Stagnation Generation: Evaluating the Impact of Higher Education Expansion on Social Mobility from the Perspective of Taiwan

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Summary: Social class stagnation is a current topic of concern. The stagnation of generational mobility could result in society losing its ability to enhance individuals' social status. This study explored higher education expansion as a possible cause of class stagnation by adopting the Human Development Index as a comprehensive indicator of individual social status, and determined dynamic mobility by observing the case of Taiwan, where higher education was expanded in 1994. Pseudo-panel data were obtained from the Family Income and Expenditure Survey. Our results indicate that rapid higher education expansion has a negative impact on social mobility for the generation who enters the labor market after the expansion starting point.

Keywords: Social class, Education expansion, Pseudo-panel data, Difference-in-difference
JEL Classifications: J62, O15, I25

1. Introduction

Over the past half century, the income gap between rich and poor has expanded in many developed and developing countries. Furthermore, the shrinking of the middle class is indicative of stagnation in the evolution of social classes (Lindley & Machin, 2012; Mok, Ho & Jiang, 2016). Although an increasing number of young people are highly educated, they have not experienced personal economic growth as rapidly as their counterparts in previous generations. Those who have recently graduated earn relatively low wages that do not increase as quickly as in previous generations, implying the presence of a problem related to intergenerational equity.

This study examined the effects of education expansion policies on the social class mobility of individuals. To prevent possible bias and weak identification problems due to estimation based on income described in the previous literature (for example, Blanden,

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Gregg, & Macmillan, 2007; Belley & Lochner, 2007), we used a multidimensional indicator comprising personal health, knowledge, and standard of living, to define the social class of all individuals in this study. The indicator was further adopted to construct a measurement of social flows (***SF***). We exploited a natural experiment arising from institutional changes that was developed by Taiwan's enactment of higher education expansion after 1994. Our identification was strengthened by the presence of a generation close to the education expansion starting point that did not benefit from it and the gradual increase in the intensity of expansion until 2007. In addition, we used the data of Taiwanese individuals who provided a complete set of information regarding personal characteristics information which could be used as panel data (named pseudo-panel). The data could be used to observe and calculate social mobility and observe the changes in this generation in the early years after they entered the workplace. These conditions enabled us to adopt a difference-in-differences approach for identification.

The remainder of this study proceeds as follows. Section 2 introduces the related studies. Section 3 describes the process of higher education expansion in Taiwan. Section 4 presents the empirical data and strategies. In Section 5, we discuss the estimation results. Finally, our conclusions are offered in Section 6.

2. Literature Review

Although individuals' social achievements are often subject to their parental social classes, according to Gary Solon (1992) and Jere Behrman, Nancy Birdsall, and Miguel Szekely (2000), education is considered to improve social class. A sufficient investment in education can improve individuals' performance in the labor market (Becker, 1964; Mincer, 1974). Therefore, numerous developed and developing countries have made efforts to improve higher education, resulting in an increase in the worldwide enrollment rate for higher education from 10% in 1970 to 29% in 2010 (World Bank Statistics), by which time regional enrollment rates were 29% in East Asia and the Pacific, 58% in Europe and Central Asia, and over 85% in North America.

Some studies have found that income stagnation among the younger generation occurs in countries whose higher education systems have undergone substantial expansion. For example, the United Kingdom expanded higher education in the 1980s. Stephen Machin and Paul Gregg (2003) and Jo Blanden, Alissa Goodman, Paul Gregg and Stephen Machin (2005) have reported that income mobility in the United Kingdom for people born in 1958 was higher than that for those born in 1970 who directly experienced higher education expansion as students. Jo Blanden and Stephen Machin (2008) suggested that the popularization of education in the United Kingdom resulted in a severe decline in income mobility. Moreover, intragenerational income mobility in the United Kingdom has remained stagnant for more than 30 years (Lindley and Machin, 2012). Robert Haveman and Timothy Smeeding (2006) proposed that the inequality of education resources after higher education expansion led students from poor families to pay more for higher education and affected their future social mobility.

Sufficient research does not exist regarding the effects of education expansion for

the purposes of policy evaluation. Moreover, although a few studies have found such a mobility problem, the literature is considerably limited in the manner by which it measures social mobility, for example, Kromydas (2017) mentioned that "the research in these areas tends to be less focused on social mobility and is less developed." Some authors proposed that social class should be defined not only by economic status but also by standards of living and empowerment (e.g., Pakulski, 2005). Nevertheless, most related studies have focused only on income, namely, measures of the level of income, income distribution, and income elasticity as indicators of social mobility (Solon, 1992; Fields & Ok, 1996; Behrman, Birdsall, & Szekely, 2000; Belley & Lochner, 2007; Blanden, Gregg, & Macmillan, 2007). Some studies have used income inequality to measure inter-generational mobility, for example, Peter Gottschalk and Enrico Spolaore (2002), John Ermisch and Marco Francesconi (2004), Nathan D. Grawe (2004), and John Ermisch, Markus Jäntti, and Timothy M. Smeeding (2012). Other studies have observed intergenerational income correlations (Atkinson, Maynard, & Trinder, 1978), and Anthony F. Shorrocks (1978a, 1978b) adopted the Markov transition matrix to estimate the intergenerational income covariance to measure mobility. A representative and convincing indicator of social mobility does not seem to exist in the literature.

To deal with these shortcomings, we examined the effects of educational expansion policy on intra-generational social mobility in this study. Our empirical results should be relevant for education policy makers in developed countries because several of these countries are currently considering expanding education. To prevent possible bias and weak identification associated with using only income-based measurements in estimations, we consider a comprehensive indicator– the Human Development Index (HDI) – constructed with proxies for personal healthy lifestyle, knowledge, and standard of living, used to define an individual's social stratification and status. This lifestyle approach incorporates the suggestions of Christopher Jencks, Lauri Perman, and Lee Rainwater (1988) and Amartya Sen (1997) that income does not exhaustively describe quality of life and fails to capture the social organization of inequality.

3. Higher Education Expansion in Taiwan

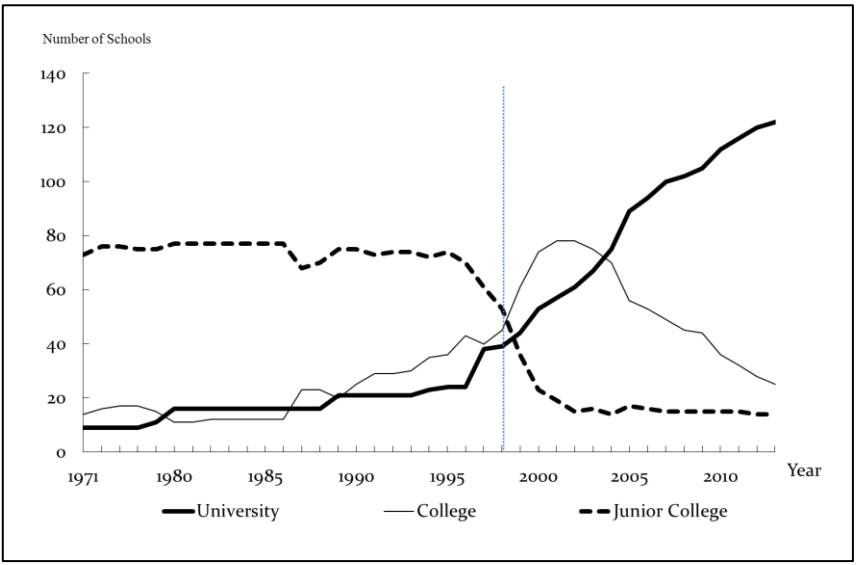
The history of educational development in Taiwan can be divided into three periods: martial law, post martial law, and expansion. Taiwan was under martial law from 1949 to 1987 to stabilize the political situation and society at that time. This period saw substantial developments in the industrial and service sectors, both of which saw considerable increases in employment and output. Employment in the industrial sector has stagnated since 1987. By contrast, the output share and employment share in the agricultural sector has dropped substantially since the 1960s. In 1958, compulsory education was extended from 6 to 9 years. Gross domestic product (GDP) and GDP per capita also experienced considerable growth during these years. Rapid growth in personal and family income were the main causes of the high demand for higher education expansion. In 1987, martial law was abolished, and the quality of life improved substantially with economic growth. Subsequently, the demand for higher

education increased as people became aware of its importance, with some attempting to organize communities for higher education reform. Under pressure from the public, the Taiwanese government abolished restrictions on junior colleges and technological institutes. Consequently, the number of such institutions increased by 18 from 1987 to 1993.

On April 10, 1994, more than 100 social organizations combined to launch the "410 Parade" and lobbied for the government to establish more high schools and universities. Subsequently, the Education Reform Committee was established by the government, and the university law was revised, resulting in education in Taiwan no longer being concentrated in the central government; local governments were conferred academic freedom and autonomy. Consequently, colleges and universities were established in larger numbers, and parts of colleges and technological institutes were restructured as universities, rapidly increasing the number of domestic universities.

Following this expansion, the quality and quantity of higher education became a subject of dispute. In 2001, the Ministry of Education implemented restrictions on enrollment numbers and student–teacher ratios in universities. In 2007, the government forbade the restructuring of colleges and vocational schools into universities, and froze the enrollment of master's and PhD students. Nevertheless, a few new schools were established. The number of colleges and universities increased by 92 from 1994 to 2012.

Figure 1 shows the trend of the number of higher education schools in Taiwan. The number was constant before 1990. The number of universities and colleges increased slightly after 1994 and then substantially after 1998. Because many junior colleges were restructured to serve as colleges, the number of junior colleges decreased considerably after 1996. Similarly, many colleges were planned to be converted into universities; therefore, the number of colleges decreased after 2002. Until 2016, 158 universities and colleges were open in Taiwan.



Source: Department of Statistics, Ministry of Education
(Accessed September, 2016)

Figure 1 Higher Education Schools in Taiwan

4. Methodology and Data

Most studies have used income mobility to investigate intergenerational social mobility. However, intergenerational upward flow has generally been more frequent and occurred more easily, particularly given the technological developments in the 20th century, with which intergenerational social mobility had a highly positive correlation (Gershuny, 1993). Christopher Jencks and Laura Tach (2005) suggested that inter–generational income cannot be an absolute indicator for judging degrees of social mobility. They reported that the highly positive correlation between parents and children in terms of inter-generational income mobility can only be explained as a result of successful parents being stricter and having higher expectations for their children enabling their children to be successful. If we use only income or education to evaluate mobility, then the evaluation may be biased and may overlook other possible factors that contribute to an individual's social class. For example, if two individuals have the same level of income and education, but one has longer working hours and the other one usually has time to engage in leisure activities, their social statues should be classified differently. Therefore, we adopted a comprehensive index, the HDI, to capture three dimensions of social status, including economic status (income/standard of living), education status (knowledge), and lifetime (health and quality of life). We choose the

HDI to observe multiple aspects of each person and specify their social class in this study.

4.1 Definitions of Social Classes

This study identifies social class in accordance with the United Nations' HDI (Human Development Report, 2016). The HDI combines individuals' endowments, independence or dominance, and employment performance, which comprises health, educational level, and standard of living. The index covers social and economic aspects and is expressed as follows:

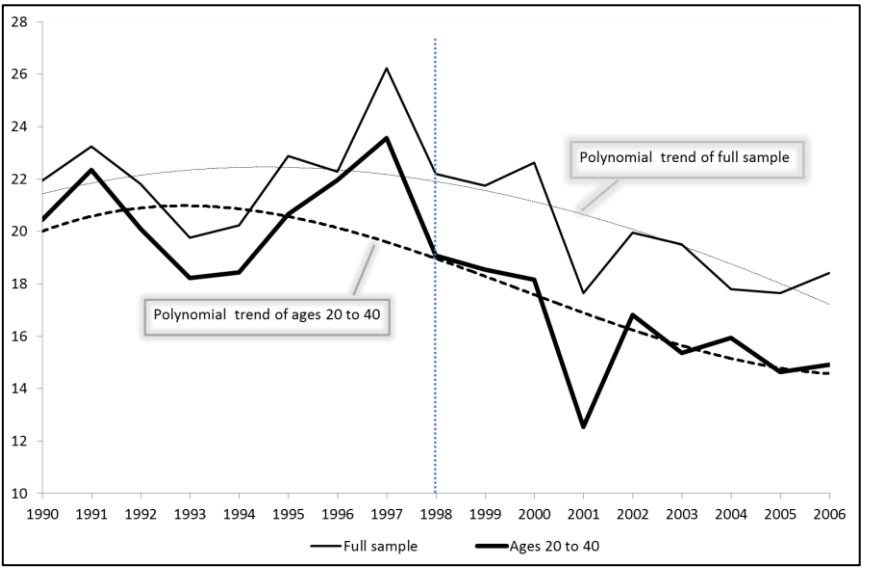
$$HDI_{it} = \sqrt[3]{L_{it} \times E_{it} \times I_{it}}\,, \tag{1}$$

where L_{it} is the percentile of individual "*i*'s" health, E_{it} is the percentile of individual "*i*'s" educational level, and I_{it} is the percentile of individual "*i*'s" standard of living. Each percentile is measured as follows:

$$Q\% = \frac{Q - \min(Q)}{\max(Q) - \min(Q)} \times 100, \quad Q = L, E, \text{or } I,$$

where max (·) and min (·) are the maximum and minimum values in year t, respectively. We consider that the education expansion policy allows most high school graduates to enroll in higher education, but choosing to complete a master's degree or a doctoral degree is still an independent option. Therefore, this paper sets junior college and university graduates as the basic observations, and subsequent years of study are regarded as independent situations. In addition, in this paper, the calculation of the HDI is based on the percentile relative to the median, not the original value, which can avoid the problem of endogeneity (see page 12 of this study).

Figure 2 shows the results of a preliminary examination of the effect of Taiwan's education expansion on the HDI. We expanded the sample period to 1990–2006 to further understand HDI trends over time. The data were obtained from the Taiwan Family Income and Expenditure Survey (TFIES), described in the Data and Samples section. The figures show HDI values from university graduate samples (including junior and senior colleges) of students aged 20–60 years. A total of 135,763 observations were collected. Figure 2 shows that annual and polynomial trends in the HDI decreased after 1998. The full sample and ages 20–40 years in the average HDI increased slightly after 1998, implying that the social status among the younger sample declined compared with the older sample (ages 41–60). To accommodate the potential effects of macroeconomic variables on the HDI, we included county unemployment rates and consumer price index to control for the effect of macroeconomic conditions in the empirical models.



Source: Authors' calculations.

Figure 2 Changes in the HDI for All University Graduates

4.2 Data and Samples

Our empirical analysis is based on a sequence of yearly cross-sectional family data from the TFIES, an annual individual-level survey that has been conducted by Taiwan's Directorate General of Budget, Accounting and Statistics since 1961. The purpose of the TFIES is to collect information regarding families' income and expenditures. Through TFIES data, the government can understand each family's overall income distribution and quality of life. In addition, the government uses TFIES data to design and evaluate fiscal policies and social welfare programs.

The TFIES survey adopts a two-stage random sampling method. In the first stage, villages and communities (called "li") are drawn as small administrative geographical units. The drawing of villages and communities in this stage is accomplished through stratified sampling, where villages and communities are stratified based on their degrees of urbanization, industrial structure, and residents' attained educational levels. In the second stage, households are drawn from the sampled villages and communities. All people in a sampled household are interviewed to collect information regarding household equipment, housing profiles, household composition, income items, and expenditures. In addition, each individual's demographic characteristics (e.g., age, sex, and relationship to head of the family), employment status, and job characteristics (e.g., occupation, industry, and sector) are collected. The sample size per year is approximately 14,000.

To estimate the relative impact of the education expansion policy between the generations just before the expansion starting point and the earlier generations, which are older than "the generations just before expansion time point," we adopted panel data to track social class changes. Because the TFIES survey is regarded as pooled data and not panel data, we used the concept of panel data to specify pseudo-panel groups. The pseudo-panel groups were categorized based on an individual's characteristics, namely sex, age, marital status, education, employment status, sector, occupation, industry, and location. We treated each panel group as a represented individual, and each panel had average items of income and expenditure. Relative to pooled data, pseudo-panel groups can be used to track a represented individual's patterns and observe marginal effects.

To observe the influence of educational expansion, we selected the last generation before the expansion of education, that is, the generation born in 1971–75, and the earlier generation, the generation born in 1966–70. Moreover, the college graduates from the generation born in 1966–70 entered the labor market in 1988–92. The 1971–75 generation entered the labor market after 1993–97, immediately before and after the educational expansion. We obtained a total series of panel group samples from 1998 to 2006, with 1998, 2002, and 2006 selected for our empirical analysis. The purpose of selecting 2002 and 2006 in this paper was to control for the employment time of the two generations and compare the gap between them. Table 1 present the definitions.

To calculate the HDI, "healthy lifestyle" was originally measured by the average final age, but we could not ascertain the interviewees' final age from the data. We assumed that a person would likely have a longer life if he or she frequently engaged in proper leisure activities. The American National Cancer Institute highlighted that physical activity during leisure hours can prolong life by approximately 4.5 years. Steven C. Moore et al. (2012) also revealed a positive relationship between leisure and lifetime. Therefore, we substituted final age with "leisure," which could be measured based on "entertainment, education and cultural expenditures" in the TFIES.

Table 1 Variable Definitions

Variables	Description of variables
Male	Binary indicator of gender, defined as Male=1 if male, Male=0 if female.
Age	Age of individual.
Employment	Binary indicator of employment status, defined as Employment =1 if employed, Employment =0 if unemployed.
Married	Binary indicator of marital status, defined as Married=1 if married, Married=0 if single.
Education_year	Years of education.
Sector	Indicator of employment sector, defined as Sector_public=1 if public sector, Sector_public=0 otherwise. Sector_private=1 if private sector, Sector_private=0 otherwise.
Identity	Indicator of employment identity, defined as Identity_employer=1 if employer, Identity_employer=0 otherwise. Identity_employee=1 if employee, Identity_employee=0 otherwise. Identity_self-employed =1 if self-employed, Identity_self-employed=0 otherwise.
Location	Regional indicator, defined as Location_north=1 if living in the north of Taiwan, Location_north=0 otherwise. Location_mid=1 if living in the middle of Taiwan, Location_mid=0 otherwise. Location_south=1 if living in the south of Taiwan, Location_south=0 otherwise.
Industry	Industry indicator, defined as Industry_manu=1 if manufacturing, Industry_manu=0 otherwise. Industry_water=1 if water, electricity, and gas Industry, Industry_water=0 otherwise. Industry_cons=1 if construction, Industry_cons=0 otherwise. Industry_trans=1 if transportation, storage, and communications, Industry_trans=0 otherwise. Industry_busi=1 if business, Industry_busi=0 otherwise. Industry_serv=1 if service, Industry_serv=0 otherwise.
Occupation	Occupation indicator, defined as Occupation_manager=1 if manager, Occupation_manager=0 otherwise. Occupation_prof=1 if profession, Occupation_prof=0 otherwise. Occupation_worker=1 if worker, Occupation_worker =0 otherwise.
Year	Yearly indicator, defined as Year_2002=1 if 2002, Year_2002=0 otherwise. Year_2006=1 if 2006, Year_2006=0 otherwise.

Source: Authors' compilation.

To prevent one of the three items in the HDI from being zero, which would result in the HDI being "0" and thereby rendering the other two items meaningless, we replaced the value of items in the HDI with 0.01 if they were zero. In addition, "knowledge" was measured by years of education. We considered the value of education to have a stronger relationship with labor supply and demand; therefore, minimum years of education was replaced by mode number of education years (not "0"), which represented the reality that an individual's educational level is relatively valueless when their years of education are located on the mode. The percentile of education was

$$\mathrm{E}\% = \left|\frac{\mathrm{E}-\mathrm{mode(E)}}{\max(\mathrm{E})-\mathrm{mode(E)}} \times 100\right|.$$

Tables 2 and 3 present statistical descriptions for all variables. In the full university graduate sample, the demographic characteristics varied slightly between the two birth periods (Table 2). In the sample where those born in 1966–70 were older, the employment status and marital rate were higher than for those born in 1971–75. The longer employment period provided those people with sufficient time to make career choices or be admitted to public offices. Therefore, the proportions of public sector employees, and employers or managers were higher for those born in 1966–70. The sample born in 1966–70 also had higher annual income and leisure expenditure on average, at NT$347,259.9 (approximately US$11,575) and NT$34,660.6 (approximately US$1,155), respectively. The 1971–75 sample had an average income of NT$190,108.4 (approximately US$6,336) and an average leisure expenditure of NT$29,548.1 (approximately US$984). These patterns were similar in the pseudo-panel samples (Table 3).

Table 2 Descriptive Statistics for University Graduates

	Born 1966−70		Born 1971−75	
Variables	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Male	0.5599	0.4964	0.4989	0.5001
Age	35.5630	3.3982	28.3061	3.7809
Employment	0.8842	0.3200	0.7668	0.4228
Married	0.8062	0.3953	0.3679	0.4823
Education_year	15.1256	1.3250	15.1738	1.3278
Sector_public	0.2179	0.4128	0.1042	0.3486
Sector_private	0.6953	0.4603	0.6690	0.4450
Identity_employer	0.0321	0.1763	0.0066	0.0812
Identity_employee	0.7875	0.4091	0.7197	0.4492
Identity_self-employed	0.0472	0.2121	0.0190	0.1366
Location_north	0.5127	0.4755	0.4561	0.3590
Location_mid	0.2460	0.2749	0.2331	0.2299
Location_south	0.1332	0.1639	0.1977	0.1621
Industry_manu	0.2910	0.3931	0.2149	0.4319
Industry_water	0.0063	0.0790	0.0015	0.0477
Industry_cons	0.0187	0.2054	0.0342	0.2313
Industry_trans	0.0332	0.1792	0.0281	0.1704
Industry_busi	0.0377	0.1905	0.0272	0.1676
Industry_serv	0.4629	0.4987	0.3458	0.4884
Occupation_manager	0.0946	0.2927	0.0196	0.1718
Occupation_prof	0.5136	0.5000	0.4046	0.4997
Occupation_worker	0.2717	0.4449	0.3295	0.4705
Year_2002	0.3239	0.4169	0.3660	0.4959
Year_2006	0.3159	0.4115	0.2982	0.4957
No. of adults (family)	2.4697	1.0668	3.0956	1.3618
No. of children (family)	1.6332	1.1068	0.7590	1.0619
Annual Income	347,259.9	411,482.9	190,108.4	248,650.0
Annual Expenditures on Leisure	34,660.6	32,193.2	29,548.1	27,883.0
CPI (base=2006)	96.1276	2.0845	96.6556	2.2003
Unemployment rate	3.6089	1.0141	4.2125	1.0301
Observations	**5,572**		**6,626**	

Source: Authors' compilation.

Table 3 Descriptive Statistics for Pseudo-panel Groups

	Born 1966−70		Born 1971−75	
Variables	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Male	0.5430	0.4984	0.4991	0.5333
Age	36.8785	2.4086	31.4973	2.5754
Employment	0.9226	0.2674	0.8998	0.3004
Married	0.7989	0.4590	0.5215	0.4997
Education_year	15.4753	1.4847	15.4644	1.4669
Sector_public	0.2408	0.4278	0.0730	0.3784
Sector_private	0.6913	0.4622	0.7784	0.4397
Identity_employer	0.0256	0.2896	0.0131	0.1389
Identity_employee	0.8005	0.4273	0.7745	0.3992
Identity_self-employed	0.0258	0.3644	0.0144	0.1876
Location_north	0.4990	0.5012	0.4732	0.4008
Location_mid	0.2565	0.3009	0.2175	0.3609
Location_south	0.1676	0.2541	0.1700	0.1545
Industry_manu	0.3155	0.3714	0.3781	0.3908
Industry_water	0.0046	0.0891	0.0055	0.0389
Industry_cons	0.0223	0.2981	0.0188	0.2563
Industry_trans	0.0294	0.1346	0.0319	0.090
Industry_busi	0.0412	0.2334	0.0324	0.1337
Industry_serv	0.4868	0.5122	0.4277	0.5180
Occupation_manager	0.1219	0.3992	0.0256	0.1232
Occupation_prof	0.5911	0.5105	0.5012	0.5587
Occupation_worker	0.2565	0.4378	0.3242	0.4516
Year_2002	0.5129	0.5001	0.4949	0.5002
Year_2006	0.4871	0.5001	0.5051	0.5002
No. of adults (family)	2.2753	0.8653	2.8943	1.1141
No. of children (family)	1.4914	0.9127	0.8512	0.8780
Annual Income	358,119.1	344,457.3	256,699.8	267,018.1
Annual Expenditures on Leisure	38,765.2	34,876.2	28,791.8	27,987.9
CPI (base=2006)	97.8920	2.0554	97.9659	2.0557
Unemployment rate	4.5562	0.6301	4.5336	0.6302
Observations	**1,002**		**1,277**	

Source: Authors' compilation.

5. Empirical Strategies and Results

To investigate the effects of higher education expansion on intragenerational social mobility, we used the difference-in-differences approach. Our empirical strategy exploited the difference between age cohorts based on the generation just before the expansion and earlier generations. Higher education expansion in Taiwan started in 1994; therefore, the first people who "benefitted" were from the sample born in 1976, who were 18 years old in 1994. The typical age to enter higher education is 18 years. The final "non-benefitted" samples included those born in 1975. To prevent the possibility of early and late enrollment students, we grouped each 5 year period as age cohorts. The final non-benefitted age cohort was born between 1971 and 1975. In our empirical analysis, the final non-benefitted age cohort was specified as a treatment group and was the most affected by the expansion policies of all the non-benefitted individuals. The effects were compared with the control group born between 1966 and 1970, which exhibited a relatively longer period in the labor market and was considered to be less affected.

The empirical data period in this study can be divided into two periods, pre- and post-expansion. We selected three comparison years: 1998, 2002, and 2006. Assuming that people born in 1975 entered the labor market, 1998 would have been the first year following entry; 2002 would have been the fifth year, and 2006 would have been the ninth year. However, 2002 was the first year that the "benefited" graduates (who entered university after 1998) entered the labor market, with 2006 being their fourth year. Therefore, the HDI difference between people entering the labor market in 2002 and 1998 represented the pre-expansion effect of social mobility changes, and that between those in 2006 and 2002 represented the post-expansion effect of social mobility changes, which are expressed as follows:

$$\textbf{Pre-expansion effect} = \left(\boldsymbol{HDI_{2002} - HDI_{1998}}\right),$$

$$\textbf{Post-expansion effect} = \left(\boldsymbol{HDI_{2006} - HDI_{2002}}\right).$$

5.1 A difference-in-difference empirical model

To illustrate our empirical strategy, we start with a conceptual model. We assume that the change in social class H (i.e., HDI) of an individual who is born in 1966–70 (indicated by 6670) or 1971–75 (indicated by 7175) is generated as follows:

$$H = D_{06} \times D_{7175} \times H_{11} + (1 - D_{06}) \times D_{7175} \times H_{01} + D_{06} \times (1 - D_{7175}) \times H_{10} + (1 - D_{06}) \times (1 - D_{7175}) \times H_{00} \qquad (2)$$

where D_{06} and $(1 - \mathrm{D}_{06})$ are binary indicators indicating the years 2006 and 2002, respectively, and D_{7175} and $(1 - D_{7175})$ are binary indicators indicating individuals born in 1971–75 and 1966–70, respectively. H_{pq} is the HDI value. "p" and "q" are also binary indicators. The year 2006 is indicated if p = 1 and individuals born in 1971–75

if q = 1. Otherwise, p=0 if the year is 2002 and q = 0 if individuals were born in 1966–70.

In our empirical specification, we assume that

$$H_{pq} = f_{pq}(x) + \varepsilon_H \ , \tag{3}$$

where $f_{pq}(x)$ is a deterministic function of x, x is a vector of socioeconomic characteristics (including a constant term), and ε_p is an unobservable random variable. Substituting $\mathrm{D}_{7175} = (\mathrm{D}_{6670} + \mathrm{D}_{7175}) \times \mathrm{D}_{7175}$ and $\mathrm{D}_{6670} = (\mathrm{D}_{6670} + \mathrm{D}_{7175}) \times (1 - \mathrm{D}_{7175})$ into Eq. (2) obtains the following in which $(\mathrm{D}_{6670} + \mathrm{D}_{7175})$ is a vector of 1 to propose a common item:

$$\begin{aligned} H = {} & (D_{7175} + D_{6670}) \\ & \times \{D_{06} \times D_{7175} \times f_{00}(x) + (1 - D_{06}) \times D_{7175} \times f_{10}(x) \\ & + D_{06} \times (1 - D_{7175}) \times f_{01}(x) + (1 - D_{06}) \times (1 - D_{7175}) \\ & \times f_{11}(x)\} + \varepsilon_H \\ = {} & (D_{7175} + D_{6670}) \times f_{00}(x) + D_{7175} \times [f_{10}(x) - f_{00}(x)] \\ & + (D_{7175} + D_{6670}) \times D_{06} \times [f_{01}(x) - f_{00}(x)] \\ & + D_{7175} \times D_{06} \times \{[f_{11}(x) - f_{10}(x)] - [f_{01}(x) - f_{00}(x)]\} + \varepsilon_H \end{aligned} \tag{4}$$

By parameterizing $\mathrm{f_{pq}(x)}$ to be a linear function of x and adding the subscripts i and t for the multi-year individual sample as indices to denote sample individuals and years, we rewrite Eq. (4) as follows:

$$\begin{aligned} H_{it} = {} & (D_{7175it} + D_{6670it})\beta'_0 x_{it} + D_{7175it}\beta'_1 x_{it} + (D_{7175it} + D_{6670it})D_{06it}\beta'_2 x_{it} \\ & + D_{7175it}D_{06it}\beta'_{12} x_{it} + \varepsilon_{Hit} \\ = {} & \beta'_0 x_{it} + D_{7175it}\beta'_1 x_{it} + D_{06it}\beta'_2 x_{it} + D_{7175it}D_{06it}\beta'_{12} x_{it} + \varepsilon_{Hit} \end{aligned} \tag{5}$$

Therefore, Eq. (5) is the DD equation for empirical analysis in this study, derived from the conceptual model Eq.(2), the specifications of Eq.(3), and the transforming of Eq.(4).

Based on the parameter estimates of the regression model in Eq. (5), we can compute the difference-in-differences (Δ_{Hi}), which gauges changes in the HDI level, $\Delta_{Hi} = [H_{11i} - H_{10i}] - [H_{01i} - H_{00i}]$. The Δ_{Hi} represents the HDI difference between the two years of the 1971–75 generation relative to the HDI difference between the two years of the 1966–70 generation; that is, the so-called difference-in-differences. By utilizing the parameter estimates, $\hat{\beta}$, we can construct estimates of the difference-in-differences, expressed as follows:

$$\widehat{\Delta_{Hi}} = \left[\left(\widehat{\beta_0} + \widehat{\beta_1} + \widehat{\beta_2} + \widehat{\beta_{12}}\right) - \left(\widehat{\beta_0} + \widehat{\beta_2}\right)\right] - \left[\left(\widehat{\beta_0} + \widehat{\beta_1}\right) - \left(\widehat{\beta_0}\right)\right] = \widehat{\beta_{12}}, \tag{6}$$

$\widehat{\Delta_{\mathrm{H1}}}$ represents the effects on the HDI difference between 2002 and 2006 for those born in 1971–75 relative to that between 2002 and 2006 for those born in 1966–70 (Mullahy, 1999; Kan & Lin, 2009).

We expect that the generation closest to the policy point is more negatively affected than the earlier generation. To estimate the probability of upward and downward flow after higher education expansion for the nearly benefitted sample, we specified a binary probability model with a logistic distribution:

$$Y_i = e^{X\beta} = e^{\beta'_0 x_{it} + D_{7175it}\beta'_1 x_{it} + D_{06it}\beta'_2 x_{it} + D_{7175it}D_{06it}\beta'_{12} x_{it} + \varepsilon_{Hit}} \quad , \qquad (7)$$

where Y is a binary indicator for upward or downward flow, expressed as follows:

$$\mathrm{P(Y=1)} = \mathrm{F}(X\beta) = \frac{e^{X\beta}}{1+e^{X\beta}} \ , \ \mathrm{P(Y=0)} = 1 - \mathrm{F}(X\beta) = 1 - \frac{e^{X\beta}}{1+e^{X\beta}} \ .$$

The occurrence of upward or downward mobility is defined as the mean of the HDI difference between two years being higher or lower than one standard deviation. These two terms are used to further calculate social mobility.

5.2 Empirical Results

The parameters in Eq. (8) were estimated based on the method of ordinary least squares. Our inference relied on cluster-robust standard errors, which accounted for the within-group (industries×occupations) serial correlation of the error term. According to Bertrand, Duflo and Mullainathan (2004), the cluster-robust standard errors perform well. The *se* are produced by using the cluster command in STATA, with the industries as the clusters.

We used the established pseudo-panel samples for regression analysis. The results are shown in Table 4. The difference-in-differences estimate of the HDI was $\Delta_{Hi} = -3.7330$ and reached a 95% significance level. Education years and marital status had positive effects on the HDI. Employees in the public sector had a higher HDI than employees in the private sector. The HDI was also relatively low when an individual lived in a large family. We divided the full sample into two groups–a male and a female sample. The results of the male and female pseudo-panel samples shown in Table 4 were $\Delta_{Hi} = -2.7132$ and $\Delta_{Hi} = -4.6951$, respectively. We adopted a *t*-test to examine the significance of the difference between men and women. The value of *t* was 24.3952, and it reached a 99% significance level. Women born in 1971–75 were more affected than men.

Table 4 Effects on the HDI for the Pseudo-Panel Groups

	Full Sample	Male	Female
D_{06}	–0.8416	–0.8636	–0.8448
	(1.5025)	(2.0506)	(2.1227)
D_{7175}	3.1684***	3.0007***	3.6470***
	(0.7238)	(0.9973)	(1.0702)
$D_{7175} \times D_{06}$	–3.7330**	–2.7132**	–4.6951**
	(1.6803)	(1.3126)	(2.4611)
Age	0.0282	0.0263	0.0265
	(0.0813)	(0.1121)	(0.1175)
Male	0.0213	—	—
	(0.4640)		
Education year	1.7613***	1.7752***	1.7531***
	(0.1677)	(0.2225)	(0.2530)
Marital status	4.8122***	5.3661***	4.0958***
	(10.6210)	(0.8619)	(0.8905)
Private sector	6.2140*	5.1981	7.0117*
	(3.4554)	(5.7242)	(0.2649)
Public sector	7.1808**	5.5582	8.6456**
	(3.5180)	(5.7991)	(3.9953)
Employment	0.2836	–0.5892	–0.3189
	(3.4079)	(5.6364)	(3.8338)
No. of adults	–2.5970***	–2.5021***	–2.9310***
	(0.2306)	(0.3163)	(0.3402)
No. of children	–2.6321***	–2.0611***	–3.3397***
	(0.3714)	(0.4973)	(0.5370)
R^2	0.58	0.59	0.58
Observations	2,275	1,219	1,056

Notes: ***: p<.001; **: p<.01; *: p<.05.

Regressions also control the employment identities, industries, occupations, locations, CPI, and unemployment rate.

Source: Authors' estimations.

We further measured the occurrence of upward or downward flow. We employed a binary probability model with a logistic distribution to estimate the effects of expansion on the final non-benefitted age cohort. A dependent variable indicating whether an upward or downward trend occurred (1), or did not occur (0), was created for the model. In addition, our regressions considered individual characteristics, industrial and occupation categories, and macroeconomic variables for the period under analysis. The results are presented in Table 5.

As reported in Table 5, the coefficients represent the probabilities of upward or downward flow. The difference-in-differences estimators were the coefficients of the interaction term, D7175 × D06. In the full pseudo-panel samples, the probability of upward flow for those born in 1971–75 during 2002-2006 decreased by 41.59%. The

probabilities for the male and female samples decreased by 40.08% and 43.13%, respectively. This result helped us to observe the asymmetry of upward and downward flow. However, the downward flow results were the opposite of those for upward flow. The probability of downward flow from 2002-2006 for those born in 1971–75 increased by 166.16%. The probabilities for the male and female samples increased by 101.64% and 202.37%, respectively, implying that education expansion dampened the power of upward mobility for those born in 1971–75 relative to those born in 1966–70 but strengthened downward mobility for those born in 1971–75 relative to those born in 1966–70.

Table 5 Marginal Effects of the Logistic Model for the Pseudo-Panel Groups

	Full Sample	**Males**	**Females**
Up flow:			
D_{06}	–0.2233**	–0.3907***	–0.0126
	(0.0993)	(0.1107)	(0.1796)
D_{7175}	0.3243**	0.3312	0.3632*
	(0.1708)	(0.2405)	(0.2041)
$D_{7175} \times D_{06}$	–0.4159***	–0.4008**	–0.4313**
	(0.1036)	(0.1494)	(0.1446)
Log pseudo-likelihood	–1391.3626	–721.4028	–662.8185
Down flow:			
D_{06}	0.3884**	0.5350**	0.2221
	(0.1816)	(0.2176)	(0.2807)
D_{7175}	–0.8851***	–0.8451***	–0.9417***
	(0.0414)	(0.0645)	(0.0431)
$D_{7175} \times D_{06}$	1.6616***	1.0164***	2.0237***
	(0.2083)	(0.3338)	(055602)
Log pseudo-likelihood	–715.1452	–403.1002	–309.3882
Observations	2,275	1,219	1,056

Notes: All of the coefficients in this table have been converted to the marginal probability value, odds ratio. ***: p<.001; **: p<.01; *: p<.05.

Source: Authors' estimations.

5.3 Extensions of Mobility Variables

We further identified the effect of Taiwan's education expansion policy on ***SF***, ***net social flow*** (NSF), and ***churning flow*** (CF). We extended the definition of worker flow in the labor market and defined the terms as follows (Davis & Haltiwanger, 1992; Burgess, Lane, & Stevens, 2000; Kan & Lin, 2011).

SF measured all social status changes of individuals in a society and was equal to the sum of individuals who exhibited upward or downward flow divided by the average

number of individuals in period *t*:

$$SF_t = \frac{UP_t + DOWN_t}{Size_t} \times 100 \quad , \tag{8}$$

where UP_t and $DOWN_t$ denote total upward or downward flow during period *t*, respectively, and $Size_t$ equals the number of individuals in period *t*.

NSF refers to the absolute value of the change in ***SF***, which is equivalent to the gross changes in upward and downward flow, expressed as

$$NSF_t = \frac{UP_t - DOWN_t}{Size_t} \times 100 \quad . \tag{9}$$

If $NSF_t > 0$, $UP_t > DOWN_t$, otherwise, $UP_t < DOWN_t$.

CF is defined as SF in excess of NSF. The CF rate is computed as follows:

$$CF_t = SF_t - NSF_t \quad . \tag{10}$$

This represents the difference between the ***SF*** and ***NSF*** rates. Churning arose from downward flow and represented the degree of stratification disturbance in a society.

The results are displayed in Table 6. For the full pseudo-panel samples, the ***SF*** maintained stability from 2002 to 2006, but the ***NSF*** decreased from 71% to 35%, inducing a decrease in the sample of those born in 1966–70 from 75% to 50% and in the sample of those born in 1971–75 from 68% to 28%. The decreased ***NSF*** represented an increase in downward flow, particularly for the sample of those born in 1971–75, which led to an increase in the ***CF*** (to 42%).

For the male pseudo-panel samples, the ***SF*** decreased slightly in 2006, but the ***NSF*** decreased from 76% to 37%, inducing a decrease in the sample of those born in 1966–70 from 83% to 50% and in the sample of those born in 1971–75 from 70% to 31%. The ***CF*** for the sample of those born in 1971–75 was 40%. Unexpectedly, the ***SF*** of the female samples increased slightly in 2006, but the ***NSF*** decreased, particularly for the sample of those born in 1971–75, which also recorded the highest ***CF*** (46%) in 2006.

Table 6 The Social Mobility for the Pseudo-Panel Groups

	Full Sample			Males			Females		
Year	***SF***	***NSF***	***CF***	***SF***	***NSF***	***CF***	***SF***	***NSF***	***CF***
2002	73%	71%	2%	78%	76%	2%	68%	66%	2%
2006	71%	35%	36%	75%	37%	32%	70%	34%	36%
1966-70:									
2002	77%	75%	2%	83%	83%	0%	69%	66%	2%
2006	75%	50%	25%	77%	50%	27%	71%	50%	21%
1971-75:									
2002	70%	68%	2%	74%	70%	2%	67%	65%	2%
2006	70%	27%	42%	71%	31%	40%	69%	23%	46%

Source: Authors' estimations.

The estimate in Table 6 accounts for observing the total flow of the overall society, which is an observation of an overall market. We can see that after the expansion of education for the 1971–75 generation, a clear decline exists in ***NSF*** compared with earlier generations. Even if the total flow of society (***SF***) was not much different, the decline in ***NSF*** for the generations across education expansion became severe, and the amount of upward mobility was relatively reduced. Therefore, we expected that the decline in ***NSF*** for generations after the expansion of education may be more severe.

6 Conclusions and Policy Implications

This study investigated the effects of education expansion on social mobility for the final non-benefitted age cohort. Although an increased level of education might improve individual performance, it might also negatively affect society if education expands rapidly. We adopted the HDI as a comprehensive index of social class to avoid the overemphasis on income present in the literature, and defined three social mobility indicators to measure the flow of intragenerational mobility. We discussed the expansion of higher education in Taiwan as designed by the Ministry of Education.

We used individual-level data from the TFIES for 1998, 2002, and 2006, and analyzed it using a difference-in-differences regression model for pseudo-panel groups. The results indicated that the impact of higher education expansion in Taiwan was negatively related to social mobility. Our conjecture was supported by empirical

evidence and consistent with the related literature. The negative impact of education expansion on social mobility for the final non-benefitted age cohort (1971–75) was larger than that of the earlier samples (1966–70).

We suggested that the final non-benefitted individuals experienced a greater negative impact from the expansion policy on social mobility than the earlier samples because of the effects of dilution. As numerous higher education graduates enter into the labor market, the labor force of the same skill level l increases, thereby diluting the advantages of higher education for "junior" laborers. This is akin to a rapid increase in the amount of water in a reservoir, causing pool turbidity. Consequently, social class cannot improve as expected and may stagnate.

It is a problem of supply and demand from an economics viewpoint. The expansion of higher education has made it hard for demand to catch up with the speed of the increase in supply, resulting in excess supply. The decline in wages is greater than the improvement in education and quality of life, and thus the social class is stagnant or reduced. Furthermore, due to the continuous improvement of technology, the demand side may not catch up with supply because the manual demand is gradually replaced by the machine. Therefore, demand stagnates and supply increases substantially, which forms the results of the empirical analysis.

Finally, this paper proposes some policy suggestions for the expansion of higher education:

The first is that higher education must be oriented toward the "differentialized" and "unbounded." The labor market after the expansion of higher education is a competitive market, and higher education institutions must demonstrate their differences and face true university autonomy. Universities should adopt a market-oriented model to manage and cultivate the talents required in various industries. In addition, the barriers between university departments and schools should be broken to allow students to experience free and unbounded learning. If students can undertake cross-domain learning during higher education, they will be able to cope with the conditions of an uncertain future.

Second, this paper proposes that the labor market must reduce "inefficient labor." In response to the increasing number of higher education talents, we urge the upgrading of technology and services in the industry and the expansion of the economic circle to increase the demand for higher education talents. In addition, it is necessary to support young workers seeking innovate, start businesses, and expand overseas resources. The government should create higher quality living conditions and suitable work, so that the quality of workers and their quality of life can be improved together, reducing inefficient labor.

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