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Zhi-xiao Jia

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GRADUATE SCHOOL OF ECONOMICS AND
MANAGEMENT TOHOKU UNIVERSITY
27-1 KAWAUCHI, AOBA-KU, SENDAI,
980-8576 JAPAN

Intergenerational Mobility of Economic Status across Three Generations: The Case of Taiwan*

Zhi-xiao Jia†

Graduate School of Economics and Management, Tohoku University, Sendai, Japan

Abstract

This paper analyzes the intergenerational mobility (IGM) of economic status across three generations in Taiwan. Grandfather-father-son relation is considered, and grandfathers' economic status is imputed based on their characteristics by applying Two-Sample Two-Stage Least Square (TS2SLS) approach. This study finds that the intergenerational elasticity (IGE) between fathers and sons is 0.154, while that between grandfathers and fathers is 0.349. Intergenerational elasticity between grandfathers and sons is 0.159, and roughly 62.83% to 66.60% of intergenerational elasticity between grandfathers and sons is explained by both parents' economic status, which implies that grandfathers' economic status is transmitted to sons' generation mainly through the indirect pathway.

Key words: intergenerational elasticity, intergenerational mobility, multigenerational mobility, Taiwan, Two-Sample Two-Stage Least Square

JEL Classification: D31, J62

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† Email address: jia.zhixiao.s1@dc.tohoku.ac.jp

1. Introduction

Since Becker and Tomes (1979, 1986) proposed their well-known theoretical model of intergenerational transmission of economic status and intergenerational investment in human capital, the so-called intergenerational mobility (IGM) has been widely studied in different countries with different economic structures, social institutions and cultural backgrounds by economists.[1, 2] This study analyzes IGM of economic status in Taiwan.

Most of previous studies focus on IGM between two adjacent generations (e.g., parents and children), and so does the only three published papers of IGM in Taiwan (Kan et al., 2015, Sun and Ueda, 2015, Chu and Lin, 2019). However, only considering two generations is not enough for Taiwan. Certain demographical and cultural features make it important to analyze IGM in Taiwan across three generations (i.e., grandparents, parents and children). First, extended families are quite prevalent in Taiwan (Freedman et al., 1978, 1982, Weinstein et al., 1990), and such extensive, or even multigenerational family structure makes it easier for grandparents to transmit their endowments and traits to their grandchildren, which indicates that the intergenerational persistence between grandparents and grandchildren should not be ignored in Taiwan. Even in recent decade, there are still roughly 40% of aged Taiwanese people (65 years and older) living together with their grandchildren, as shown in Figure 1:

[Place Figure 1 here]

Moreover, living standard of Taiwan increased significantly during past few decades, which increased life expectancy of both sexes from 69.1 in 1970 to over 80 in early 2010s.[3] Plus, Taiwan faces rapid population aging and it has achieved aging society and aged society in 1993 and 2018, respectively.[4, 5] These further make it important to analyze grandparents' role in the process of transmission of economic status, since aged people have become a

[1] Throughout the entire paper, intergenerational mobility (IGM) refers to intergenerational mobility of *economic status*, instead of educational or occupational mobility across generations.
[2] Corak (2013) provides a detailed review of empirical studies of IGM in different countries.
[3] *Data source:* Ministry of the Interior
[4] *Data source:* Ministry of the Interior
[5] For a more detailed description, one may refer to Mason and Lee (2004).

substantial part of entire Taiwanese population.

Besides above demographical characteristics, cultural background also makes IGM in Taiwan across three generations an interesting case to study. As influenced by ancient Chinese culture (e.g., Confucianism or Ruism), Taiwanese people have strong sense of family lineage, which partially explains why extended or multigenerational families are relatively common in Taiwan and enhances intergenerational transfer. What's more, as a famous Chinese saying goes, "Filial piety is the most important of all virtues", Taiwanese people respect, or be good to their elders (i.e., parents, grandparents, etc.) from every aspect. To sum up, all these demographical and cultural features strengthens the linkage across multi-generations in Taiwan, which makes it necessary to expand two-generation analysis to three-generation analysis.

Over last few decades, both economists and sociologists have paid some attention on mobility across more than two generations, that is, multigenerational mobility. However, most of these studies focused on educational mobility and occupational mobility (e.g., Behrman and Taubman,1985, Warren and Hauser, 1997, Jaeger, 2012, Zeng and Xie, 2014, Lindahl et al., 2015, Ferrie et al., 2016). Very few empirical literatures regarding multigenerational mobility of economic status, for instance, multigenerational earning or multigenerational income mobility, mainly focused on the U.S. (Olivetti et al., 2018) and European countries (Lucas and Kerr (2013) for Finland, Lindahl et al. (2015) for Malmö of Sweden). [6] As for Asia, there exists no empirical literatures focusing on multigenerational mobility of economic status to the best knowledge of the author.

The main contribution of this study is that this is the first study of intergenerational mobility of economic status across three generations not only in Taiwan, but also in Asia. The primary reason why there exists very rare empirical studies about multigenerational earning or income mobility is the lacking of datasets which contains information of earning or income of three or more consecutive generations.[7] Based on *Panel Study of Family Dynamics* (PSFD) conducted by Academia Sinica of Taiwan, this study extracts a sample which contains data of children's earning, parents' earning and grandparents' characteristics. Even though grandparents' earning, which is essential for analyzing

[6] Solon (2018) provides a more detailed literature review of multigenerational mobility.
[7] Olivetti and Paserman (2015) proposed a method that using first name to create *pseudo* links across generations and Olivetti et al. (2018) use this method to analyze IGM across three generations is U.S.

intergenerational mobility of economic status across three generations, is not asked in PSFD, it can be imputed based on their characteristics by employing Two Sample Two Stage Least Square (TS2SLS) approach, which was firstly used by Björklund and Jäntti (1997) in their study of IGM in Sweden and U.S., and has been widely used in a plenty of Asian literatures (Ueda (2009), Lefranc et al. (2008, 2014) for Japan, Ueda (2013) for Korea, Gong et al. (2012) for urban China, Kan et al. (2015), Sun and Ueda (2015), Chu and Lin (2019) for Taiwan; etc.).[8] In this study, supplementary sample used for imputing grandfathers' missing earnings is extracted from *Manpower Utilization Survey* (MUS) conducted by Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan of Taiwan.

Whether grandparents' condition has a direct and independent effect on grandchildren's condition or not is a crucial question in studies of mobility across multi-generations. Some previous literatures do find such effect, that is to say, the estimated coefficient of grandparents' condition is not small and/or significant (Lucas and Kerr, 2013, Lindahl et al., 2015, Ferrie et al., 2016) even after parents' condition is controlled, while some others do not find such effect (Behrman and Taubman, 1985, Warren and Hauser, 1997, Jaeger, 2012). To sum up, under different circumstances, the answer to this question is inconclusive. By employing Blanden et al. (2014)'s decomposition method,[9] this study decomposes the total grandparents' effect into two parts: (i) direct effect of grandparents' condition on children's condition and (ii) indirect effect of grandparents' condition on children's condition through its direct effect on parents' condition. Therefore, this study may provide a more comprehensive understanding of grandparents' role in transmission of economic status, instead of simply answering the question that whether grandparents have a direct and independent effect on children or not.

The estimation results show that intergenerational elasticity (IGE) between fathers and sons lies around 0.154, while that between grandfathers and fathers lies around 0.349. This discrepancy might be attributed to life-cycle effect and difference between estimation methods. IGE between grandfathers and sons lies around 0.159, and over 60% of intergenerational persistence between grandfathers and sons is transmitted through parents' economic status, which means that economic status of grandfathers affects that

[8] As for statistical properties of TS2SLS estimator, one may refer to Inoue and Solon (2010).
[9] Blanden et al. (2014) use this method to analyze the mechanisms underlie IGM.

of sons mainly through the indirect way.

The remainder of this paper is organized as follows. Section 2 introduces the empirical methodologies. Section 3 explains PSFD and MUS data as well as variables in detail. Section 4 presents main estimation results and discussion. Section 5 concludes.

2. Empirical Methodologies

The most standard approach of analyzing intergenerational mobility is to estimate so-called intergenerational elasticity (IGE), that is, β in the following AR (1) equation:

$$\log(I_{ti}) = \alpha + \beta \log\left(I_{(t-1)i}\right) + e_i \tag{1}$$

where I_{ti} and $I_{(t-1)i}$ refers to permanent or lifetime economic status, which is always measured by income or earning, of generation t and generation t-1, respectively. IGM can be measured by $1-\beta$. In this study, economic status is measured by earning, and paternal lineage, that is, paternal grandfather-father-son relation, is considered.[10]

2.1 Father-son relation

The estimation equation for IGE between fathers and sons takes the form of:

$$\log(y_{si}) = \alpha_1 + \beta_1 \log\left(\bar{y}_{fi}\right) + \varphi_1(age_{si}) + \varphi_2\left(\overline{age}_{fi}\right) + \varepsilon_{1i} \tag{2}$$

where y_{si} is son's one-year earning, and $\bar{y}_{fi}$ is father's five-year average earning. Since $\bar{y}_{fi}$ is a better proxy for permanent earning, therefore it can mitigate the attenuation bias caused by classical measurement errors arising from using annual earning to measure permanent earning (Solon, 1992, Zimmerman, 1992). $\varphi_1(age_{si})$ is a fourth-degree polynomial function of son's age, and $\varphi_2\left(\overline{age}_{fi}\right)$ is a fourth-degree polynomial function of father's five-year average age. Subscript i refers to each father-son pair. β_1 is the IGE

[10] Throughout the entire paper, grandfather refers to *paternal* grandfather.

between fathers and sons. OLS is used to estimate equation (2).

Life-cycle bias (Grawe, 2006, Haider and Solon, 2006) is another issue that needs to be taken into consideration. Economic status in early (late) stage of life will underestimate (overestimate) permanent economic status, and this non-classical type of measurement error may induce so-called life-cycle bias, which will underestimate IGE if children's (parents') earning is observed at very young (very old) ages.[11] In this study, age of sons belongs to [26, 40].[12] Fathers' five-year average age belongs to [27, 72] and fathers whose five-year average age are equal to or bigger than 55 are excluded. Based on Haider and Solon (2006)'s conclusion that life-cycle bias is big in early 20s and will begin to vibrate around zero from 30 to mid 40s, it is reasonable to believe that life-cycle bias in this study is relatively minor, especially compared with some previous studies where children's and parents' economic status are observed simultaneously in the same survey year, which implies that children's economic status is observed at very young ages (e.g., early 20s) while parents' economic status is observed at very old ages (e.g., late 50s) (e.g., Ng, 2007, Gong et al., 2012, Kan et al., 2015).

2.2 Grandfather-father relation and grandfather-son relation

In this study, earning of sons and earning of fathers can be observed. However, earning of grandfathers cannot be observed, which means that it needs to be "imputed" based on their observable characteristics. Two Sample Two Stage Least Square (TS2SLS) approach is employed here. In the first step, a supplementary sample is used, in which both "pseudo" grandfathers' earning and their characteristics can be observed. In the second step, grandfathers' earning is imputed based on the first step estimation results by using the primary sample. The crucial assumption is that pseudo grandfathers have to be representative of grandfathers' population.[13] To sum up, we have to observe both pseudo grandfathers' earning and characteristics in the supplementary sample, while we only need to observe grandfathers' characteristics in the primary sample.

[11] Symmetrically, if children's (parents') economic status is observed at very old (very young) ages, then the estimation of IGE will be biased upward.
[12] Age of sons in this study is relatively young due to the special data structure of PSFD, which will be illustrated in Section 3.1.
[13] In other words, both grandfathers and pseudo grandfathers should be randomly drawn from the same underlying population.

The first step equation takes the form of:

$$\log(y_{gj}^{II}) = \gamma + \phi_1(X_{gj}^{II}) + \phi_2(age_{gj}^{II}) + \phi_3(X_{gj}^{II}, age_{gj}^{II}) + \epsilon_j \quad (3)$$

where superscript *II* refers to supplementary sample, subscript j refers to each pseudo grandfather. y_{gj}^{II} is pseudo grandfather's one-year earning. X_{gj}^{II} contains several common characteristics of both pseudo grandfathers and grandfathers, which will be discussed in detail in Section 3. ϕ_1 is a linear function of X_{gj}^{II}. In order to correct life-cycle bias, grandfathers' earning is imputed at the age of 40 based on Haider and Solon (2006)'s conclusion that life-cycle bias vibrates around zero from 30 to mid 40s. This is done by introducing ϕ_2 and ϕ_3. ϕ_2 is a quadric function of pseudo grandfather's age, that is, age_{gj}^{II}. ϕ_3 is a function of interaction terms of variables in X_{gj}^{II} with age_{gj}^{II} and ${age_{gj}^{II}}^2$.[14] age_{gj}^{II} is centered at 40. This is the same as Lefranc et al. (2008, 2014)'s approach. The prediction of grandfather's earning at the age of 40 is:

$$\hat{\phi}_1(X_{gi}^{I}) \stackrel{\text{def}}{\equiv} \widehat{\log}(y_{gi}) \quad (4)$$

where superscript *I* refers to primary sample, and subscript i refers to each grandfather. One should note that variables in X_{gi}^{I} are exactly the same as variables in X_{gj}^{II}.

Thereby, the second step equation for IGE of grandfather-father relation and that for IGE of grandfather-son relation takes the form of:

$$\log(\bar{y}_{fi}) = \alpha_2 + \beta_2 \widehat{\log}(y_{gi}) + \varphi_3(\overline{age}_{fi}) + \varepsilon_{2i} \quad (5)$$

and

$$\log(y_{si}) = \alpha_3 + \beta_3 \widehat{\log}(y_{gi}) + \delta_1(D_i \times \widehat{\log}(y_{gi})) + \varphi_4(age_{si}) + \varepsilon_{3i} \quad (6)$$

respectively.[15] D_i is a dummy variable that equals to 1 if grandfather had passed away when son was born. β_2 is the IGE between grandfathers and fathers, and $\beta_3 + \delta_1 D_i$ is

[14] For instance, if X_{gj}^{II} contains two variables, ${Z_1}_{gj}^{II}$ and ${Z_2}_{gj}^{II}$. Then $\phi_3(X_{gj}^{II}, age_{gj}^{II}) = \theta_1 {Z_1}_{gj}^{II} age_{gj}^{II} + \theta_2 {Z_2}_{gj}^{II} age_{gj}^{II} + \theta_3 {Z_1}_{gj}^{II} {age_{gj}^{II}}^2 + \theta_4 {Z_2}_{gj}^{II} {age_{gj}^{II}}^2$.

[15] Grandfathers' age is not controlled in equation (5) and (6), since grandfathers' earning has already been imputed at the age of 40.

the IGE between grandfathers and sons.[16]

2.3 Decomposition of IGE between grandfathers and sons

Based on the spirit of Blanden et al. (2014)'s decomposition method, suppose that grandfathers' economic status affects sons' economic status through two pathways: (i) direct effect and (ii) indirect effect through its effect on fathers' economic status, as shown in the Figure 2:

[Place Figure 2 here]

It can be seen from Figure 2 that son's earning is influenced by both father's earning and grandfather's earning, that is:

$$\log(y_{si}) = \alpha_4 + \beta_4 \log(\bar{y}_{fi}) + \beta_5 \widehat{\log}(y_{gi}) + \delta_2 (D_i \times \widehat{\log}(y_{gi})) + \varphi_5(age_{si}) + \varphi_6(\overline{age}_{fi}) + \varepsilon_{4i} \quad (7)$$

Then, plug equation (5) into equation (7) and we have:

$$\log(y_{si}) = a_5 + (\beta_5 + \beta_2\beta_4 + \delta_2 D_i) \widehat{\log}(y_{gi}) + \varphi_5(age_{si}) + \varphi_7(\overline{age}_{fi}) + \varepsilon_{5i} \quad (8)$$

where $a_5 \stackrel{\text{def}}{=} \alpha_4 + \alpha_2\beta_4$, $\varphi_7(\overline{age}_{fi}) \stackrel{\text{def}}{=} \beta_4\varphi_3(\overline{age}_{fi}) + \varphi_6(\overline{age}_{fi})$, and $\varepsilon_{5i} \stackrel{\text{def}}{=} \varepsilon_{4i} + \beta_4\varepsilon_{2i}$. Compare equation (8) with equation (6), it is obvious that

$$\beta_3 + \delta_1 D_i = \beta_5 + \beta_2\beta_4 + \delta_2 D_i \quad (9)$$

The indirect effect of grandfathers on sons is measured by $\beta_2\beta_4$, which is transmitted through fathers' economic status. The direct effect is measured by $\beta_5 + \delta_2 D_i$, where $D_i \in \{0, 1\}$.[17] Grandfathers' death only affects direct effect.

[16] During the analyses, year dummies are not included in regressions since respondents are drawn from several very close survey years (see Section 3). As shown in footnotes of Section 4, estimation results remain almost the same after controlling for year dummies.

[17] Specifically, β_4 is IGE between fathers and sons after controlling grandfathers' economic status, and $\beta_5 + \delta_2 D_i$ is IGE between grandfathers and sons after controlling fathers' economic status.

3. Data

3.1 Primary sample: R survey of *Panel Study of Family Dynamics* (PSFD)

Primary sample is extracted from R survey of *Panel Study of Family Dynamics* (PSFD) conducted by Academic Sinica of Taiwan. PSFD is an annual longitudinal survey from 1999 (from 2012, it became a biennial survey), which is representative of all Taiwanese households. PSFD has 3 different surveys: R survey, RCI survey and C survey. R survey is the core survey of PSFD, and it contains 5 cohorts: (1) 1953~1964 cohort (initial cohort), (2) 1935~1954 cohort (added in 2000), (3) 1964~1976 cohort (added in 2003), (4) 1977~1983 cohort (added in 2009), and (5) 1984~1991 cohort (added in 2016). These 5 cohorts of respondents are called the "main respondents" of PSFD. C survey and RCI survey was conducted from 2000 and 2004, respectively. C survey consists of children of main respondents aged 16 to 24, while RCI survey consists of children of main respondents aged 25. From 2005, children of main respondents aged 26 and older were added into main respondents and surveyed by questionnaire for R survey.

In this study, fathers are extracted from first 3 cohorts of main respondents, while sons are extracted from children of these 3 cohorts of main respondents aged 26 and older. Due to this special data structure, sons in this study are relatively young (aged 26 to 40).[18] PSFD assigns each household an identification number, based on which I can identify each father-son pair. Grandfathers' information is reported *ex post* by fathers. To sum up, grandfathers' data and fathers' data are from 1999's, 2000's and 2003's R survey of PSFD, while sons' data is from 2016's, 2014's and 2012's R survey of PSFD. However, PSFD does not ask for grandfathers' earning or income, but only their characteristics (education, occupation, etc.) based on which their earning can be imputed. Therefore, a supplementary sample will be used for imputing grandfathers' missing earnings.

3.2 Supplementary sample: *Manpower Utilization Survey* (MUS)

When deciding which supplementary sample to use, one should be careful of choosing the suitable period. In this study, Grandfathers' age is centered at early-mid 70s from 1999 to

[18] In this study, since sample size is relatively small, therefore sons whose age are younger than 30 (aged 26 to 29) are not dropped. As Haider and Solon (2006) shows, life-cycle bias in late 20s is much smaller than life-cycle bias in early 20s.

2003, and it is roughly 30 years ago that grandfathers were in their mid-career. This means that the ideal supplementary sample should be drawn from early 1970s. In Taiwan, however, the earliest micro-data I can get is conducted from 1976 (***Survey of Family Income and Expenditure*** (SFIE)) or 1978 (***Manpower Utilization Survey*** (MUS)). Supplementary sample is extracted from MUS 1978-1979, since compared with SFIE, MUS is more comparable to PSFD, the primary sample, and therefore is easier to operate. MUS 1978-1979 is conducted in late 1970s, and it is not very far from early 1970s. Therefore, the assumption that both pseudo grandfathers and grandfathers are randomly drawn from the same underlying population is relatively reliable.

MUS is an annual repeated cross-sectional data from 1978 conducted by Directorate-General of Budget Accounting and Statistics (DGBAS), Executive Yuan of Taiwan. It is a representative data of Taiwanese civilian population aged 15 and older (with the exception of current in-service soldiers and incarcerated population). MUS contains detailed information on earning, employment status and several social-demographical characteristics (education, marital status, living area, etc.). It is an ideal dataset for analyzing earning structure.

3.3 Variables

Son's annual earning is used to measure economic status of son, and father's 5-year average earning is used to measure economic status of father. Annual earning equals pre-tax real annual salary plus bonus over the past year.[19] Pseudo grandfather's annual earning is observed in supplementary sample, and grandfather's economic status is measured by imputing value by using TS2SLS method as mentioned in Section 2.2. Throughout the paper, part-time jobs earnings are not taken into consideration.

Three characteristics, that is, education, occupation and self-employment status are used as predictors for grandfather's economic status. Education classification in PSFD and MUS is different,[20] and I categorize education into 6 levels: (1) illiteracy and self-study (i.e., no formal education), (2) elementary school, (3) junior high school and vocational junior high school, (4) senior high school, vocational high school and first 3 years of junior college of

[19] Annual earning is adjusted based on annual CPI, where CPI in 2016 equals 100. (*Data source:* DGBAS, Executive Yuan)
[20] PSFD divides education into 16 categories, while MUS only divides education into 8 categories.

5-year program, (5) junior college (including junior college of 2-year, 3-year, and 5-year program)[21] and (6) university (both undergraduate and graduate program). In both PSFD and MUS, occupation is divided into 7 categories based on the *International Standard Classification of Occupation* 1968 (ISCO-68): (1) professional, technical and related workers, (2) administrative and managerial workers, (3) clerical and related workers, (4) sales workers, (5) service workers, (6) agricultural, animal husbandry and forestry workers, fishermen and hunters and (7) production and related workers, transport equipment operators and labourers. It should be noted that for grandfathers in PSFD, occupation refers to their "major" occupations in their entire careers. While for pseudo grandfathers in MUS, occupation refers to their occupations at that point of time. Besides education and occupation, an indicator of self-employment status is also used to impute grandfather's earning.

3.4 Sample selection and descriptive statistics

For sons, those who have no earning report are dropped.[22] As for fathers, since I use 5-year average of annual earning to measure their economic status, therefore if I can observe at least one earning report in the first survey round and the four following survey rounds, then I do not exclude it. Moreover, fathers whose 5-year average age are equal to or greater than 55 are dropped in order to control the life-cycle bias. In order to impute grandfathers' missing earnings, fathers who do not report their fathers' characteristics are also excluded.

After selection, I merge sons, fathers and grandfathers into three samples based on household identification number provided by PSFD. Sample 1 contains 562 father-son pairs living in 425 households, which is used for estimating father-son relation. Sample 2 contains 1,721 grandfather-father pairs living in 1,721 households, which is used for estimating grandfather-father relation. Sample 3 consists of 379 grandfather-father-son observations living in 283 households, which is used for estimating grandfather-son

[21] Based on education system of Taiwan, students who graduate from junior high school may choose to enroll in junior college of 5-year program. If they complete this 5-year study, they will get junior college degree. For students who graduate from senior high school, they may choose to enroll in junior college of 2-year program or 3-year program. If they complete this 2-year or 3-year study, they will get junior college degree as well. However, the students who enroll in junior college of 5-year program but only complete first 3-year study will only get vocational high school degree. Moreover, vocational junior high school and junior college of 3-year program have been abolished in current education system in Taiwan.

[22] For instance, those who have no earning, those who refuse to answer and those who do not remember.

relation. Descriptive statistics for these three primary samples is shown in Table 1.

[Place Table 1 here]

As for pseudo grandfathers in MUS, those who have no earning report are dropped. Plus, those who do not report their characteristics are also dropped. As shown in Table 1, average age of grandfathers in survey years (i.e., 1999, 2000 and 2003) is 70.9 or 76.1, which implies that their average age should belongs to [45.9, 56,1] from 1978 to 1979 (20 to 25 years ago). Therefore, pseudo grandfathers in MUS whose age are older than 59 or younger than 40 are also excluded. At the end, there is 12,557 pseudo grandfathers in MUS. Table 2 shows descriptive statistics for supplementary sample.

[Place Table 2 here]

One important assumption for TS2SLS is that both primary sample and supplementary sample are randomly drawn from the same underlying population. Figure 3 shows the comparison between pseudo grandfathers and grandfathers. As shown in Figure 3, the distribution of characteristics among grandfathers and pseudo grandfathers does not vary that much, which implies that this assumption generationally holds in this study.

[Place Figure 3 here]

4. Estimation Results

4.1 Father-son relation

The estimate of intergenerational elasticity between fathers and sons based on sample 1 is shown in Table 3. Errors are clustered at household level.

[Place Table 3 here]

As shown in the column (1) of Table 3, the estimate of intergenerational elasticity between fathers and sons is 0.154. Since age of sons in this study is relatively young (26 to 40) due

to data structure as mentioned in Section 3.1 and OLS, instead of TS2SLS, is used here, therefore this result is smaller than results in previous Taiwanese studies (0.18 in Kan et al. (2015), 0.18 to 0.30 in Sun and Ueda (2015), 0.47 in Chu and Lin (2019)). In column (2) where fathers' economic status is measured by parents' earning, IGE between parents and sons is 0.197, and the difference between these two estimates is significant at conventional level.[23] One possible explanation is that parents' earning is a better proxy for family background, which contains more resources that can be transmitted from fathers' generation to sons' generation, and therefore may play a more important role than fathers' own earning.[24]

4.2 Grandfather-father relation and grandfather-son relation

The estimate of intergenerational elasticity between grandfathers and fathers based on sample 2 as well as that between grandfathers and sons based on sample 3 are shown in Table 4. Errors are clustered at household level. The estimation results of first step that using MUS 1978-1979 to estimate equation (3) is shown in Table A-1 in the Appendix. The R^2 for first step equation is 0.36, which indicates that education, occupation and self-employment status are strong earning predictors.[25]

[Place Table 4 here]

Column (1) of Table 4 shows the estimation results for grandfather-father relation. The estimate of IGE between grandfathers and fathers is 0.349, higher than that in Kan et al. (2015) (0.18) and Sun and Ueda (2015) (0.18 to 0.30), but smaller than that in Chu and Lin (2019) (0.47).[26] IGE estimate for grandfather-father relation is much higher than that for father-son relation. One explanation is life-cycle effects. In Section 4.1, sons' age is from 26 to 40 with an average age of 32.8 while fathers' 5-year average age is from 36.3 to 54.5 with an average of 47.3. In this section, however, fathers' 5-year average age is from 27 to 54.8 with an average of 41.3, while the earning of grandfathers is imputed at the age of 40. Such age patterns will make IGE estimates for sons much smaller than that for fathers because of the life-cycle patterns of earning or income. What's more, in Section 4.1, OLS

[23] Bootstrap Wald Test is used here. $\chi^2(1)$ Statistic is 4.08 ($p<0.05$) (number of replications = 500).
[24] After adding year dummies, the estimate of IGE between fathers and sons is 0.151, while that between parents and sons is 0.195.
[25] R^2 for first step equation is 0.35 after dropping all the age controls (i.e., ϕ_2 and ϕ_3).
[26] After adding year dummies, the estimate of IGE between grandfathers and fathers is 0.352.

is used and fathers' earning is averaged over 5 years. While in this section, TS2SLS is used and imputed values are used to replace grandfathers' missing earnings. Differences in estimation methods may further enlarge the gap between IGE estimate for sons and that for fathers. Moreover, from sons' generation to fathers' generation, Taiwan experienced very rapid economic growth and dramatic social changes (e.g., democratization and Taiwanization).[27] Such prosperous economy and pluralistic society may also contribute to increasing in IGM, that is, decreasing in IGE, from fathers' generations to sons' generations since children have more opportunities to get rid of the effect of family background. However, Chu and Lin (2019) found that for children in 1990-1994 periods and for children in 2005-2010 periods, IGE remains almost the same, which implies that the so-called "Taiwan Miracle" does not increase the intergenerational mobility.

Column (2) of Table 4 shows the estimation results for grandfather-son relation. The estimate of IGE between grandfathers and sons is 0.159 and is statistically significant ($p = 0.052$).[28] This result indicates that in Taiwan, grandparents' economic status does affect sons' economic status. After considering grandfather's death, it is surprising to find that the death of grandfather only reduces IGE by 0.009, although it is statistically significant ($p = 0.058$).[29] It means that although grandfather had passed away when son was born, which indicates that they do not have any chance to meet each other in this life, grandfather's economic status can still be stably transmitted to his grandson.

4.3 Decomposition of IGE between grandfathers and sons

Next, IGE between grandfathers and sons is decomposed based on Blanden et al. (2014)'s method as mentioned in Section 2.3. Decomposition results is shown in Table 5. In this part, all the analyses are conducted in sample 3.[30]

[Place Table 5 here]

[27] Chu and Lin (2019) provides a more detailed description of background in Taiwan.
[28] After adding year dummies, the estimate of IGE between grandfathers and sons is 0.156.
[29] Here, "death of grandfather" means that grandfather had passed away when son was born as mentioned in Section 2.2. If death of grandfather is defined as grandfather had passed away when son was ***three*** years old (***six*** years old), then death of grandfather will reduce IGE by -0.007 with $p = 0.132$ (-0.006 with $p = 0.299$).
[30] The same as Section 4.1 and 4.2, errors are clustered at household level, and year dummies are excluded.

In the top panel of Table 5, fathers' economic status is measured by own earning. After controlling for both fathers' economic status and grandfathers' economic status, the estimate of IGE for sons *wrt.* fathers is 0.144. The estimate of IGE for fathers *wrt.* grandfathers is 0.460 after re-estimating equation (5) in sample 3. This means that the indirect effect of grandfathers' economic status, which is transmitted through fathers' economic status, is 0.066, which can explain about 41.46% of IGE between grandfathers and sons.

In the bottom panel of Table 5, fathers' economic status is measured by parents' earning. The estimate of IGE for sons *wrt.* parents after controlling for both parents' and grandfathers' economic status is 0.201, while the estimate of IGE for parents *wrt.* grandfathers is 0.497. These results indicate that the indirect effect of grandfathers' economic status is 0.100, which can explain about 62.83% of IGE between grandfathers and sons. Lastly, if grandfather had passed away when son was born, then the percentages of indirect effect are higher. One should note that the estimate of IGE for parents *wrt.* grandfathers is higher than that for fathers *wrt.* grandfathers.[31] This reflects the effect of assortative mating on IGM. As summarized by Chadwick and Solon (2002), the IGE of child's couple *wrt.* child's parents equals to the weighting average of the IGE of child *wrt.* his own parents and the IGE of child's spouse *wrt.* her parents-in-law. The weighting factor is the share of child's own earning / income in couple's total earning / income. Therefore, this result implies that IGE for fathers' spouses *wrt.* their fathers-in-law is higher than IGE for fathers' *wrt.* their own fathers, which further indicates that marriage will reduce IGM (i.e., increase IGE) in fathers' generation because of the effect of assortative mating.

These decomposition results indicate that, most of grandparents' effect on grandchild is transmitted through its direct effect on parents. Meanwhile, more researches are needed for exploring the remaining 30% to 40% of grandfathers' effect, which can be divided into two parts based on the spirit of this study: (1) indirect effect through its effect on other relatives (e.g., uncles, aunts, …) that might effect sons' economic status; (2) unexplained part that might be attributed to grandfathers' direct and independent effect on sons' economic status.

[31] The difference, however, is insignificant ($\chi^2(1)$ Statistic for Bootstrap Wald Test is 0.67 with p>0.40).

5. Conclusion

This study provides initial evidence of intergenerational mobility of economic status across multi-generations in Asian world. Father-son relation, grandfather-father relation as well as grandfather-son relation are considered, and grandfathers' earning is imputed based on their characteristics by applying Two-Sample Two-Stage Least Square method.

Estimation results indicate that the intergenerational elasticity between fathers and sons lies around 0.154, and the intergenerational elasticity between grandfathers and fathers lies around 0.349. The difference between these two estimates might be attributed to life-cycle effect and difference between OLS and TS2SLS. This study also finds that the intergenerational elasticity between grandfathers and sons lies around 0.159 and is significant, which indicates that grandparents' economic status does affect children's economic status in Taiwan. Grandfathers' death does not affect estimation results much although it has significant negative effect. After controlling for fathers' or both parents' earning, decomposition results indicate that fathers' earning can explain 41.66% to 44.16% of IGE between grandfathers and sons, while both parents' earning can explain 62.83% to 66.60% of IGE between grandfathers and sons. This means that grandparents' economic status mainly affects children's economic status indirectly.

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Table 1 Descriptive statistics for three primary samples

	Variable	Mean	S.D.	Min.	Max.
Sample 1: father-son relation (n = 562)	annual earning of son	13.17	0.54	9.44	15.52
	5-year average earning of father	13.21	0.61	10.94	15.27
	5-year average earning of parents	13.54	0.62	10.94	15.47
	son's age	32.76	3.36	26.00	40.00
	father's 5-year average age	47.32	3.96	36.33	54.50
Sample 2: grandfather-father relation (n = 1,721)	5-year average earning of father	13.34	0.59	9.33	16.15
	father's 5-year average age	41.33	6.97	27.00	54.75
	grandfather's age in survey year	70.92	9.79	45.00	107.00
	grandfather's education (ref: illiteracy and self-study)				
	elementary school	46.78%	0.50		
	junior high school	10.11%	0.30		
	senior high school	11.45%	0.32		
	junior college	2.73%	0.16		
	university	5.11%	0.22		
	grandfather's occupation (ref: agricultural)				
	professional	5.29%	0.22		
	administrative and managerial	6.51%	0.25		
	clerical	8.66%	0.28		
	sales	10.75%	0.31		
	service	8.31%	0.28		
	production	26.21%	0.44		
	self-employed	54.56%	0.50		

Table 1 Descriptive statistics for three primary samples (Continued)

Sample 3: grandfather - son relation (n = 379)	annual earning of son	13.20	0.55	9.44	15.52
	5-year average earning of father	13.24	0.64	10.94	15.27
	5-year average earning of parents	13.56	0.64	10.94	15.47
	son's age	32.57	3.41	26.00	40.00
	father's 5-year average age	47.01	3.93	36.50	54.50
	grandfather's age in survey year	76.08	8.06	56.00	98.00
	grandfather's death when son was born	0.16	0.37		
	grandfather's education (ref: illiteracy and self-study)				
	elementary school	46.17%	0.50		
	junior high school	9.23%	0.29		
	senior high school	5.80%	0.23		
	junior college	1.32%	0.11		
	university	2.90%	0.17		
	grandfather's occupation (ref: agricultural)				
	professional	2.90%	0.17		
	administrative and managerial	2.90%	0.17		
	clerical	11.35%	0.32		
	sales	7.12%	0.26		
	service	5.01%	0.22		
	production	20.05%	0.40		
	self-employed	64.91%	0.48		

Notes:

1. Earnings are in form of logarithm.

Table 2 Descriptive statistics for supplementary sample

Variable	Mean	S.D.	Min.	Max.
pseudo grandfather's annual earning	12.22	0.60	8.53	15.03
pseudo grandfather's age	48.47	5.54	40.00	59.00
pseudo grandfather's education (ref: illiteracy or self-study)				
elementary school	53.93%	0.50		
junior high school	10.34%	0.30		
senior high school	10.25%	0.30		
junior college	2.82%	0.17		
university	4.44%	0.21		
pseudo grandfather's occupation (ref: agricultural)				
professional	4.60%	0.21		
administrative and managerial	2.44%	0.15		
clerical	10.47%	0.31		
sales	11.28%	0.32		
service	8.41%	0.28		
production	28.59%	0.45		
self-employed	48.41%	0.50		

Notes:

1. Num. of obs. = 12,557.
2. Earnings are in form of logarithm.

Table 3 Intergenerational elasticity between fathers and sons

	(1) log (son's annual earning)	(2) log (son's annual earning)
log (father's 5-year average earning)	0.154***	
	(0.044)	
log (parents' 5-year average earning)		0.197***
		(0.039)
age of son	-14.191	-12.870
	(24.282)	(23.798)
(age of son)^2	0.683	0.618
	(1.126)	(1.103)
(age of son)^3	-0.014	-0.013
	(0.023)	(0.023)
(age of son)^4	0.000	0.000
	(0.000)	(0.000)
5-year average age of father	1.781	0.370
	(18.258)	(18.446)
(5-year average age of father)^2	-0.042	0.001
	(0.606)	(0.612)
(5-year average age of father)^3	0.000	-0.000
	(0.009)	(0.009)
(5-year average age of father)^4	-0.000	0.000
	(0.000)	(0.000)
constant	95.177	101.900
	(280.774)	(278.979)
Obs.	562	562
R-squared	0.104	0.124

Notes:

1. Robust standard errors are in parenthesis (errors are clustered at household level).
2. *** p<0.01, ** p<0.05, * p<0.1.

Table 4 Intergenerational elasticity between grandfathers and fathers as well as that between grandfathers and sons

	(1) log (father's 5-year average earning)	(2) log (son's annual earning)
grandfathers' earning at 40 (imputed value)	0.349***	0.159*
	(0.039)	(0.082)
grandfathers' earning at 40 (imputed value) × death of grandfather		-0.009*
		(0.005)
5-year average age of father	-2.139	
	(1.408)	
(5-year average age of father)^2	0.088*	
	(0.053)	
(5-year average age of father)^3	-0.002*	
	(0.001)	
(5-year average age of father)^4	0.000*	
	(0.000)	
age of son		0.827
		(28.714)
(age of son)^2		0.001
		(1.328)
(age of son)^3		-0.001
		(0.027)
(age of son)^4		0.000
		(0.000)
constant	27.462**	-2.335
	(13.795)	(231.919)
Obs.	1721	379
R-squared	0.065	0.093

Notes:

1. Robust standard errors are in parenthesis (errors are clustered at household level).
2. *** p<0.01, ** p<0.05, * p<0.1.

Table 5 Decomposition results

measurement of fathers' economic status	grandfathers' death (D_i)	total IGE between grandfathers and sons ($\beta_3 + \delta_1 D_i$)	decomposition		percentage of IGE that is explained by indirect effect
			IGE between grandfathers and fathers (β_2)	IGE between fathers and sons (β_4)	
fathers' own earning	alive ($D_i = 0$)	0.159	0.460***	0.144***	41.66%
			(0.134)	(0.053)	
	dead ($D_i = 1$)	0.150			44.16%
parents' earning	alive ($D_i = 0$)	0.159	0.497***	0.201***	62.83%
			(0.127)	(0.045)	
	dead ($D_i = 1$)	0.150			66.60%

Notes:

1. Robust standard errors are in parenthesis (errors are clustered at household level).
2. *** p<0.01, ** p<0.05, * p<0.1.

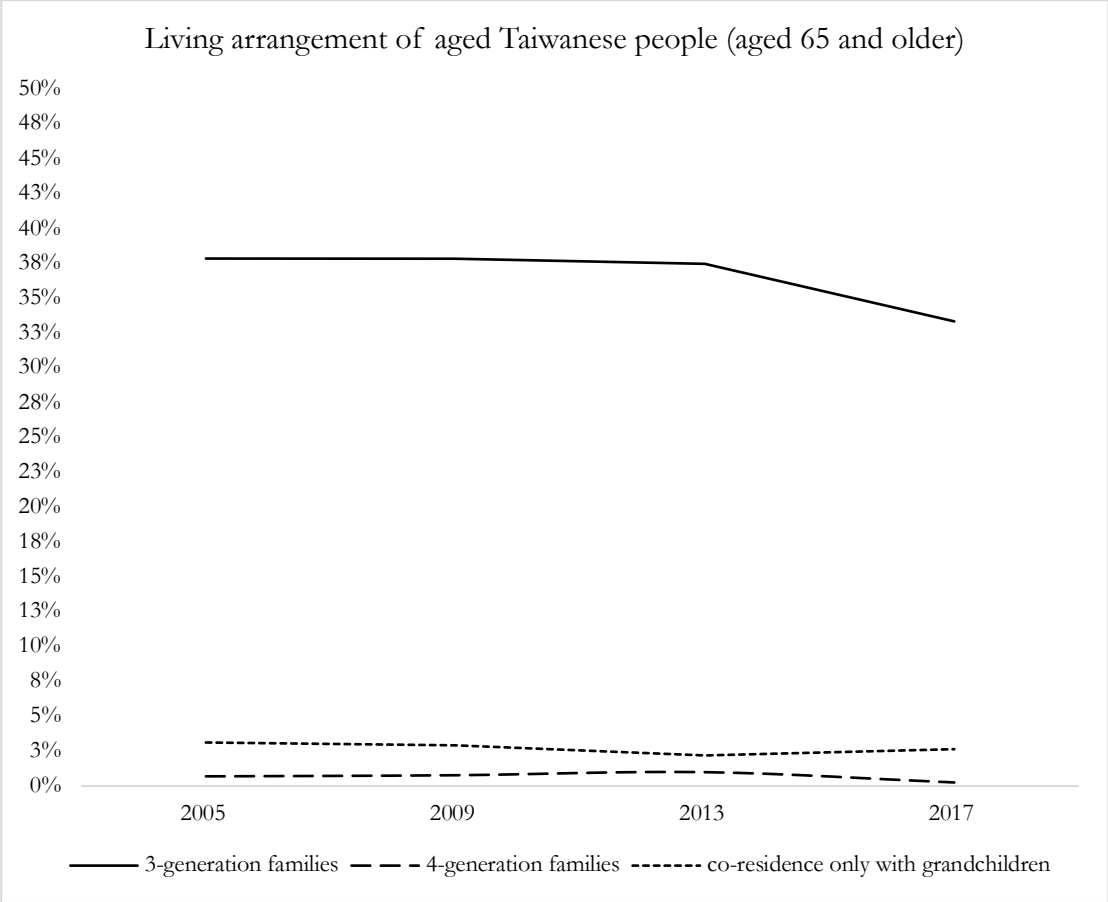

Figure 1 Living arrangement of aged Taiwanese people (aged 65 and older)

Data source: *Report of the Senior Citizen Condition Survey*, Ministry of Health and Welfare

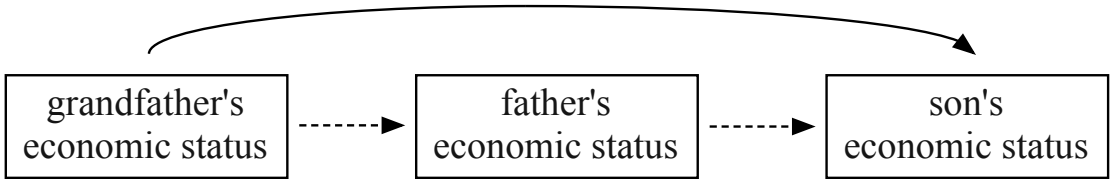

Figure 2 Effect of grandfathers' economic status on sons' economic status

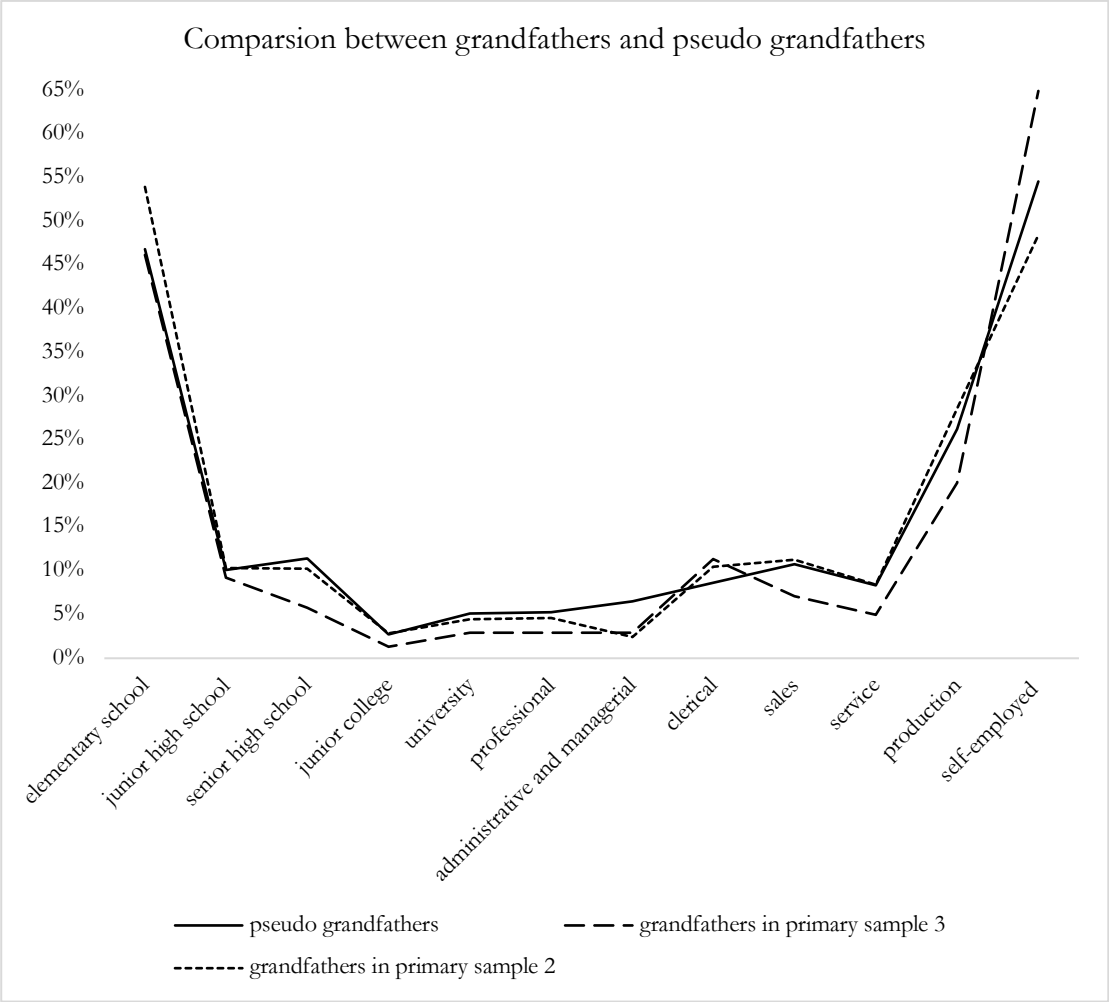

Figure 3 Comparison between grandfathers and pseudo grandfathers

Appendix

Table A-1: First step regression results

elementary school	0.063**	elementary school × (age – 40)	0.007	professional × (age – 40)	0.008
	(0.031)		(0.008)		(0.016)
junior high school	0.135***	junior high school × (age – 40)	0.010	administrative and managerial × (age – 40)	0.016
	(0.042)		(0.011)		(0.022)
senior high school	0.337***	senior high school × (age – 40)	-0.015	clerical × (age – 40)	0.019
	(0.049)		(0.013)		(0.013)
junior college	0.448***	junior college × (age – 40)	-0.038*	sales × (age – 40)	-0.029**
	(0.080)		(0.020)		(0.011)
university	0.592***	university × (age – 40)	-0.028*	service × (age – 40)	-0.004
	(0.066)		(0.017)		(0.012)
professional	0.645***	elementary school × $(age – 40)^2$	-0.000	production × (age – 40)	-0.001
	(0.060)		(0.000)		(0.009)
administrative and managerial	1.004***	junior high school × $(age – 40)^2$	-0.000	Professional × $(age – 40)^2$	0.000
	(0.078)		(0.001)		(0.001)
clerical	0.652***	senior high school × $(age – 40)^2$	0.001	administrative and managerial × $(age – 40)^2$	0.000
	(0.048)		(0.001)		(0.001)
sales	0.707***	junior college × $(age – 40)^2$	0.002**	clerical × $(age – 40)^2$	-0.001
	(0.040)		(0.001)		(0.001)
service	0.471***	university × $(age – 40)^2$	0.001	sales × $(age – 40)^2$	0.002**
	(0.049)		(0.001)		(0.001)
production	0.561***			service × $(age – 40)^2$	-0.000
	(0.031)				(0.001)
self-employed	0.179***			production × $(age – 40)^2$	-0.000
	(0.027)				(0.001)
(age – 40)	-0.010			self-employed × (age – 40)	-0.007
	(0.010)				(0.008)
$(age – 40)^2$	0.000			self-employed × $(age – 40)^2$	0.000
	(0.001)				(0.000)
constant	11.695***				
	(0.037)				
Obs.	12557				
R-squared	0.355				

Notes:

1. Robust standard errors are in parenthesis.
2. *** p<0.01, ** p<0.05, * p<0.1.
3. Dependent variable is logarithm of pseudo grandfathers' annual earning.
4. Year dummies are not included in regressions (After adding year dummies, estimation results remain almost the same.).