic welfare because consumption reflects not only current income, but also life-time resources.

We apply the Deaton and Paxson measure to Japanese household microdata. In this study, we use the 1979, 1984, and 1989 versions of the *National Survey on Family Income and Expenditure* conducted by the Statistics Bureau of the Japanese Government (Statistics Bureau, 1979, 1984, and 1989). The main findings are summarized as follows. First, within-cohort inequality of consumption increases rapidly after the age of 40. Second, both income and consumption inequality grow within a fixed cohort at a similar average speed. Third, younger generations face a more unequal consumption distribution from the start of their life-cycle. Fourth, half of the increase in the economy-wide consumption inequality during the 1980s was caused by population aging, while one third was due to the increasing cohort effect. In addition, the paper compares the above results with those for the U.S., the U.K., and Taiwan, all of which are reported by Deaton and Paxson (1994).

This paper is organized as follows. In Section 2, we show that the inequality measure proposed by Deaton and Paxson (1994) has a rigorous theoretical content. In addition, we emphasize the advantage of consumption inequality measures over income inequality measures in separating age effects from cohort effects. In Section 3, we estimate both the cohort effect and the age effect using the within-cohort inequality measure of consumption and income. In Section 4, we compare the estimation results with those for the U.S., the U.K., and Taiwan. Section 5 analyses the impact of population aging on the rapid increase in the economy-wide consumption inequality during the 1980s in Japan. Section 6 concludes.

2. Consumption Inequality Measure

This section shows that the within-cohort inequality of consumption proposed by Deaton and Paxson (1994) or the variance of log-consumption within a fixed cohort has a well-defined theoretical content in the context of the permanent income hypothesis (hereafter, PIH) with incomplete insurance.

[1]In the empirical literature on inequality, Cutler and Katz (1991), Slesnick (1993, 1994), and others recognize that the level of inequality in the U.S. differ between consumption and income.

Although Deaton and Paxson suggest that their measure can be justified by Hall's version of the PIH (Hall, 1978), that model does not yield their measure exactly. In this section, we propose a simple theoretical framework, thereby showing that their measure corresponds to a rigorous measure under much less restrictive assumptions; we do not need any assumptions such as constant safe returns, the equality between interest rates and time preference rates, or a quadratic utility function, all of which are assumed in Hall's version of the PIH.[2,3]

Suppose that agent i who was born in year j has a utility function with constant relative risk aversion as below:[4]

$$U = E_j\left[\sum_{t=j}^{T+j-1} \exp(-\rho(t-j))\frac{c_i(t)^{1-\gamma}}{1-\gamma}\right], \tag{1}$$

where E_j is the expectation operator conditional on the information available at time j, $c_i(t)$ is the consumption of individual i at time t, ρ is the time preference rate, γ is the coefficient of relative risk aversion, and T is the life span.

When agent i, who was born in year j and is k years old now, maximizes the value function (1), the following Euler equation holds.

$$\exp(r(t)-\rho)E_t\left[\frac{c_i(t+1)}{c_i(t)}\right]^{-\gamma} = 1, \tag{2}$$

where $t=j+k$, and $r(t)$ denotes safe real interest rates.

The above Euler equation can hold under rather general assumptions. That is, it holds whether insurance markets are complete or incomplete, whether a pair of cohorts are linked altrustically or not, and, whether the life span is short or long. The most important assumption under which equation (2) holds is that consumer i can self-insure either by lending or borrowing on the safe bond market. Conversely, if liquidity constraints are binding, equation (2) does not hold. We will later examine the implication of liquidity constraints for our model.

We introduce two kinds of random shocks into equation (2). One is an aggregate shock common to all individuals (ε_a), while the other is an idiosyncratic shock specific to agent i (ε_i). For example, the former shock includes macroeconomic shocks on financial returns and business cycle effects on national income, while the latter includes preference shocks and person-specific shocks on individual endowment. Suppose that ε_a and ε_i are distributed according to

$$\varepsilon_a(t+1) \sim N(0, \sigma_a(t)^2)$$

and

$$\varepsilon_i(t+1) \sim N(0, \sigma_h(t)^2).$$

$\varepsilon_i(t+1)$ is i.i.d. over individuals, and is not correlated with $\varepsilon_a(t+1)$.

[2]Deaton and Paxson (1994) suggest that they can relax their assumptions (pp. 460–1). They do not, however, construct models explicitly.

[3]Fukushige (1989) derives a consumption inequality measure from the PIH. His model, however, differs from our model in that the former does not have any cohort structure; consequently, he cannot decompose his inequality measure into age and cohort effects.

[4]We assume that utility is separable between consumption and leisure. See Altug and Miller (1990) and Hayashi, Altonji, and Kotlikoff (1996) for the discussion on the non-separable case.

We assume that the following equation obtains when the expectation operator is taken away from equation (2).

$$(3) \qquad \exp(r(t)-\rho)\left[\frac{c_i(t+1)}{c_i(t)}\right]^{-\gamma} = \exp(-\varepsilon_a(t+1)-\varepsilon_i(t+1))\exp\left(-\frac{\sigma_a(t)^2+\sigma_h(t)^2}{2}.\right)$$

It is easy to show that the conditional expectation of the right-hand side of equation (3) is equal to one, and accordingly equation (3) is consistent with the Euler equation (2). When idiosyncratic shocks are perfectly pooled among agents in insurance markets, $\varepsilon_i(t+1)$ does not appear in the right-hand side of equation (3), and $\sigma_h(t)$ reduces to zero.[5]

Taking the logarithm of both sides of equation (3) leads to

$$(4) \qquad \ln c_i(t+1)-\ln c_i(t)=\frac{1}{\gamma}(r(t)-\rho)+\frac{1}{2\gamma}(\sigma_a(t)^2+\sigma_h(t)^2) + \frac{1}{\gamma}\varepsilon_a(t+1)+\frac{1}{\gamma}\varepsilon_i(t+1).$$

Notice that all terms except for the last term in equation (4) are common across individuals within the same cohort.

Using equation (4), we obtain the consumption of agent i who lives until time t $(=j+k)$ as

$$(5) \qquad \ln c_i(t+1)=\ln c_i(j)+\sum_{\tau=j}^{t}\left[\frac{1}{\gamma}(r(\tau)-\rho)+\frac{1}{2\gamma}(\sigma_a(\tau)^2+\sigma_h(\tau)^2) + \frac{1}{\gamma}\varepsilon_a(\tau+1)+\frac{1}{\gamma}\varepsilon_i(\tau+1)\right].$$

Deaton and Paxson define their within-cohort consumption inequality measure as

$$Var \ln c(t)=\frac{1}{I}\sum_{i=1}^{I}\left[\ln c_i(t)-\frac{1}{I}\sum_{i=1}^{I}\ln c_i(t)\right]^2,$$

where I denotes the population of a cohort born in year j. Noting that $1/I\sum_{i=1}^{I}\varepsilon_i(t+1)$ approaches zero by the law of large number as I becomes large, we can express the within-cohort log-consumption variance as follows[6,7]

[5]In this paper, the meaning of the term "insurance" is broader than usual. It includes not only insurance contracts available in markets, but also implicit insurance made among family or community members.

[6]Under Hall's version of the PIH, the derived inequality measure is the variance of the level of consumption, not of the logarithm of consumption.

[7]In Deaton and Paxson (1994), they compare Gini coefficients, which is a more conventional measure of inequality, with their proposed measure of log-consumption variances. They do not find any substantial difference between these two measures. There are, however, underlying differences between the two measures. As Karoly (1993) discusses, the log variance is more sensitive to changes in the lower tail of the distribution while the Gini is more sensitive to changes in inequality around the median.

$$(6) \qquad Var \ln c(j+k) = Var \ln c(j) + \frac{1}{\gamma^2} \sum_{l=0}^{k-1} \sigma_h (j+l)^2.$$

The first term of the right-hand side of equation (6) measures the level of inequality which prevailed when this cohort entered the economy at time j, while its second term reflects the within-cohort inequality which increases with age due to accumulated uninsured shocks. Hereafter, the former term is called the cohort effect, whereas the latter the age effect. The age effect indicates the absence or incompleteness of insurance markets; under complete insurance, the age effect disappears. The cohort effect, on the other hand, can be interpreted as the cross-sectional dispersion of life-time income expected when cohort j enters the economy.

In the next section, we estimate the following equation based on equation (6).

$$(7) \qquad Var \ln c(j+k) = \sum_{m=J_0}^{J} \alpha_m \, \text{cohort}_m + \sum_{n=K_0}^{K} \beta_n \, \text{age}_n,$$

where cohort_m is the cohort dummy variable which takes the value one if $m=j$, and zero otherwise, and age_n is the age dummy variable which is equal to one if $n=k$, and zero otherwise. In equation (7), the cohort effect is captured by the coefficient α_m, while the accumulated age effect by the coefficient β_n.

Before completing this section, we make two further remarks. First, we emphasize that it is not possible to identify the age effect caused by uninsured permanent shocks, even if equation (7) is applied to within-cohort income inequality. Under the PIH, individual consumption at birth immediately reflects individual life-time income expected at birth; accordingly, the cohort effect can absorb the cross-sectional dispersion expected at birth, while only the dispersion caused by idiosyncratic shocks, which are unexpected at birth and realized later, remains in the age effect. That is, the age effect estimated from consumption inequality can capture the effect caused purely by unexpected shocks. The age effect estimated from within-cohort income inequality, however, may include not only unexpected, but also expected dispersions. For example, suppose that the wage profile is steeper for those with a college degree than for those without one. In this case, within-cohort income inequality grows with age even if insurance markets are complete.

Second, the comparison between income and consumption inequality may detect the possibility of liquidity constraints, under which our model may become irrelevant as discussed before. When the equality between income and expenditure can be represented as a simple form of liquidity constraints, income and consumption inequality should move together within a fixed cohort. Conversely, a substantial difference in within-cohort inequality between income and consumption may allow us to exclude the possibility of liquidity constraints.

3. Estimated Cohort Effects and Age Effects

3.1. *Data*

In this section, we estimate both the cohort effect and the age effect on the log consumption variance using equation (7). The data used in this section is the

microdata from the *National Survey on Family Income and Expenditure* (hereafter, NSFIE). While the survey has been conducted every five years since 1959 by the Statistical Bureau of the Japanese Government, we can only gain access to the 1979, 1984, and 1989 versions of NSFIE (Statistics Bureau, 1979, 1984, and 1989). The survey contains rich information concerning the income earned in the past one year and the expenditure made from September through November of each surveyed year.

We select a sample of households according to the following criteria: (i) households with two or more members, (ii) with heads engaged in non-agricultural sectors, (iii) with heads aged between 22 and 75, and (iv) without any missing data. The numbers of observations we use is 44,208 (1979), 42,368 (1984), and 49,487 (1989) respectively.

As for consumption data, we use both household consumption and per capita household consumption data; the latter data may control the effect of household sizes to some extent.[8] Consumption categories include total consumption, food consumption, and nondurable goods. In NSFIE, total consumption includes most items consumed in September, October, and November for each surveyed year. It, however, does not include either a large part of medical expenditures (which are usually covered by public medical insurance) or imputed rents. Although in principle it covers education expenditures, families tend to spend money on education just before or after a new academic year starts in April. Therefore, the data used in this study does not cover a major part of education expenditures. Food consumption includes not only food consumed at home, but also eaten out. Nondurable consumption is total consumption minus durable consumption. When utility is separable among different goods, equation (6) holds for any kind of consumption good.

We apply the same empirical equation to not only household consumption, but also annual income for two reasons. First, as discussed before, the comparison of the decomposition based on equation (6) between income and consumption inequality may provide some information on the possibility of liquidity constraints. Second, since Deaton and Paxson (1994) estimate the same model for income inequality in the U.S., the U.K., and Taiwan, we can make a cross-country comparison in terms of both income and consumption distribution.

Both the mean and variance of log-consumption and log-income for the same age group are calculated item by item for each year. Before reporting the estimation result, we take a quick look at both consumption and income inequality year by year. As Table 1 shows, the log-variance of both total expenditure and total income increased during the 1980s. Figure 1-1 depicts the age profile of the log-consumption variance year by year. The age profile is upward sloping, and the log-consumption variance for those aged under 50 increased in 1989. Figure 1-2 shows that the age profile is also upward sloping for the log-income variance. The slope of the age profile of income inequality, however, did not change substantially in 1989.

[8]An alternative adult equivalence scale is the consumption divided not by a family size, but by (a family size)$^{0.5}$ (see Ruggles, 1990). This scale considers economies of scales associated with larger household sizes. The estimation result discussed in Section 3.2, however, does not depend on whether economies of scales are taken into account.

TABLE 1

ECONOMY-WIDE INEQUALITY IN TERMS OF LOG-VARIANCE TOTAL EXPENDITURE AND INCOME IN JAPAN

	Expenditure	Income
1979	0.200	0.254
1984	0.210	0.268
1989	0.241	0.290

Source: The authors' calculation.

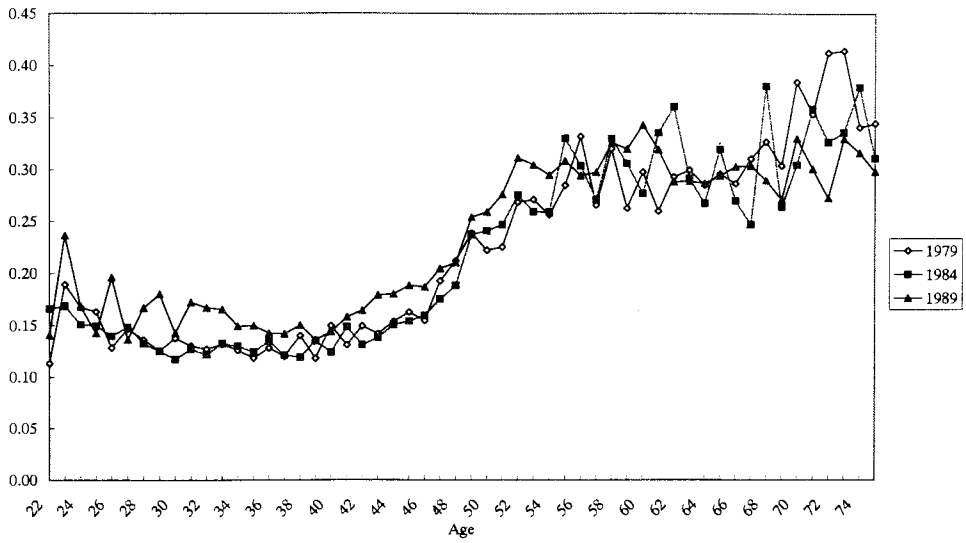

Figure 1-1. Log-Consumption Variance (Japan)

Source: The National Survey on Family Income and Expenditure

3.2. *Estimation Results*

3.2.1. Construction of Dummy Variables

Age dummies are constructed for those aged 22–75 according to the age of household heads.[9] We drop an age dummy variable for the age 22 group to avoid the multicollinearity among age dummies. Cohort dummies are defined by the 10-year age band; that is, those born in the 1900s, the 1910s, the 1920s, the 1930s, the 1940s, the 1950s, and the 1960s.[10] We again drop a cohort dummy variable for those born in the 1960s to avoid multicollinearity among cohort dummies.

[9]A household head is defined as a person who earns the highest income within a household. Thus, the defined household head may not include retired persons who live with their children who earn higher income than retired persons or young adults who live with their middle-aged parents who earn higher income than young adults.

[10]Deaton and Paxson (1994) construct a cohort dummy for the 5-year age band given more than 10 data points. On the other hand, we construct a cohort dummy for the 10-year age band since we have only three data points (1979, 1984, and 1989).

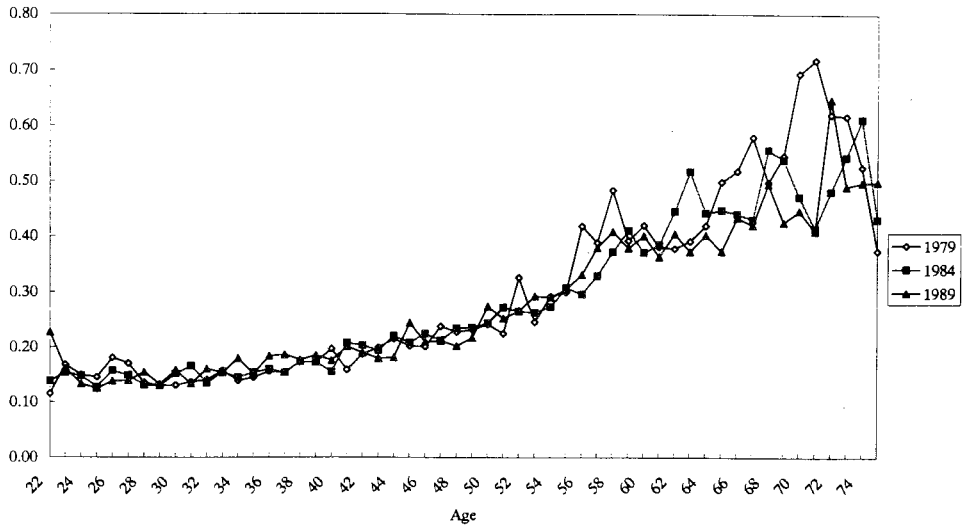

Figure 1-2. Log-Income Variance (Japan)

Source: The National Survey on Family Income and Expenditure

3.2.2. Cohort Effects

Table 2 reports the estimation result of the cohort effect or the estimated α_m of equation (7). Most cohort effects are statistically significant for total consumption. That is, consumption inequality is larger for young cohorts than for older cohorts. For example, the cohorts born in the 1960s faced a larger consumption inequality by 0.072 at the start of their life-cycle than those born in the 1910s did. As Table 2 shows, cohort effects are weaker for food consumption, while they are stronger for nondurable consumption. These results suggest that consumption inequality may be transmitted through intergenerational transfer, and that this tendency is reflected more in consumption of luxuries than in consumption of necessities.

Another interesting observation is that there is no significant cohort effect for the log-income variance. What can explain the difference in the cohort effect between the log-consumption variance and the log-income variance? We offer three explanations for this difference. First, within-cohort inequality of consumption may reflect the dispersion of life-time resources under the PIH, but within-cohort inequality of current income may not. According to this explanation, consumption inequality can measure welfare dispersion within a cohort more correctly than income inequality.

A second interpretation is that, while current income may be a good measure of welfare, the income used in this study may not be appropriate. One problem with our income measure is that it does not include either inter- or intra-family transfers, and it captures only partially capital gains on financial and real assets.[11]

[11]NSFIE reports transfers between households and governments (local and central), but it does not include transfers made within a family or directly among families such as inheritance and gifts.

TABLE 2

ESTIMATED COHORT EFFECTS IN JAPAN

(Relative to the cohort born in the 1960s, Standard errors in parentheses)

	Total Consumption	Food	Nondurable	Income
Cohort born in the 1900s	−0.021	0.051*	−0.079*	0.118*
	(0.023)	(0.015)	(0.024)	(0.044)
1910s	−0.072*	−0.008	−0.129*	0.022
	(0.020)	(0.013)	(0.021)	(0.039)
1920s	−0.067*	−0.030*	−0.117*	−0.010
	(0.018)	(0.012)	(0.019)	(0.035)
1930s	−0.050*	−0.033*	−0.087*	−0.013
	(0.016)	(0.011)	(0.017)	(0.030)
1940s	−0.036*	−0.037*	−0.064*	−0.015
	(0.013)	(0.009)	(0.014)	(0.025)
1950s	−0.021*	−0.017*	−0.038*	−0.001
	(0.010)	(0.007)	(0.010)	(0.019)

Source: The authors' estimation.

* Denotes significance at the 5 percent level.

If welfare inequality is caused by either capital gains, or inter- or intra-family transfers, our income measure cannot work correctly.

Third, the difference in cohort effects between consumption and income inequality may be interpreted as an indirect evidence of the separability of consumption and leisure in utility. If the choice of leisure (working hours) is separable from that of consumption (see footnote 4), the income inequality due to the within-cohort difference of working hours may have a negligible relation with the within-cohort consumption dispersion.

3.2.3. Age Effects

Figure 2-1 shows the estimation result of the age effect or the estimated β_n of equation (7). The estimated parameters are standardized at the level of the age of 25. Within-cohort inequality of total expenditure, food consumption, and nondurable consumption grows rapidly after the age of 40. This pattern is the clearest for nondurable consumption. On the other hand, the inequality of income increases steadily from early ages. The above finding is not the consequence of a growing variance of household sizes within a cohort. As Figure 2-2 shows, the result based on per capita household consumption does not differ from that based on household consumption.

What causes the difference in age effects between consumption and income inequality? One immediate consequence of this difference is that it provides some evidence against a simple version of liquidity constraints. As discussed in Section 2, if the PIH can approximate the household consumption behavior, then the age effect for consumption inequality only includes uninsured permanent shocks unexpected at the beginning of life, but the age effect for income inequality includes expected shocks as well as unexpected ones. According to this interpretation, the above difference in the age effect between consumption and income inequality

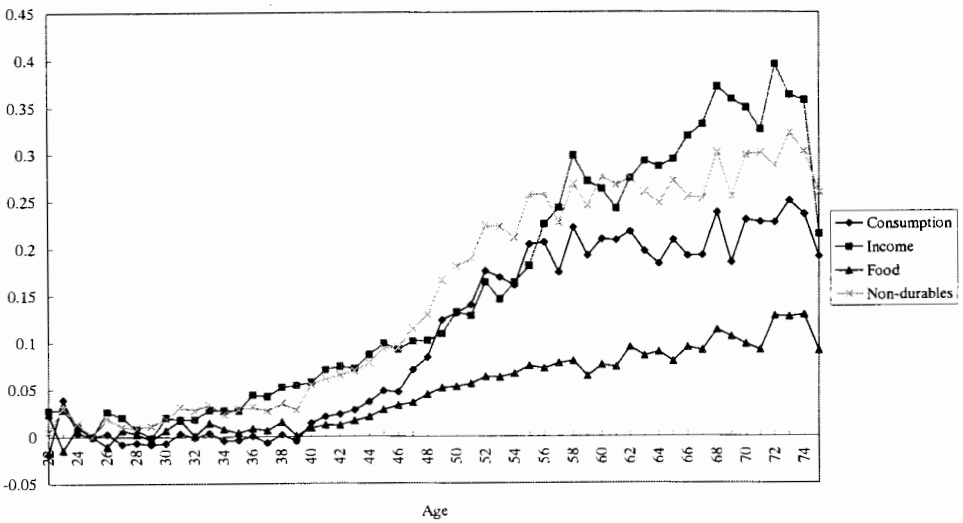

Figure 2-1. Age Effects on Log-Consumption Variance (Japan)
(25 years old = 0)

Source: The authors' estimation

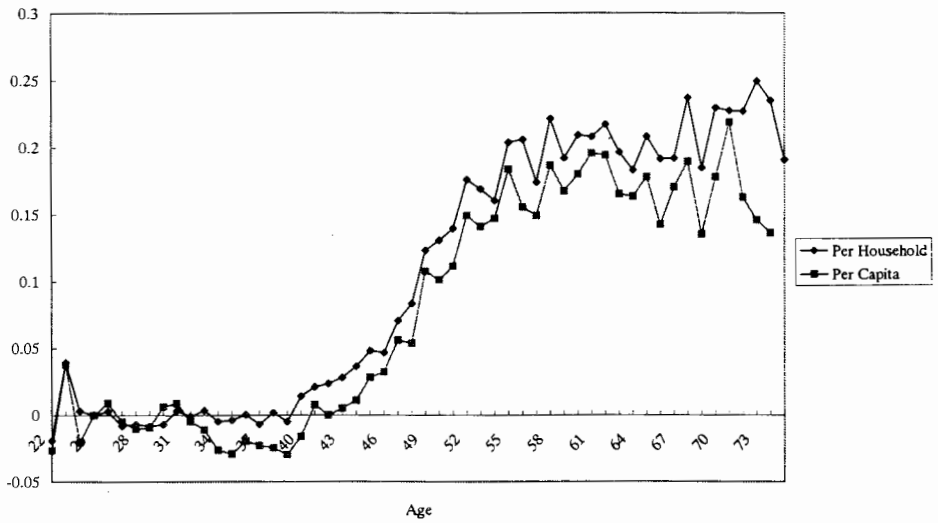

Figure 2-2. Age Effects on Log-Consumption Variance (Japan)
(25 years old = 0)

Source: The authors' estimation

indicates that Japanese households face large unexpected permanent shocks after the age of 40.

Then, why do Japanese households start to face such large shocks after the age of 40? We can offer a few explanations. First, as discussed in Koike (1988), Japanese firms usually announce layoffs of workers over the age of 40 in the face of temporary reductions in sales or production. According to Ohtake (1997),

displacement rates (displaced workers per 100 employees) increase dramatically after the age of 40 in Japan (Table 3).[12] Since such layoffs do not necessarily accompany any recall, they often contribute to permanent negative shocks on labor income for those aged 40 or over.

TABLE 3

DISPLACEMENT RATES BY AGE IN JAPAN
(Displaced Workers per 100 Employees)

Age	1981–82	1986–87
20–24	0.41	0.67
25–29	0.40	0.80
30–34	0.44	0.63
35–39	0.48	0.81
40–44	0.56	0.94
45–49	0.73	1.17
50–54	0.93	1.69
55–59	1.00	1.70
60–64	1.52	1.57
65+	1.31	1.08
Average	0.63	1.04

Source: Ohtake (1997), based on the 1982 and 1987 Employment Status Survey.

Note: Displaced workers refer to persons with tenure of 3 years or more who lost or left their job between October 1981 and October 1982, and October 1986 and October 1987 because of personnel curtailment, liquidation or bankruptcy.

Another possibility is that the promotion pattern in Japanese firms may be responsible for the age pattern in consumption inequality. According to Koike (1988) and others, it is after the mid-thirties that the promotion speed differs substantially among workers in most Japanese corporations. There is, however, a gradual increase in wage differences among them even before that age. The above-mentioned rapid increase in consumption inequality after the age of 40 may reflect the fact that workers have clearer expectations of future wages and measure life-time resources more accurately around the age of 40. One warning of this interpretation is, however, that more recent empirical research, in particular Tachibanaki *et al.* (1997a), indicates that the promotion speed differs even before the mid-thirties.

Finally, the effect of inheritance may explain the discrepancy in age profiles between consumption and income inequality. Inheritance from parents to children can be decomposed into a part expected at birth and an unexpected one. The former part can be captured by the cohort effect, while the latter by the age effect. Since the amount of gifts from parents to children is usually finalized when children are 40 years old or over, such realization of inheritance may contribute to an additional increase in within-cohort inequality after the age of 40. More concretely, the market value of land, which is the most typical form of inheritance

[12]Ohtake (1997) follows Gardner's (1993) definition of displaced workers. That is, displaced workers refers to persons with tenure of 3 years or more who lost or left their job due to personnel curtailment, liquidation or bankruptcy.

in Japan (Barthold and Ito, 1992; Ohtake, 1991), is volatile and geographically heterogeneous. Such surprises in the land valuation may be a major source of realized variation of inheritance.

4. Comparison Among Japan, Taiwan, the U.S., and the U.K.

In this section, we compare the age effects obtained in the previous section with those of the U.S., the U.K., and Taiwan, all of which are estimated by Deaton and Paxson (1994).[13] We compare the results based on household levels.

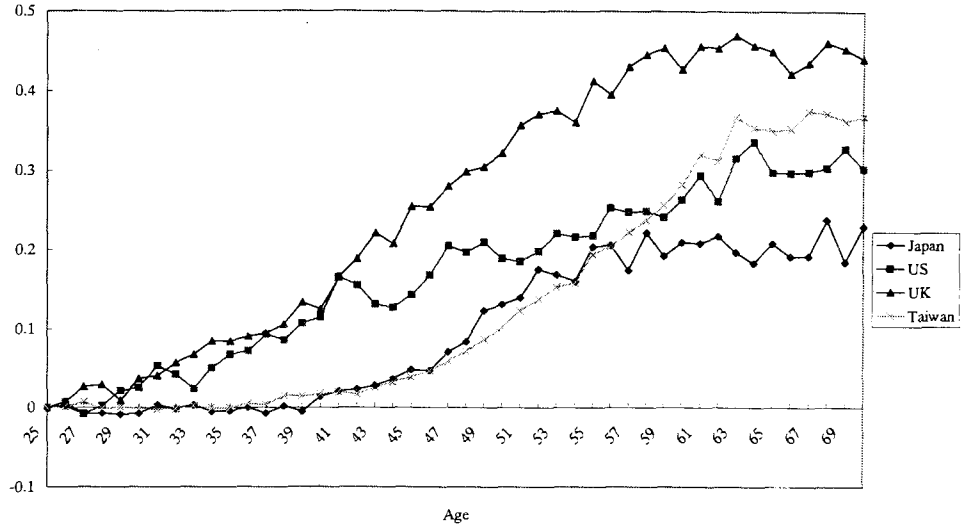

Figure 3-1. Age Effects on Consumption Variance: International Comparison

Source: Deaton and Paxson (1994) for U.S., U.K., and Taiwan, and the authors' estimation for Japan.

Figure 3-1 depicts the age effects on consumption inequality for four countries (standardized by the level at age 25). In the U.S. and the U.K., consumption inequality increases from the early stage of the life-cycle. In Japan and Taiwan, on the other hand, consumption inequality increases rapidly after the age of 40 and reaches almost the same level as in the U.S. in the late fifties. One unique feature of the Japanese age-inequality-profile is that consumption inequality does not increase after the late fifties. Among the other three countries, consumption inequality continues to increase after the age of 55, in particular in Taiwan.

Next, we compare the difference of the age-inequality-profile between income and consumption country by country (Figures 3-2, 4-1, 4-2, 4-3, and 4-4). In the

[13]It is well known that international comparisons of distributions are difficult because of cross-country differences in practices of data collection and definitions of variables. In particular, the comparison of absolute levels of distributions is often subject to such a problem. The investigation in this paper, however, is not concerned with the comparison of absolute levels, but with that of changes in distributions caused by aging and birth dates (age and cohort effects). Due to our interest in relative changes in distributions, the international comparison in this paper may be less subject to the above potential problem.

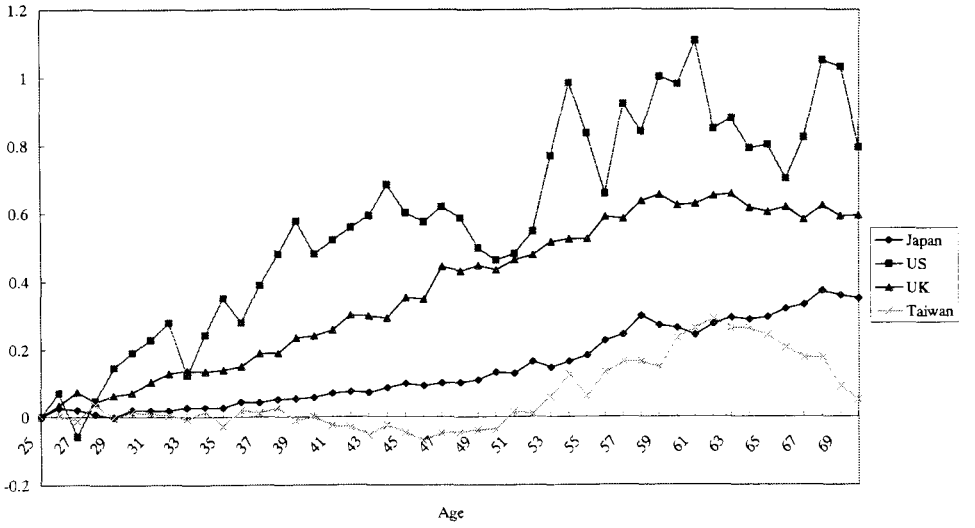

Figure 3-2. Age Effects on Income Variance: International Comparison

Source: Deaton and Paxson (1994) for U.S., U.K., and Taiwan, and the authors' estimation for Japan.

U.S. and the U.K., income inequality grows with age much faster than consumption inequality. In Taiwan, consumption and income inequality move in opposite directions. In Japan, both income and consumption inequality increase with age at a similar average speed.

In order to quantify the above observations, we estimate the following linear model for the age effect on both income and consumption inequality for each

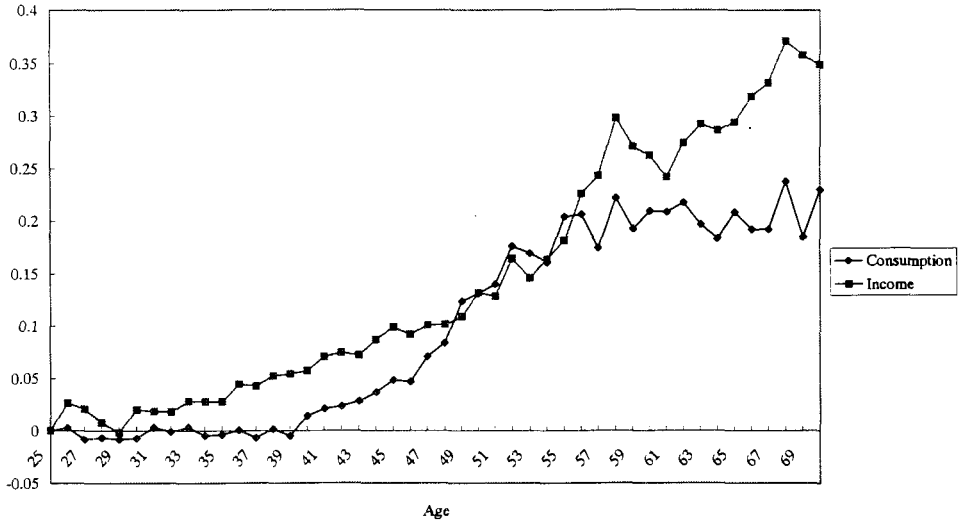

Figure 4-1. Consumption and Income Variance: Japan

Source: The authors' estimation

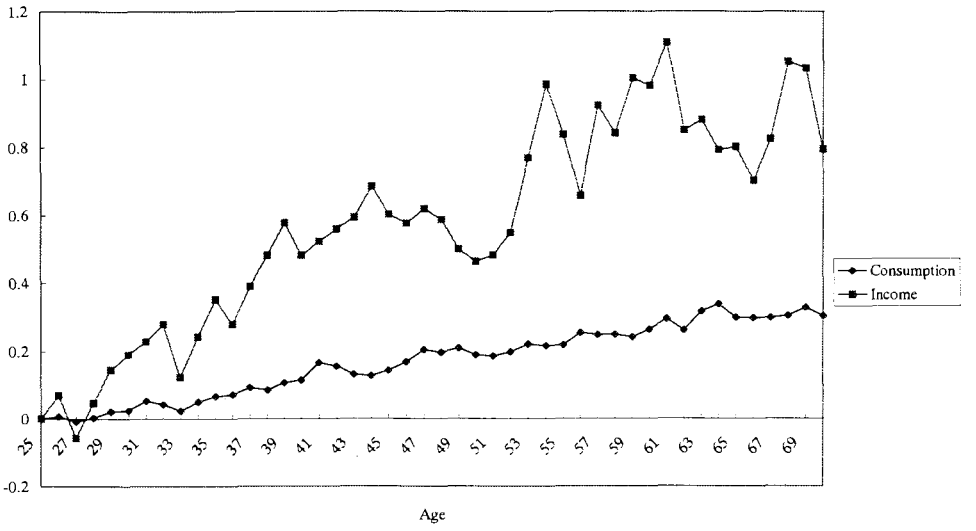

Figure 4-2. Consumption and Income Variance: The U.S.
Source: Deaton and Paxson (1994)

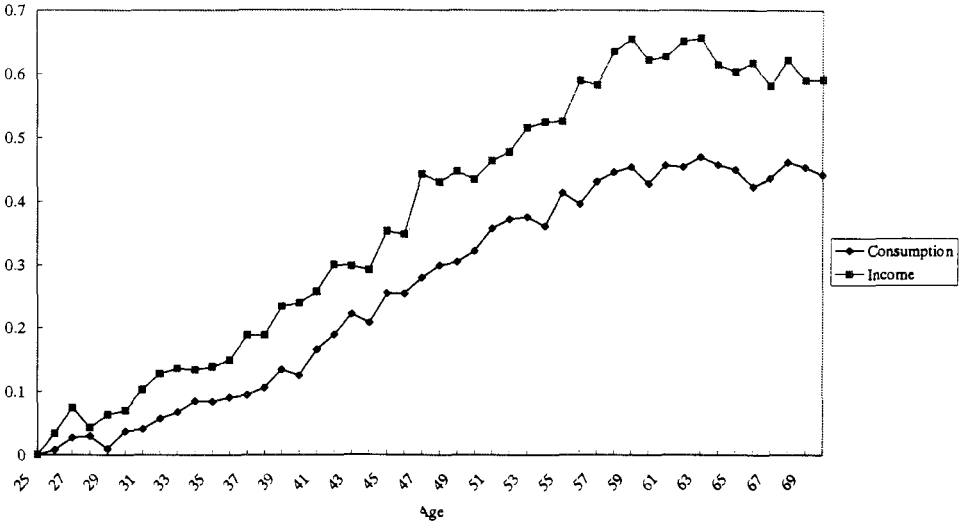

Figure 4-3. Consumption and Income Variance: The U.K.
Source: Deaton and Paxson (1994)

country:

(8) $$\beta_n = a + bn$$

where β_n is the age effect on the log consumption (income) variance for age n estimated in equation (7). The parameter b indicates an average annual change in the age effect. The estimated coefficient b is reported in Table 4. The estimation result confirms that income inequality grows faster than consumption inequality

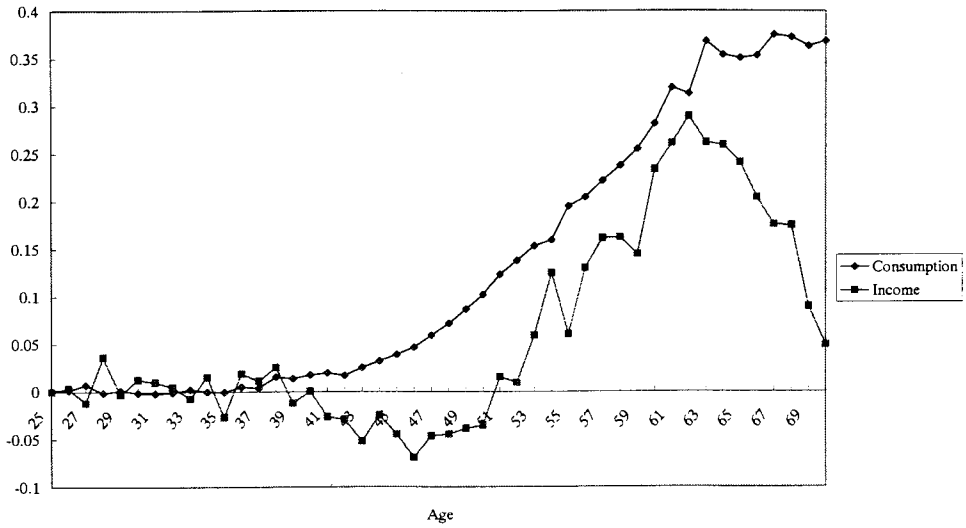

Figure 4-4. Consumption and Income Variance: Taiwan
Source: Deaton and Paxson (1994)

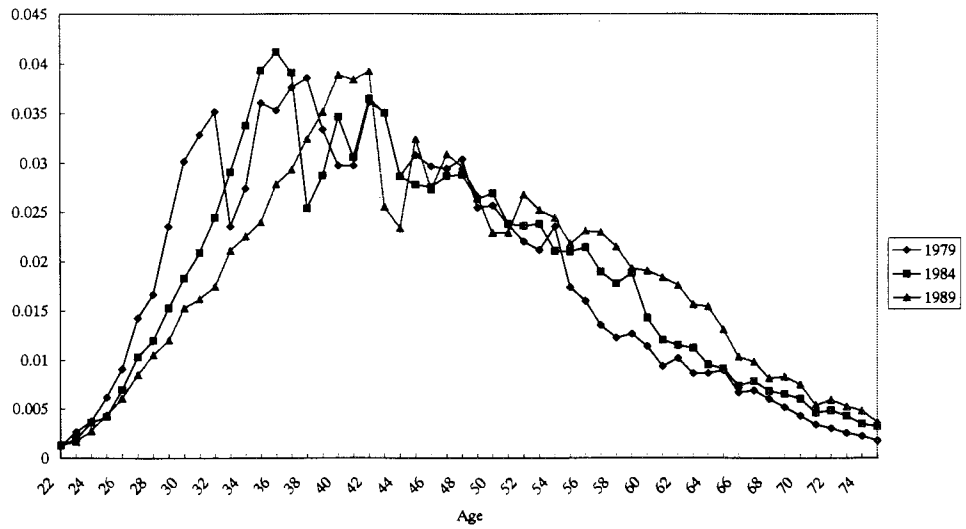

Figure 5. Population Share by Age in Japan
Source: The National Survey on Family Income and Expenditure

in the U.S. and the U.K., while both consumption and income inequality grow at a similar average speed in Japan.

What causes the difference in the age pattern of income and consumption inequality among these countries? As discussed before, under the PIH, the age effect of income inequality captures both idiosyncratic shocks and expected components, but the age effect of consumption inequality is caused only by

TABLE 4

ESTIMATED COEFFICIENTS ON AGE EFFECTS IN LINEAR APPROXIMATION
(Standard errors in parentheses)

	Consumption	Income
Japan	0.0053	0.0083
	(0.0006)	(0.0007)
U.S.	0.0069	0.0208
	(0.0002)	(0.0012)
U.K.	0.0102	0.0136
	(0.0004)	(0.0005)
Taiwan	0.0084	0.0027
	(0.0004)	(0.0008)

Source: Deaton and Paxson (1994) for U.S., U.K., and Taiwan, and the authors' estimation for Japan.

idiosyncratic shocks. Therefore, there are two possibilities to explain the cross-country differences. First, they may depend on how much idiosyncratic shocks are insured on the markets. According to this interpretation, income inequality is much larger than consumption inequality in both the U.S. and the U.K. because idiosyncratic shocks hitting individual income are insured to a large extent. In both Japan and Taiwan, however, financial markets are more regulated than in the U.S. and the U.K., and therefore a good insurance contract may be less available in markets.[14] Such malfunctioning insurance markets may not cause a large difference between income and consumption inequality.[15]

Second, unlike the first interpretation, the cross-country differences may not be due to uninsured parts of income processes, but due to parts expected at the beginning of life. The cross-sectional income dispersion may be caused by expected components more substantially in the U.S. and the U.K. than in Japan and Taiwan. For example, in the former countries, fixed characteristics when agents enter job markets, such as education or family backgrounds, may be more responsible for the determination of wage profiles than good or bad luck after their market entry. For example, a large part of the wage variation among workers can be explained by education levels in the U.S. and by occupational choice in the U.K. Both education backgrounds and occupational choice are likely to be determined prior to the entry of job markets. On the other hand, the length of tenure is largely responsible for the cross-sectional wage variation in Japan. Contrary to education or occupational choice, the length of tenure (how long they work at a particular job) is likely to be uncertain at the market entry.[16]

[14]Goldsmith (1985) documents that insurance markets are less dependable in Japan than in both the U.S. and the U.K. One main reason for the poor performance of insurance markets in Japan is that the public regulation and protection for the insurance industry make markets less competitive; consequently, it is rather difficult for consumers to purchase good insurance contracts in markets.

[15]As for Taiwan, there is a possibility of under-reporting of income in the survey. If unreported income differs among workers more substantially than reported income, and if consumption is financed from unreported income, consumption inequality would be greater than income inequality.

[16]Tachibanaki (1997b) carefully compares the labor market condition among the U.S., the U.K., and Japan.

There is an alternative interpretation in particular for the Japanese age-inequality-profile. In Japan, income risk may be shared between firms and workers, and the fluctuation in compensation paid to workers may be, accordingly, reduced to some extent. In other words, idiosyncratic shocks are pooled not only in insurance markets, but also by risk sharing between firms and workers. Itoh (1994) shows that a high level of risk-sharing via wage contracts is attained in Japanese firms because they can monitor workers' efforts relatively well. This interpretation can explain why income and consumption inequality grow at a similar average speed. It is also consistent with the fact that the level of income variance in Japan is about half of those in the U.S. and the U.K., while the level of the consumption variance is similar among these countries.

Finally, we point out that the cross-country difference in age profiles of consumption inequality may reflect that of employment practices. As discussed in the previous section, the rapid increase in consumption inequality after the age of 40 in Japan is possibly caused by the dramatic increase in displacement rates after the same age. According to a survey on the recent empirical literature on displaced workers by Fallick (1996), there are not large differences in displacement rates among different age groups in the U.S. *The Employment Gazette* published by the U.K. Department for Education and Employment indicates that there is no large disparity in displacement rates by age in the U.K. either. The above contrast between Japan and these two countries may explain the smooth rather than abrupt increase in consumption inequality in the latter two countries.[17,18]

5. Population Aging and Consumption Inequality

The rapid increase in within-cohort consumption inequality after the age of 40 has important implications on economy-wide consumption inequality or consumption-distribution as a whole. In particular, the effect of the rapid aging due to the baby boomers reaching the age of 40 or over was significant during the 1980s. According to Ohtake (1994), the NSFIE used in this study records the progress of population aging during the 1980s. As Figure 5 depicts, the share of households with heads aged between twenty and forty decreased, while that of households with heads over the age of 50 increased drastically from 1979 to 1989. During the same period, the economy-wide consumption inequality (measured in terms of log-variance) grew from 0.2002 (1979) to 0.2412 (1989), an increase of 0.0412 or 20 percent.

In this section, we quantify how much population aging contributed to such an increase in consumption inequality during the 1980s.[19] To this purpose, we

[17]Ohtake (1997) uses the same definition of displacement rates as Gardner (1993) does. As mentioned before, the former study finds a clear difference in displacement rates by age (see Table 3), but the latter does not.

[18]There are a few hypotheses offered to explain the difference in the age pattern of displacement rates between the U.S. and Japan. For example, according to Genda (1995), plant closing is often responsible for job destruction in the U.S. and it affects workers uniformly across ages. In Japan, on the other hand, job reduction is usually caused by a reduction in plant sizes, and is born mainly by layoffs of middle-aged or old workers.

[19]Our empirical investigation is related to Teruyama and Ito (1996). Using a simulation study, they show that even if there is no change in the distribution of life-time income within a fixed cohort, population aging may seemingly raise the economy-wide inequality of consumption.

decompose the change in consumption inequality into three factors: demographic effects (or effects of population aging), cohort effects, and between-age effects.[20] To carry out this decomposition, we collect the following 1979 and 1989 data: (a) the population share by age ($s_t = \{s_{tj}\}_{j=22}^{75}$), (b) the estimated within-age variance based on equation (7) ($\sigma_t = \{\sigma_{tj}\}_{j=22}^{75}$), and (c) the average of log-consumption within the same age group ($C_t = \{C_{tj}\}_{j=22}^{75}$)) where t (=1979 or 1989) denotes a point of time and j the age. Notice that the difference between the estimated σ_{1979} and σ_{1989} is due to the cohort effect.

The log-consumption variance can be decomposed as follows:

$$(9) \qquad Var \ln c_{it} = V(s_t, \sigma_t, C_t) = \sum_{j=22}^{75} s_{tj}\sigma_{tj}^2 + \sigma_{bt}^2,$$

where $\sigma_{bt}^2 = \sum_{j=22}^{75} s_{tj} C_{tj}^2 - (\sum_{j=22}^{75} s_{tj} C_{tj})^2$. Hereafter, the first term of the right-hand side of equation (9) is called the within-cohort variance, and the second term the between-age variance.

The demographic effect is defined as a change in economy-wide consumption inequality which would prevail if the population share (s_t) were changed from 1979 to 1989, but both σ_t and C_t were fixed at the 1979 level

$$(10) \qquad \text{Demographic Effect} = V(s_{1989}, \sigma_{1979}, C_{1979}) - V(s_{1979}, \sigma_{1979}, C_{1979}).$$

This measure quantifies how much population aging contributed to the increase in consumption inequality during the 1980s.

Similarly, the cohort effect is measured by changing σ_t or the estimated within-cohort variance and fixing both s_t and C_t at the 1979 level

$$(11) \qquad \text{Cohort Effect} = V(s_{1979}, \sigma_{1989}, C_{1979}) - V(s_{1979}, \sigma_{1979}, C_{1979}).$$

This measure captures how much consumption inequality was raised by the increasing within-cohort variance for younger generations (see Section 3.2).

Finally, the between-age effect is computed by changing C_t or the average of log-consumption within the same age group and fixing both s_t and σ_t at the 1979 level

$$(12) \qquad \text{Between-Age Effect} = V(s_{1979}, \sigma_{1979}, C_{1989}) - V(s_{1979}, \sigma_{1979}, C_{1979}).$$

This measures how much consumption inequality was affected by a change in the difference in average consumption among different age groups.

Table 5 summarizes the result of the above decomposition. For the increase in consumption inequality by 0.0412 during the 1980s, about half (0.0209) was caused by population aging, while about one-third (0.0136) was due to the increasing cohort effect. On the other hand, the between-age effect (0.0042) was not as strong as the other two effects. The unexplained part (0.0025 = 0.0412-0.0209-0.0136-0.0042) includes the estimation error of equation (7) and the cross effects among the above three effects. To sum up, the aging population structure and the increasing cohort effect are jointly responsible for the increase in consumption inequality during the 1980s.[21]

[20] von Weizsächer (1996) develops a similar decomposition.

[21] Referring to the labor market conditions, Tachibanaki (1996) discusses several sources of the recent increase in income inequality of Japan.

TABLE 5

SOURCES OF INCREASE IN ECONOMY-WIDE CONSUMPTION INEQUALITY IN JAPAN: 1979–89

Actual Change in Consumption Inequality	Demographic Effects*	Between-Age Effects**	Cohort Effects***	Unexplained parts
0.0412	0.0209 (51%)	0.0042 (10%)	0.0136 (33%)	0.025 (6%)

The number in parentheses denotes the contribution of each effect to the increase in economy-wide inequality.

*The demographic effect on consumption inequality is measured by the change in variance due to changes in the population structure between 1979 and 1989, holding the other effects constant.

**The between-age effect is measured by the change in variance due to the change in the average log-consumption within each age group between 1979 and 1989, holding the other effects constant.

***The cohort effect is measured by the change in variance due to the change in the within-cohort variance between 1979 and 1989, holding the other effects constant.

6. CONCLUSION

In this paper, we have investigated which factors were reflected in the rapid increase in consumption inequality during the 1980s in Japan. The major findings are summarized as follows. First, within-cohort consumption inequality starts to increase at the age of 40. This feature made economy-wide consumption distribution more uneven in the 1980s because the baby-boomers who were born in the 1940s reached the age of 40 or over during the same decade. Second, younger generations face a higher consumption inequality from the start of their life-cycle. This finding suggests that within-cohort inequality may be transmitted from older generations to younger generations through inter-generational transfers. As demonstrated in Section 5, the rapid increase in the economy-wide consumption inequality during the 1980s was caused by both population aging and the increasing cohort effect.

In addition, we have compared the above findings with those for the U.S. and the U.K., both of which are reported in Deaton and Paxson (1994). An eminent difference between Japan and the two countries is that consumption inequality increases from the early stage of the life-cycle in the latter countries. Another important difference is that income inequality increases with age much faster than consumption inequality in both the U.S. and the U.K. In Section 4, we proposed several factors which may generate such cross-country differences in the within-cohort distribution.

What are the policy implications of the increase in the overall consumption inequality during the 1980s? Does the increase in inequality justify intensifying income redistribution by introducing new taxes or social insurance? How to answer these questions may depend partly on which factors cause population aging. When a decrease in fertility rates is responsible for population aging, the increase in aggregate inequality caused by aging does not imply a deterioration of life-time welfare from the individuals' point of view. In this case, a redistribution system does not have to be introduced. On the other hand, when a decrease in mortality rates promotes population aging, implementing a new redistribution system may be desirable to reduce the additional uncertainty due to longer life expectancy. The increase in the aggregate inequality caused by the increasing

cohort effect has different implications. Strengthening the redistribution system and raising inheritance taxes, may enable the economy to avoid further increases in inequality.

As a final remark, we emphasize that the observed within-cohort inequality of consumption is different from that of income in terms of statistical features. As discussed in Section 3, significant cohort effects are found in consumption inequality, but not in income inequality. Since the measure of consumption inequality used in this study has a well-defined theoretical content (Section 2), more serious attention should be paid to the empirical results obtained from consumption inequality.

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