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Intergenerational Mobility of Earnings and Income in Japan

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Abstract

This study estimates the intergenerational mobility of economic status in Japan from the perspective of international comparison. The intergenerational elasticity of earnings and income of offspring with respect to parental income is estimated using microdata from the 1993–2004 rounds of the *Japanese Panel Survey of Consumers*. The result of instrumental variables estimation suggests intergenerational elasticity of 0.4 or less for married sons, and around 0.3 for daughters. A downward time trend of elasticity is also found. Quantile regression does not suggest a relation between elasticity and the earnings achievement of offspring conditioned on parental income. Nonlinear analysis of the relation between parental log income and log earnings of offspring suggests an S-shaped relation for married sons and single daughters and suggests a linear relation for married daughters.

JEL classification: D31, J62

Keywords: earnings mobility, intergenerational earnings elasticity, intergenerational mobility

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1 Introduction

Increasingly numerous studies investigate the degree of intergenerational transmission of economic status from parents to their offspring. According to the seminal work by Solon (1992) and Zimmerman (1992), the intergenerational elasticity of a son's earnings with respect to a father's earnings is estimated as the order of 0.4 for the United States. They remark that the estimate is greater than twice those found in previous studies when correcting measurement error in single-year economic status.

Research across countries was surveyed by Solon (2002). Many papers were subsequently reviewed by Corak (2004). Estimated results from international studies indicate that intergenerational mobility in some societies is likely to be less than in others: less mobile countries, with elasticity of 0.4–0.6, include the United States, Britain (Dearden, Machin and Reed, 1997), Italy (Mocetti, 2007; Piraino, 2007), and Brazil (Dunn, 2007); others, with elasticity of 0.3 or less, include Canada (Corak and Heisz, 1999), Scandinavian countries (Björklund and Jäntti, 1997; Bratberg, Nilsen, and Vaage, 2005; Bratsberg, Røed, Raaum, Naylor, Jäntti, Eriksson, and Österbacka, 2007), Australia (Leigh, 2007), and Singapore (Ng, 2007).

This paper presents an investigation of intergenerational mobility of economic status in Japan. For international comparison, this study mainly follows empirical methods used in previous studies. The analyses use data from the 1993–2004 rounds of the *Japanese Panel Survey of Consumers*, which tracks data of women born during 1959–1979 with information about family members. The estimated elasticity is that of earnings and income of offspring with respect to parental income. For married daughters, family earnings and income are considered. The results suggest that the elasticity is 0.4 or less for married sons, 0.2–0.3 for single daughters, and around 0.3 for married daughters from instrumental variables estimates. The estimate seems to be lower than those from less mobile countries such as the US and Britain, but slightly higher than others such as Scandinavian countries.

This paper also addresses issues related to intergenerational mobility. First, the time trend of the mobility in Japan is examined. Using US data, Fertig (2003) finds an increase in the mobility but only for son-father pairs, Lee and Solon (2006) find no major changes, and Aaronson and Mazumder (2007) find that the mobility increased during 1950–1980 and declined thereafter. Regarding other countries, Blanden, Goodman, Gregg, and Machin (2004) find that mobility has declined in Britain, while Bratberg et al. (2005) find no time trend for Norway. Results of the present study show that mobility increases both for sons and daughters in Japan.

Secondly, differences in mobility between low-achieving and high-achieving offspring are often investigated using quantile regression. Eide and Showalter (1999), Fertig (2003), and Grawe (2004b) find that the mobility in upper quantiles is apparently higher than in lower quantiles in the US or Canada, which implies that low-achieving offspring are influenced by parental economic status more than high-achieving offspring. In contrast, Grawe (2004b) finds that this is notably not the case in either Germany or the UK. For Japan, quantile regression does not indicate a particular relation between mobility and earnings achievement of offspring.

Finally, nonlinearity in terms of parental income is investigated. Corak and Heisz (1999) and Bratsberg et al. (2007) find an S-shaped relation of log earnings, respectively, between parents and offspring in Canada and Norway. Bratberg et al. (2005) find a convex relation with low elasticity for low-income fathers and increasing elasticity for middle-income and high-income fathers in Nordic countries, but find a linear relation in the US and Britain. For Japan, the S-shaped relation is apparently applicable to married sons and single daughters; a linear relation is apparent for married daughters.

The remainder of this paper is arranged as follows. Section 2 describes the analytical framework applied in previous studies reported in the relevant literature. Section 3 explains the source data, variables, and empirical specifications. Section 4 presents estimates of intergenerational elasticity in Japan. Section 5 describes an examination of the time trend of mobility. Section 6 examines differences in the mobility among individuals using quantile regression and nonlinear regression. Section 7 summarizes the salient conclusions of this study.

2 Framework of Empirical Analysis

Recent studies estimating intergenerational mobility are based mostly on the empirical framework proposed by Solon (1992) as follows. Let y_i and z_i respectively denote lifetime economic status of offspring and her parent for an intergenerational pair of i. The relation of intergenerational economic status is expressed as

$$y_i = a_0 + \rho z_i + \epsilon_i, \tag{1}$$

where a_0 is a constant, and ϵ_i is an error term. Economic status is normally represented by earnings, income, or consumption. With application of the logarithm of earnings to $\{y_i, z_i\}$, ρ indicates the elasticity of offspring's earnings with respect to parental earnings. However, the lifetime economic status is not usually observable for statisticians. In practice, it is often measured by short-time economic status $\{y_{it}, z_{it}\}$ for the pair i at time t such as annual earnings. The annual earnings shift with age (experience) over time; they fluctuate because of various business and personal conditions at time t. Therefore, the short-time economic status of the offspring is expressed as

$$y_{it} = y_i + a_1 g_{it} + a_2 g_{it}^2 + u_{it}, \tag{2}$$

where g_{it} is the age of the offspring i at time t, a_1 and a_2 are coefficients, and u_{it} is an error term. The short-term economic status of the parent is expressed similarly as

$$z_{it} = z_i + b_1 h_{it} + b_2 h_{it}^2 + v_{it}, \tag{3}$$

where h_{it} is the age of the parent i at time t, b_1 and b_2 are coefficients, and v_{it} is an error term. With substitution of eqs. (2) and (3) into eq. (1), the short-term economic status of the offspring is expressed as

$$\begin{aligned} y_{it} &= a_0 + \rho z_{it} + a_1 g_{it} + a_2 g_{it}^2 - \rho b_1 h_{it} - \rho b_2 h_{it}^2 + (\epsilon_i + u_{it} - \rho v_{it}) \\ &\equiv a_0 + \rho z_{it} + a_1 g_{it} + a_2 g_{it}^2 + \widetilde{b_1} h_{it} + \widetilde{b_2} h_{it}^2 + \widetilde{\epsilon_i}. \end{aligned} \tag{4}$$

In estimating eq. (4), the OLS estimate of ρ is downward biased subject to measurement error because of the correlation between z_{it} and $\widetilde{\epsilon_i}$. For this reason, Solon proposes two approaches. One approach is to apply a several-period average to z_{it}. The estimate of ρ is still downward biased, but the bias can be reduced. Another approach is to apply instrumental variables (IV) such as education or social status of the parent. In this case, the estimate of ρ may be upward biased when parental education (or social status) is positively correlated with ϵ_i[1]; for example, innate ability is inherited, or better-educated parents provide better environment to develop earning-ability of their offspring. Therefore, it is considered that an estimate from the former approach is a lower bound, and that an estimate from the latter is an upper bound.

3 Data

3.1 Sample used for the analysis

The analysis uses microdata obtained from 1993–2004 rounds of the *Japanese Panel Survey of Consumers* (JPSC). The JPSC traces 1500 women at initial ages of 24–34 from 1993, adding 500 women at the initial ages of 24–27 from 1997, and 836 women at the initial ages of 24–29 from 2003. Eventually, the data include 2836 woman respondents born during 1959–1979.

The JPSC includes information of household members as well as information related to the respondent's parents and her husband's parents. Using the data, intergenerational pairs of three types are examined: pairs of a married son (husband of respondent) and his parents, pairs of a single (never-married[2]) daughter and her parents, and pairs of a married daughter and her parents. Daughters are analyzed separately according to their marital status. One reason is that, as described by Chadwick and Solon (2002), earnings of daughters do not necessarily represent economic status because women's labor force participation rates are much lower than men's. It is especially true in Japan: almost half of married women do not

[1] Mazumder (2005) argues that IV estimates might be consistent or even downward-biased compared to OLS estimates using the 15-year average of z_{it}.

[2] Divorced and widowed daughters are excluded because it is difficult to define their economic status, especially for single mothers: some decide to live with their parents again, some receive assistance from parents including material support, some acquire assets when divorced or widowed, although others do not. An analysis addressing lifetime economic status including the change of marital status is therefore left as a subject for future analysis.

participate in the labor market in the JPSC. The remainder often choose low-paying part-time employment as labor market work. Married men and single women are mostly engaged in full-time labor market work.

The final sample includes 1114 married sons, 906 single daughters, and 1390 married daughters. Daughters who got married during survey rounds are included in both the single-daughter sample and the married-daughter sample. Offspring without parental information[3] are excluded.

3.2 Variables

Short-time economic statuses of sons and daughters are represented by annual earnings and income[4]. Earnings represent the total of salary income and earnings from self-employment before taxes. Income includes financial income, social security benefit, and other income such as remittances, as well as earnings. Regarding married daughters, both the husband's and the couple's earnings and income are considered.

Earnings and income are retrieved from the latest round for each observation because those measured at early ages might result in underestimation of the elasticity, as argued by Solon (2002). If positive earnings and income[5] are not observed at the latest survey round, they are retracted to the last round when they are observed to minimize attrition bias. Earnings and income of offspring are treated as unobserved when they are at school. Regarding single daughters, for example, earnings might be retrieved from the latest round, the last round during which positive earnings and income are observed, or the round immediately before marriage.

A disadvantage of the use of the JPSC is that respondents reported parental income as

[3] Parental income and job information of the father are not solicited as responses when he is not alive (or when the respondent does not know whether he is alive). In fact, 9% of women and 18% of husbands have already lost fathers at an initial round of each cohort. The response ratio of parental income exceeds 96% if the father is alive.

[4] Earnings and income are in the nominal term. Price levels were extremely stable during the surveyed periods: the CPI (100.0 in 2005) was 100.2–103.3 during 1993–2004 (Statistics Bureau, Ministry of Internal Affairs and Communications of Japan).

[5] Minicozzi (2003) presents the argument that exclusion of unemployed sons downwardly biases the estimate. However, the data include only a few married men without annual earnings.

within one of seven listed ranges, and are surveyed only every two years. In addition, fathers' ages are close to the prevailing retirement age of 60 in Japan. For this reason, this study uses single-year parental income in the earliest round for each observation.

For comparison, a subsample of single daughters living with parents is examined using actually observed parental income. Observed parental income is the response given to the question of "earnings and income of family members other than the respondent and her husband." However, this question is responded to only when parents live with the respondent at the time of the survey. Furthermore, parental income cannot be identified when other co-resident family members, such as grandparents or siblings, receive income. The observed parental income is therefore retrieved only for some single daughters living with parents[6].

The father's age is applied to the age of the parent h_{it} because fathers in this generation are typically the main income earners of the household, whereas mothers are typically homemakers or engaged in low-paying part-time jobs even when employed.

Table 1 reports sample characteristics. The average age is around 36 for married sons and husbands of married daughters, and around 28 for single daughters. The average earnings of husbands are nearly twice the earnings of single daughters. The average age of fathers is around 60 for married sons, and 56–57 for daughters. The sample includes retired parents of nearly 30% for married men, nearly 20% for married daughters, and 11% for single daughters.

3.3 Empirical Specifications

Considering the possibility of retirement of the father at the time of measurement, parental income eq. (3) is modified as

$$\begin{aligned} z_{it} &= z_i + (1 - Dr_{it})(b_1 h_{it} + b_2 h_{it}^2 + b_3 Dw_{it}) + b_4 Dr_{it} + v_{it} \\ &\equiv z_i + x_{it} b + v_{it}, \end{aligned} \tag{5}$$

where Dr_{it} is a dummy variable indicating a non-working father of age 60 or older, and Dw_{it} is a dummy variable indicating a working father of age 60 or older. Furthermore, Dr_{it}

[6] Some married offspring also live with parents, but the number of observations is insufficient because some couples live with the husband's parents, whereas others live with the wife's parents.

captures the old-age pension income in direct relation to earnings before retirement, and Dw_{it} captures the "re-employment" for those wishing to remain employed after retirement with shorter working hours or demotion with lowered payment. For simplified notation, x_{it} denotes a vector of age-related variables, and b is a coefficient vector. As an alternative investigation, a subsample with working fathers and another subsample with fathers of age 59 or younger are examined.

One important difficulty is that z_{it} is observed only by income group, except for parents residing with a single daughter. For this reason, this paper applies procedures in Dearden et al. (1997). The first approach is OLS estimation using the midpoints of grouped parental income as z_{it}[7] to estimate

$$y_{it} = a_0 + \rho z_{it} + a_1 g_{it} + a_2 g_{it}^2 + x_{it}\widetilde{b} + \widetilde{\epsilon}_i, \tag{6}$$

where $\widetilde{b} = -\rho b$. For the subsample of single daughters living with parents, the observed parental income is applied instead of midpoints[8].

A second approach is another OLS estimation using the predicted parental income. Assuming that z_i can be predicted using a vector of father's characteristics q_i, z_i is given as $q_i\alpha$, where α is a vector of the coefficient. Then, eq. (5) is rewritten as

$$z_{it} = q_i\alpha + x_{it}b + v_{it}. \tag{7}$$

When z_{it} is observed, α is estimated by OLS using eq. (7). When z_{it} is observed only as income groups, the following model is estimated using interval censored regression (which is

[7] 16.25 million yen is applied for the highest income group of 15 million yen or more in Table 1.

[8] OLS estimation using age-adjusted parental income is attempted as described in Dearden et al. (1997), but the result closely resembles those obtained using the first approach.

similar to the Tobit model).

$$
\begin{aligned}
z_{it}^* &= q_i\alpha + x_{it}b + v_{it}, \qquad (8)\\
z_{it} &= 1, \quad \text{if } z_{it}^* < Z_1\\
z_{it} &= 2, \quad \text{if } Z_1 \le z_{it}^* < Z_2\\
&\vdots\\
z_{it} &= 7, \quad \text{if } Z_6 \le z_{it}^*
\end{aligned}
$$

where z_{it}^* is unobserved parental income, and Z_1, ..., Z_6 are threshold values. Applying the predicted parental income $\widehat{z}_i$ equaling $q_i\widehat{\alpha}$ to z_i, the elasticity ρ is estimated by OLS as

$$y_{it} = a_0 + \rho z_i + a_1 g_{it} + a_2 g_{it}^2 + \widetilde{\widetilde{\epsilon}}_i, \qquad (9)$$

where $\widetilde{\widetilde{\epsilon}}_i = \epsilon_i + u_{it}$[9].

The third approach is instrumental variables estimation using the following equation.

$$y_{it} = a_0 + \rho(z_{it} - x_{it}b) + a_1 g_{it} + a_2 g_{it}^2 + \widetilde{\epsilon}_i \qquad (10)$$

That equation applies age-adjusted parental income $(z_{it} - x_{it}\widehat{b})$ from estimates of eq. (7) or eq. (8). It is considered that the estimate from the first OLS approach is a lower bound, and that the one from the third IV approach is an upper bound.

Selection of q_i is the years of education and dummy variables for occupation and firm size. Occupation and firm size possibly affect lifetime earnings because most fathers are of the generation for which the lifetime seniority system prevailed and job-hopping was uncommon in Japan. In the third approach, two sets of instruments are examined: years of education, and the same set as q_i.

Tables 2 and 3 present the intergenerational transitional distribution: the earnings distribution of married offspring is indicated in quintiles by column for each parental income group

[9] One concern is that $\widehat{z}_i$ lacks unobserved heterogeneity in parental income that is not predicted from q_i. Dearden et al. (1997) explains that the estimate of ρ can be unbiased if observed and unobserved components have the same ρ without correlation in error terms.

by row. The percentage in each cell is expected to be 20% if earnings of offspring are independent from parental income. The tables exhibit, however, a positive correlation between the offspring's earnings and parental income. For example, more than 30% of offspring from the bottom (top) group of parental income is likely to stay at the lowest (highest) quintile.

4 Estimation Result of Intergenerational Elasticity

4.1 Intergenerational Elasticity of Earnings and Income

Tables 4 and 5 respectively present estimates of the elasticity ρ using earnings and income of offspring. The OLS estimates are 0.09–0.16. The OLS estimates using the predicted parental income are 0.23–0.42, and IV estimates are 0.23–0.38 (0.24–0.54) using education and occupational characteristics of the father (education of the father alone) as instruments. The IV estimates using a full set of instruments are almost equivalent to OLS estimates using the predicted parental income, whereas IV estimates with education alone are higher than others and are associated with comparatively large standard errors. Estimates are similar between earnings and income.

Estimates using the observed parental income are mostly close to those using grouped parental income in the case of single daughters, which suggests that the application of grouped parental income is likely to yield to reasonable estimates.

The OLS estimates with prediction and the IV estimates with full instruments suggest that the elasticity is 0.2–0.4 overall. Regarding married sons, the elasticity is around 0.4 using the entire sample, 0.31–0.36 using the subsample of working fathers, and less than 0.3 using the subsample of fathers younger than age 60. However, it is noteworthy that smaller estimates using subsamples might be affected by the possible sample selection bias because of the exclusion of considerable number of retired fathers. Regarding daughters, estimates are 0.23–0.32 for single daughters, and around 0.3 for married daughters. Similar to Chadwick and Solon (2002), estimates are lower for daughters than for sons.

The estimates of Japan seem to be somewhat lower than those from less mobile countries with elasticity of 0.4–0.6. For the US, Solon (1992) reports an IV estimate of 0.53 when an

OLS estimate is 0.39 with a single-year measure. Regarding studies using predicted parental income or IV estimation, Dearden et al. (1997) report an OLS estimate of 0.24, estimates of 0.39–0.44 using predicted wages, and IV estimates of 0.56–0.59 for sons, and even higher estimates for daughters in Britain. In addition, Mocetti (2007) and Piraino (2007) report estimates of around 0.5 using predicted income and applying the two-sample method in Italy.

Regarding other countries, Björklund and Jäntti (1997) report an estimate obtained using the predicted income of 0.22, and the IV estimate of 0.28 in the case of Sweden. Furthermore, Leigh (2007) uses predicted parental earnings and suggests the estimate of 0.2-0.3 in Australia. For Japan, the IV estimate of 0.4 for married sons is slightly higher than in those earlier studies, although the estimate of 0.3 or less for daughters is almost equivalent to their studies.

Hereinafter, intergenerational mobility elasticity is examined for earnings using the estimation method with predicted parental income, which is a practically useful method as an alternative to IV estimation.

4.2 Estimation with Alternative Prediction of Parental Income

Age at the time of measurement is widely acknowledged as affecting estimates of the elasticity. Solon (2002) points out that the elasticity might be underestimated if earnings of offspring are measured at early ages such as the early twenties[10]. Grawe (2006) also points out that the estimate is reduced when earnings of fathers are measured at upper ages such as the fifties because of the rise in variance of permanent earnings over the life cycle. The suggested age to reduce the bias is around age 40 for both sons and fathers.

The average age of 36 nearly meets this requirement in cases of married sons and husbands of married daughters. It is possible, however, that the average age of 28 for single daughters reduces the estimate. In other words, the estimate of order 0.2 for single daughters might be underestimated.

The parental income measured during the fifties or even older can be another source of the bias in these analyses. A method to avoid this problem is to generate predicted parental

[10] For example, Couch and Dunn (1997) report the elasticity of 0.2 or less in Germany and also in the US, on average, using earnings measurements of people in their early twenties or mid-twenties.

income without the ages of fathers. For this purpose, an alternative parental income is predicted by $q_i\widehat{\delta}$ with $\widehat{\delta}$ from estimates of earnings equations of married sons.

$$y_{it} = r_i\delta + a_1 g_{it} + a_2 g_{it}^2 + u_{it} \tag{11}$$

Therein, r_i is a vector of education and occupational characteristics of married sons. In this approach, the father's age and parental income group variables are not referred[11].

Table 6 presents estimates obtained using the alternative predicted parental income. The estimates are mostly similar to the previous estimates presented in Table 4. A possible reason is that the estimation using prediction might reduce the bias from the variance of earnings even when parental income is measured at upper ages. Another reason might be the seniority system and lifetime employment custom that once prevailed in Japan, which might reduce the rise in variances of parental income.

5 Time Trend of Intergenerational Mobility

The time trend of intergenerational mobility is a recent concern. Decreasing intergenerational mobility might become a social problem that requires policy measures to increase equality of opportunities for children.

The proposed specification is similar to that reported by Fertig (2003) with time-varying elasticity. The relation of intergenerational economic status in equation (1) is modified as

$$\begin{aligned} y_i &= a_0 + (\rho_0 + \rho_1 \cdot t_i)z_i + \epsilon_i \\ &= a_0 + \rho_0 z_i + \rho_1(t_i \cdot z_i) + \epsilon_i, \end{aligned} \tag{12}$$

where ρ_0 and ρ_1 are coefficients. Time t_i is defined as the birth year of offspring. Then, eq. (9) is modified as

$$y_{it} = a_0 + \rho_0 z_i + \rho_1(t_i \cdot z_i) + a_1 g_{it} + a_2 g_{it}^2 + \widetilde{\widetilde{\epsilon}}_i \tag{13}$$

and estimated using the predicted parental income $\widehat{z}_i$. In addition, an extended specification is considered. In estimating the change of the elasticity over time, Lee and Solon (2006) propose

[11] This approach follows the two-sample approach proposed by Björklund and Jäntti (1997), which utilizes the father's information when the father's earnings are not observed.

a regression model with a quartic in parental age, a quartic in offspring's age normalized at age 40, and interaction terms of parental income and a quartic in the offspring's age. Similarly, the model is extended as

$$y_{it} = a_0 + \rho_0 z_i + \rho_1 (t_i \cdot z_i) + \sum_{j=1}^{4} a_j (g_{it} - 40)^j + \sum_{j=1}^{4} a_{4+j} (g_{it} - 40)^j z_i + \widetilde{\widetilde{\epsilon}}_i, \qquad (14)$$

which applies $q_i \widehat{\alpha}$ to z_i, as estimated from the parental income function

$$z_{it} = q_i \alpha + (1 - Dr_{it})(\sum_{j=1}^{4} b_j h_{it}^j + b_5 Dw_{it}) + b_6 Dr_{it} + v_{it},$$

modified from eq. (5).

Table 7 presents estimates of ρ_1 using eqs. (13) and (14) for daughters born during 1959–1979 and their husbands. Estimates are negative and mostly statistically significant. The result suggests that intergenerational mobility is likely to increase in Japan over time; the extent of the decline in the elasticity is around 0.01–0.02 per decade.

6 Differences in Mobility among Individuals

6.1 High-achieving and Low-achieving Offspring

Mean regression predicts expected earnings of offspring conditioned on parental income. However, earning ability and preferences vary among individuals even if they have similar family background; the importance of parental income might differ between high-achieving and low-achieving offspring. To examine the mobility for out-of-average offspring, quantile regression is applied.

Quantile regression fits the regression line to the median, quartile, or any other percentile instead of the mean (e.g., Koenker, 2005; Hao and Naiman, 2007). In the estimating equation of $y = f(z) + \epsilon$, least-square method minimizes

$$\sum_{i=1}^{N} \{y_i - f(z_i)\}^2,$$

whereas quantile regression at the p-th quantile minimizes

$$p \sum_{y_i \geq f(z_i)} |y_i - f(z_i)| + (1 - p) \sum_{y_i < f(z_i)} |y_i - f(z_i)|.$$

Quantile regression is applied to estimate eq. (1) using $\{\widehat{y}_i, \widehat{z}_i\}$ for $\{y_i, z_i\}$, where $\widehat{y}_i$ represents age-adjusted earnings of the offspring.

Table 8 presents estimates of the elasticity at 10%, 25%, 50%, 75%, and 90% from the bottom. Overall, the result does not suggest a relation between percentiles and estimated elasticity. Estimates seem to be low at the 10th percentile for married offspring, but not for single daughters.

Eide and Showalter (1999) and Fertig (2003) find, using US data, that the elasticity for lower quantiles is larger than for upper quantiles, at least for father-son pairs. Grawe (2004b) finds similar tendencies in the US and Canada, but not in Germany or the UK. For Japan, the result resembles that of the European case, and is almost opposite from that of the North American case in the sense that a lower quantile exhibits smaller elasticity than others, at least for married offspring.

6.2 Nonlinearity in Parental Income

Results of recent studies show that nonlinear relations exist in intergenerational pairs, which implies that intergenerational mobility might differ among offspring from low-, middle-, and high-income families. With the presence of nonlinearity, eq. (1) is modified as

$$y_i = f(z_i) + \epsilon_i, \tag{15}$$

and the elasticity is defined as $df(z)/dz|_{z=z_i}$. The analysis applies two approaches to approximate $f(z_i)$. One approach is to introduce a polynomial function in z_i[12]; another is to introduce a nonparametric approach[13]. With introduction of an orthogonal polynomial function, eq. (9) is modified as

$$y_{it} = \sum\nolimits_{j=1}^{K} \gamma_j \varphi_j(z_i) + a_1 g_{it} + a_2 g_{it}^2 + \widetilde{\widetilde{\epsilon}}_i. \tag{16}$$

[12] Y. Amemiya (1985) points out that the estimator for nonlinear simultaneous equations model proposed by T. Amemiya (1974) is inconsistent for error-in-variables model. Herein, a method developed by Hausman, Newey, Ichimura, and Powell (1991) is applied to estimate a polynomial function with instruments, but reasonable estimates are not obtained and the assumption of overidentifying restrictions is rejected by the chi-square test,

[13] Raaum et al. (2007) employ a polynomial function approach. Regarding the nonparametric approach, Grawe (2004a) applies a spline method, and Corak and Heisz (1999) apply local regression method, for example.

Selected orthogonal polynomials are the Chebyshev polynomials, where $\varphi_1(z_i) = 1$, $\varphi_2(z_i) = T(z_i)$, $\varphi_j(z_i) = 2T(z_i) \cdot \varphi_{j-1}(z_i) - \varphi_{j-2}(z_i)$ for j$\geq$ 3, and $T(z_i) = 2(z_i - z_{\min})/(z_{\max} - z_{\min}) - 1$ over the range of $[z_{\min}, z_{\max}]$ for z_i. Coefficients $\{\gamma_j\}_{j=1}^K$ and $\{a_1, a_2\}$ are estimated with substitution of $\widehat{z}_i$ for z_i in eq. (16). The order of polynomial K is 4[14].

Another approach is to apply local regression (Locfit) following Corak and Heisz (1999), which is a nonparametric method that fits a polynomial function for each fitting point using a local weight function[15]. The predicted parental income $\widehat{z}_i$ and age-adjusted earnings of offspring $\widehat{y}_i$ are applied to estimate eq. (15). The polynomial function approach is expected to engender smoother but less flexible approximation than nonparametric approach.

Figure 1 depicts the nonlinear relation between the parental log income and log earnings of offspring. Both the polynomial method and the Locfit create similar curves[16]; the fitted curve is an S shape for married sons and single daughters, but it appears to be nearly linear for married daughters. The S-shaped pattern reflects that a marginal difference in parental income is important for offspring from middle-income families more than for others. However, the linear relation for married daughters indicates that a marginal difference in parental income matters for all married daughters in terms of the husband's economic status.

Previous studies found an S-shaped pattern (or an inverted-V shape curve between parental log income and the elasticity), as found by Corak and Heisz (1999) in Canada and Bratberg et al. (2005) in Norway. Furthermore, Bratsberg et al. (2007) find a convex pattern with low elasticity for low-income families and increasing elasticity for middle-income and high-income families in Nordic countries, but find a linear relation in the US and Britain. In the case of Japan, the S-shaped relation for married sons and single daughters is similar to the cases of Canada and Norway, although the linear relation for married daughters resembles those of cases in the US and Britain.

[14] The result resembles the case using K equals 5 or more.

[15] Package Locfit version 1.5-4 is used on R downloaded from a CRAN mirror site. The smoothing parameter is 0.5. The fitted curve shape is little affected by changing the smoothing parameter or the degree of the polynomial.

[16] The difference in the vertical level is likely to arise from the difference in age adjustment: polynomial regression estimates the age effect at once in the regression, although the age effect is adjusted in advance before Locfit is applied.

7 Summary

This paper has described intergenerational mobility of economic status in Japan. Estimation results described herein indicate that the elasticity is 0.4 or less for married sons, and around 0.3 for daughters, considering possible downward bias for single daughters, which suggests that the mobility in Japan is likely to be higher than in countries that are known to have less mobility such as the US and Britain, but mobility in Japan is likely to be slightly lower than in other countries, such as Scandinavian countries.

The analyzed data of Japan provide parental income information related to seven groups. Estimation was carried out using prediction of parental income from education and occupation of the father, for which the estimates are similar to IV estimates. Estimation using observed parental income supports estimation results obtained with grouped parental income in the case of single daughters.

Results also show that mobility in Japan is increasing over time for daughters born during 1959–1979 and their husbands. Actually, quantile regression indicates no relation between the mobility and earnings achievement of offspring. Finally, an S-shaped nonlinear relation is found between parental log income and log earnings of married sons and single daughters: a linear relation is found for married daughters.

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Table 1: Sample Characteristics

	Married sons	Single daughters	Married daughters
Earnings (million yen)	5.33 (3.95)	2.74 (1.30)	-
Earnings of the husband (million yen)	-	-	5.21 (2.76)
Earnings of the couple (million yen)	-	-	6.20 (3.17)
Income (million yen)	5.40 (3.95)	2.79 (1.28)	-
Income of the husband (million yen)	-	-	5.33 (2.86)
Income of the couple (million yen)	-	-	6.41 (3.91)
Distribution of parental income group			
less than 2.5 million yen	21.5%	11.4%	18.4%
2.5--4.99 million yen	28.6%	20.8%	29.3%
5.0--7.49 million yen	23.2%	25.2%	22.0%
7.5--9.99 million yen	11.9%	18.3%	13.4%
10--12.49 million yen	8.0%	12.1%	9.5%
12.5--14.99 million yen	2.7%	5.6%	3.0%
15 million yen or more	4.0%	6.6%	4.4%
Age	36.2 (6.9)	27.9 (4.0)	-
Age of the husband	-	-	36.4 (6.9)
Age of the father	60.0 (6.4)	55.6 (4.7)	57.2 (5.6)
Ratio of working fathers	72.0%	88.7%	81.7%
Years of education of the father	11.4 (2.3)	12.4 (2.5)	11.5 (2.3)
Sample Size	1114	906	1390

Note: Standard deviations are in parentheses.

Table 2: Transition matrix of married sons

Parental income group	Quintiles of age-adjusted earnings of married sons					Total	Sample size
	Lowest 20%	20--40%	40--60%	60--80%	Highest 20%		
Lowest	32.3%	17.7%	22.9%	11.5%	15.6%	100%	96
Second	29.4%	18.3%	22.9%	15.1%	14.2%	100%	218
Third	15.2%	22.0%	19.7%	25.1%	17.9%	100%	223
Fourth	8.6%	22.4%	20.7%	22.4%	25.9%	100%	116
Fifth	9.9%	21.0%	14.8%	28.4%	25.9%	100%	81
Top two groups	19.1%	16.2%	13.2%	17.6%	33.8%	100%	68
Sixth	18.5%	7.4%	25.9%	33.3%	14.8%	100%	27
Highest	19.5%	22.0%	4.9%	7.3%	46.3%	100%	41

Notes: Pairs of married sons and their working fathers. Sample size is 802.

Table 3: Transition matrix of married daughters

Parental income group	Quintiles of age-adjusted earnings of husband of daughters					Total	Sample size
	Lowest 20%	20--40%	40--60%	60--80%	Highest 20%		
Lowest	31.4%	22.1%	20.7%	15.0%	10.7%	100%	140
Second	24.4%	22.8%	19.7%	20.3%	12.8%	100%	320
Third	20.6%	19.6%	20.3%	19.9%	19.6%	100%	281
Fourth	14.0%	16.4%	20.5%	24.0%	25.1%	100%	171
Fifth	10.3%	19.8%	22.2%	17.5%	30.2%	100%	126
Sixth	10.3%	19.8%	22.2%	17.5%	30.2%	100%	40
Highest	15.5%	17.2%	12.1%	17.2%	37.9%	100%	58

Notes: Pairs of married daughters and their working fathers. Sample size is 1136.

Table 4: Estimated intergenerational elasticity using earnings of offspring

Pairs of offspring and parents (dependent variable)	Age and job status of the father	OLS with midpoints of parental income			OLS with predicted parental income			IV (years of education of father)			IV (years of education and occupation of father)			Sample size
Married son and his parents	Younger than 60	0.099	(0.025)	**	0.259	(0.069)	**	0.241	(0.112)	*	0.266	(0.080)	**	552
	Working	0.129	(0.023)	**	0.351	(0.059)	**	0.419	(0.084)	**	0.309	(0.069)	**	802
	All	0.145	(0.019)	**	0.412	(0.053)	**	0.458	(0.075)	**	0.379	(0.063)	**	1114
Single daughter and her parents	Younger than 60	0.133	(0.032)	**	0.288	(0.078)	**	0.436	(0.139)	**	0.297	(0.084)	**	717
	Working	0.111	(0.032)	**	0.247	(0.075)	**	0.326	(0.123)	**	0.242	(0.084)	**	804
	All	0.102	(0.029)	**	0.229	(0.074)	**	0.296	(0.118)	*	0.225	(0.082)	**	906
Single daughter and her parents living together	Younger than 60	0.129	(0.049)	**	0.298	(0.123)	*	0.536	(0.211)	*	0.313	(0.138)	*	333
	Working	0.161	(0.048)	**	0.291	(0.114)	*	0.429	(0.175)	*	0.310	(0.122)	*	376
	All	0.108	(0.044)	*	0.281	(0.115)	*	0.493	(0.202)	*	0.285	(0.119)	*	418
Married daughter and her parents (husband's earnings)	Younger than 60	0.097	(0.020)	**	0.297	(0.054)	**	0.404	(0.095)	**	0.286	(0.062)	**	955
	Working	0.126	(0.019)	**	0.299	(0.051)	**	0.386	(0.078)	**	0.287	(0.059)	**	1136
	All	0.116	(0.017)	**	0.300	(0.046)	**	0.353	(0.069)	**	0.303	(0.055)	**	1390
Married daughter and her parents (couple's earnings)	Younger than 60	0.110	(0.020)	**	0.295	(0.057)	**	0.353	(0.069)	**	0.284	(0.060)	**	955
	Working	0.127	(0.019)	**	0.303	(0.050)	**	0.370	(0.090)	**	0.295	(0.057)	**	1136
	All	0.115	(0.016)	**	0.292	(0.045)	**	0.361	(0.075)	**	0.300	(0.054)	**	1390

Notes: The sample of single daughters and parents living together uses observed parental income; other samples use grouped parental income. Standard errors are in parentheses. **, and * respectively indicate 1% and 5% significance levels.

Table 5: Estimated intergenerational elasticity using income of offspring

Pairs of offspring and parents (dependent variable)	Age and job status of the father	OLS with midpoints of parental income			OLS with predicted parental income			IV (years of education of father)			IV (years of education and occupation of father)			Sample size
Married son and his parents	Younger than 60	0.100	(0.024)	**	0.265	(0.068)	**	0.239	(0.111)	*	0.272	(0.079)	**	552
	Working	0.133	(0.022)	**	0.359	(0.058)	**	0.430	(0.084)	**	0.316	(0.069)	**	802
	All	0.148	(0.019)	**	0.415	(0.053)	**	0.466	(0.075)	**	0.380	(0.062)	**	1114
Single daughter and her parents	Younger than 60	0.143	(0.029)	**	0.313	(0.070)	**	0.446	(0.126)	**	0.324	(0.075)	**	717
	Working	0.123	(0.029)	**	0.269	(0.068)	**	0.357	(0.113)	**	0.277	(0.076)	**	804
	All	0.116	(0.027)	**	0.252	(0.067)	**	0.322	(0.108)	**	0.257	(0.075)	**	906
Single daughter and her parents living together	Younger than 60	0.121	(0.043)	**	0.278	(0.109)	*	0.519	(0.190)	**	0.288	(0.120)	*	333
	Working	0.158	(0.044)	**	0.277	(0.103)	**	0.421	(0.159)	**	0.289	(0.108)	**	376
	All	0.112	(0.039)	**	0.252	(0.102)	*	0.464	(0.180)	**	0.254	(0.105)	*	418
Married daughter and her parents (husband's income)	Younger than 60	0.090	(0.020)	**	0.299	(0.054)	**	0.403	(0.095)	**	0.289	(0.289)	**	955
	Working	0.120	(0.019)	**	0.302	(0.051)	**	0.394	(0.079)	**	0.288	(0.059)	**	1136
	All	0.116	(0.017)	**	0.305	(0.046)	**	0.360	(0.069)	**	0.302	(0.055)	**	1390
Married daughter and her parents (couple's income)	Younger than 60	0.112	(0.020)	**	0.296	(0.053)	**	0.397	(0.091)	**	0.283	(0.059)	**	955
	Working	0.128	(0.019)	**	0.309	(0.050)	**	0.385	(0.076)	**	0.296	(0.057)	**	1136
	All	0.122	(0.016)	**	0.296	(0.045)	**	0.329	(0.066)	**	0.298	(0.053)	**	1390

Notes: The sample of single daughters and parents living together uses observed parental income; other samples use grouped parental income. Standard errors are in parentheses. **, and * , respectively indicate 1% and 5% significance levels.

Table 6: Estimation using alternative prediction of parental income from earnings of offspring

Pairs of offspring and parents (dependent variable)	Age and job status of the father	Estimates			Table 4 column 2	Sample size
Married son and his parents	Younger than 60	0.277	(0.079)	**	0.259	552
	Working	0.372	(0.075)	**	0.351	802
	All	0.391	(0.062)	**	0.412	1114
Single daughter and her parents	Younger than 60	0.308	(0.082)	**	0.288	717
	Working	0.249	(0.081)	**	0.247	804
	All	0.245	(0.079)	**	0.229	906
Single daughter and her parents living together	Younger than 60	0.329	(0.134)	*	0.298	333
	Working	0.291	(0.131)	*	0.291	376
	All	0.293	(0.126)	*	0.281	418
Married daughter and her parents (husband's earnings)	Younger than 60	0.320	(0.062)	**	0.297	955
	Working	0.317	(0.060)	**	0.299	1136
	All	0.320	(0.053)	**	0.300	1390
Married daughter and her parents (couple's earnings)	Younger than 60	0.320	(0.061)	**	0.295	955
	Working	0.330	(0.058)	**	0.303	1136
	All	0.320	(0.052)	**	0.292	1390

Notes: The sample of single daughters and parents living together uses observed parental income; other samples use grouped parental income. Standard errors are in parentheses. **, and * respectively indicate 1% and 5% significance levels.

Table 7: Time trend of the mobility

Pairs of offspring and parents (dependent variable)	Age and job status of the father	Basic model			Extended Model			Sample size
Married son and his parents	Younger than 60	-0.00089	(0.00061)		-0.00084	(0.00061)		552
	Working	-0.00133	(0.00051)	**	-0.00114	(0.00052)	*	802
	All	-0.00115	(0.00044)	**	-0.00105	(0.00044)	*	1114
Single daughter and her parents	Younger than 60	-0.00152	(0.00053)	**	-0.00161	(0.00053)	**	717
	Working	-0.00093	(0.00050)		-0.00106	(0.00050)	*	804
	All	-0.00101	(0.00049)	*	-0.00110	(0.00049)	*	906
Single daughter and her parents living together	Younger than 60	-0.00263	(0.00093)	**	-0.00264	(0.00094)	**	333
	Working	-0.00188	(0.00088)	*	-0.00184	(0.00089)	*	376
	All	-0.00188	(0.00087)	*	-0.00189	(0.00088)	*	418
Married daughter and her parents (husband's earnings)	Younger than 60	-0.00098	(0.00040)	*	-0.00095	(0.00040)	*	955
	Working	-0.00117	(0.00035)	**	-0.00119	(0.00035)	**	1136
	All	-0.00115	(0.00031)	**	-0.00117	(0.00031)	**	1390
Married daughter and her parents (couple's earnings)	Younger than 60	-0.00135	(0.00038)	**	-0.00132	(0.00039)	**	955
	Working	-0.00153	(0.00034)	**	-0.00154	(0.00034)	**	1136
	All	-0.00140	(0.00030)	**	-0.00142	(0.00030)	**	1390

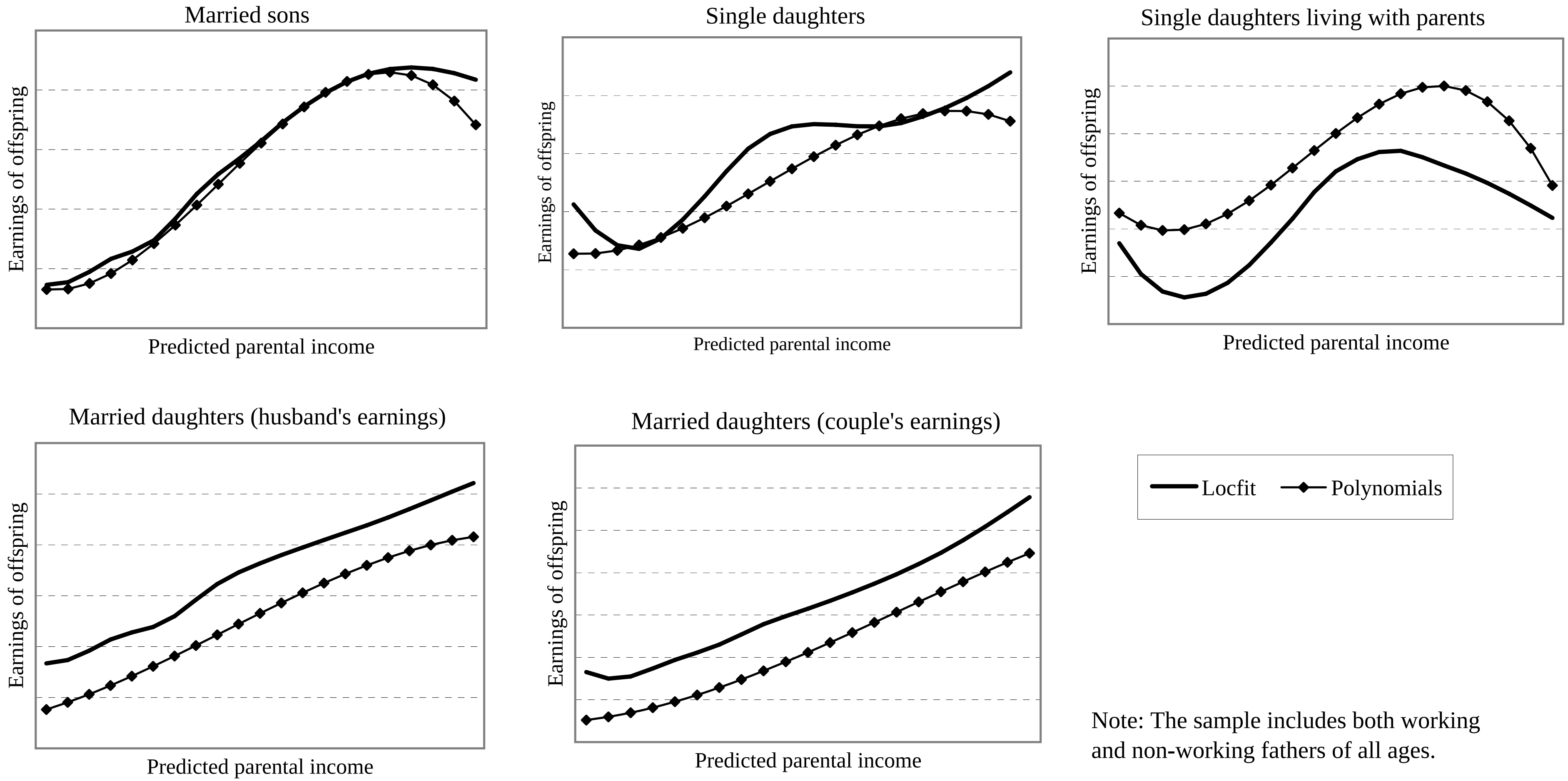
Note: Standard errors are in parentheses. **, and * respectively indicate 1% and 5% significant levels.

Table 8: Estimated elasticity by quantile regression

Pairs of offspring and parents (dependent variable)	Percentile of earnings distribution of offspring 10%	25%	50%	75%	90%	Sample size
Married son and his parents	0.351 **	0.404 **	0.401 **	0.374 **	0.436 **	1114
	(0.130)	(0.066)	(0.045)	(0.071)	(0.066)	
Single daughter and her parents	0.243	0.206	0.249 **	0.199 **	0.264 **	906
	(0.209)	(0.116)	(0.060)	(0.058)	(0.072)	
Single daughter and her parents living together	0.303	0.315	0.216 *	0.160	0.234 *	418
	(0.379)	(0.163)	(0.107)	(0.093)	(0.109)	
Married daughter and her parents (husband's earnings)	0.259 *	0.295 **	0.325 **	0.303 **	0.297 **	1390
	(0.114)	(0.053)	(0.047)	(0.039)	(0.060)	
Married daughter and her parents (couple's earnings)	0.263 **	0.255 **	0.333 **	0.307 **	0.316 **	1390
	(0.074)	(0.062)	(0.059)	(0.046)	(0.085)	

Notes: The sample includes both working and non-working fathers of all ages. Standard errors in parentheses are computed using bootstrapping. **, and * respectively indicate 1% and 5% significant levels.

Figure 1: Nonlinear estimation



Note: The sample includes both working and non-working fathers of all ages.