The Effect of Instructional Expenditure on College Graduates' Earnings: Evidence from Taiwan's Plan to Encourage Teaching Excellence in Universities

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Abstract

This paper uses Taiwan's Plan to Encourage Teaching Excellence in Universities as a natural experiment to generate an exogenous variation in instructional expenditure. This paper investigates the effects of instructional expenditure on college graduates' earnings based on the combination of data on higher education institutions' financial reports and taxation administrative records. The result suggests that government funding substantially stimulates colleges' and universities' investment in instructional expenditure. Although an increase in instructional expenditure does not benefit all graduates, it has a significant effect on helping economically disadvantaged students climb out of poverty. Increasing per-graduate instructional expenditure by NTD 100 thousand for students from low-income families leads to 3.62 percentage points increase in the likelihood of reaching the median of annual earnings.

Keywords— higher education, instructional expenditure, graduates' earnings

1 Introduction

While plenty of literature investigates the relationship between K-12 school spending and future earnings (Betts, 1996; Burtless, 2011; Grogger, 1996; Rizzuto & Wachtel, 1980), and college wage premiums (Card & Lemieux, 2001; Fortin, 2006; Katz & Murphy, 1992), few of them pay attention to the effect of higher education expenditure on labor market outcomes. The government and the society invest a great amount of money in higher education, with higher the per-student expenditure than that

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at the primary and secondary education levels (OECD, 2019).[1] Besides, given the dramatic expansion of higher education since the mid-twentieth century (Schofer & Meyer, 2005; Trow, 1972), the role of higher education has transformed from elite to mass, and even to universal education (Trow, 2010). Accordingly, higher education is not less important than K-12 education, and examining the effect of college spending is crucial.

Despite the large government investment, since the publication of the Coleman Report (1966), many studies have questioned whether education spending affects student outcomes. Hanushek (2003) reviews US and international studies on the effect of school resources on student achievement and suggests that the evidence on the effect of spending on student performance is scanty and weak. Among 163 estimates, only 27% of studies find a significant and positive effect of expenditure on student performance. Though recently, some studies (such as Hyman (2017) and Jackson, Johnson, and Persico (2015)) have found evidence supporting the effect of school spending on student achievement at the K-12 education level, the study on higher education is still insufficient.

This paper investigates the effect of instructional expenditure on college graduates' future earnings. I utilize *the Plan to Encourage Teaching Excellence in Universities* (hereinafter referred to as PETEU), a higher education funding policy in Taiwan, as a natural experiment, with the timing of receiving funding as an exogenous shifter of instructional expenditure. Employing the difference-in-differences (DID) and instrumental variable (IV) estimation methods, this paper compares the outcomes of graduates who had benefited from the plan with those of the graduates of the same colleges who had not benefited from the plan across different years to estimate the effect of instructional expenditure. The finding suggests that the effect of instructional expenditure only appears in helping individuals climb out of poverty. For graduates from economically disadvantaged families, increasing per-graduate instructional expenditure by NTD 100 thousand (around USD 3.28 thousand) leads to 3.61 percentage points increases in the likelihood of reaching the median of annual earnings (i.e., NTD 253,063/year or about USD 8,435/year). The magnitude of effect size for disadvantaged students is 5.16 times greater than rich students. These findings imply that educational investment in higher education does not have an extensive effect on all students but does benefit the underprivileged in the society.

[1] In Organization for Economic Co-operation and Development (OECD) countries, on average, per-student expenditure at tertiary level (USD 15,556) is 56% greater than the secondary level (USD 9,968) and 84% greater than the primary level (USD 8,470). In the United States, per-student expenditure at tertiary level (USD 30,165) is 118% greater than the secondary level (USD 13,845), and 148% greater than the primary level (USD 12,184) expenditures.

This paper contributes to the current literature in terms of focusing on higher education as well as employing a detailed expenditure data. Although some studies have examined the effect of school spending on students' future earnings, they have not precisely captured the variation of educational expenditure among different students. Some studies use the average school district level expenditure without including variation within single district (Grogger, 1996; Jackson et al., 2015). Some studies use individual educational institutions' expenditures but fail to include the variation across years within an institution (Behrman, Rosenzweig, & Taubman, 1996; James, Alsalam, Conaty, & To, 1989). This paper uses the data acquired from financial reports of each college and university and taxation administration records to link instructional expenditure and graduates' labor market outcomes. The plenitude of data allows this study to track institutions and individuals from 2005 to 2015, and to estimate the model by controlling for both institution and time effects, improving the estimated model and helping in understanding the effect of educational expenditure on student outcomes.

2 Previous Literature

The linkage between education and earnings has received great attention from the previous literature (Card & Krueger, 1992; Card, 1999; Psacharopoulos, 1994). Most studies focus on return to education (Duflo, 2001; Peet, Fink, & Fawzi, 2015; Psacharopoulos, 1994), and the effect of school or college attendance on employment (Angrist & Keueger, 1991; Dadgar & Trimble, 2015). Only a few studies investigate the effect of educational spending on students' future earnings (Card & Krueger, 1992; Hanushek, 1997) due to the challenge of linking data on resources of schools that the graduates attended with data on their labor market outcomes (Card & Krueger, 1996), as well as the difficulties in finding an exogenous variation of spending.

James et al. (1989) is the first literature that investigates the relationship between college quality, measured as per-student expenditure and other college characteristics, and students' annual earnings. Their result suggests no evidence supporting the effect of expenditure on students' future earnings, but they also speculate that the absence of evidence partly due to the data limitation as they could not separate research spending from teaching expenditure. Dee (2005) argues that total expenditure is too extensive to represent the quality and quantity of teaching resources since some portion of the spending does not go to teaching activities. Several studies even indicate that total school spending only has little or non-significant, even negative effect on student performance (Grogger, 1996; Wöß-

mann, 2003). Therefore, the findings by James et al. (1989), which showed that money has no effect on student earnings, can partly be explained by the combinations of teaching expenditure and other categories of spending. This paper, therefore, only includes instructional expenditure in the estimated model to precisely capture educational resource effects on student achievement.

Another previous study that focuses on college expenditure effect on future earnings is Behrman et al. (1996). They used the Minnesota Twin Registry data to address the endogeneity problem caused by unobservable factors that may affect both college choice and adult wage. They find that while both estimations acquired from the OLS and within siblings model suggest positive effects of expenditure on earnings, the within MT (Monozygotic Twins) estimation is insignificant, implying that both the OLS and results for the within siblings comparison might be upward biased. However, Behrman et al. (1996) only use expenditure data from 1975 as a representation due to the data incompleteness, even though some of their respondents attended college in the late 1960s. This data limitation not only results in imprecise estimation, but also neglects variation in expenditure within institutions (between periods). Therefore, the authors could not use fixed institution effects in eliminating other unobservable factors related to college preference. This paper, conversely, tracks the changes in the expenditure of each college or university from 2005 to 2014 in order to include variation in spending both within institutions and across years.

Disregard the level of education, the most relevant previous study to this paper is Jackson et al. (2015), which focuses on the effect of primary and secondary school spending on students' long-term outcomes. They utilize the timing of school finance reforms across different school districts as an exogenous cause of school spending to identify the causal effect of expenditure increase on students' adult earnings. Their results support the finding that increases in K-12 school spending leads to higher wage and lower probability of poverty in adulthood. However, they measure school resources at school district level instead of at the school level. Hanushek (1997) points out that the estimation of school resources effect would be upward biased as the level of aggregation increases from school level to state-level because local policies influence the level of funding as well as the school performance, and a regression analysis without controlling for the policy environment will overestimate the effect of school resources on student performance. Further, Jackson et al. (2015) focus on K-12 education and can provide little information for higher education.

3 Policy Background

The PETEU comes out of the reflection on the rapid expansion of higher education in Taiwan (Yang & Huang, 2012). The Ministry of Education (MOE) noticed that the past higher education policies had excessively emphasized on the research performance and paid too little attention to the teaching function of higher education institutions (HEIs) (MOE, 2006; Wang, Chou, & Wang, 2011). To provide incentives and resources for HEIs to enhance teaching quality, the MOE initiated PETEU in 2005 (MOE, 2006), with three phases that ended in 2017.

The PETEU invested in higher education through an incentive mechanism system of dedicated funding to promote teaching quality. HEIs which wanted to apply for the funding needed to submit a plan to the MOE and the plan had to clarify how the institution would use the funding to promote teaching quality. The MOE would decide which HEIs can qualify for funding according to the content of the submitted plans and previous performance of the institutions. The total budget within the 13 years duration was NTD 33 billion (around USD 1.1 billion). Overall, 97 of all 140 HEIs (equivalent to 69%) received funding from the PETEU, at an average of 7.6 times each, with the average funding per-institution at NTD 49.7 million (around USD 1.63 million). Not all universities received funding every year or continuously, resulting in a variation in the timing of receiving funding for different institutions. This paper assumes that no unobservable factors correlated with both the timing of receiving funding and the trend of graduates' earnings would confound the estimation. This assumption could be true because the awarded lists varied adequately during the project period as some institutions received funding in the first and third periods but missed the funding in the second period, implying some arbitrariness and randomness in the funding allocation process.

Previous studies find that the universities and colleges which received funding from the PETEU used the funding on teaching environment, system establishment and organizational reformation in HEIs (Chen & Zhang, 2016; Chi, 2008; Wang et al., 2011; Ke, 2010; Wu, 2010). For example, they improved classroom digitization, established online learning platforms (Wang et al., 2011), improved the instructional evaluation system, and included field industry experts in their curriculum committees (Yeh, 2009). The above efforts were expected to help universities enhance teaching quality, track students' performance, as well as strengthen the link between course design and labor market demand. However, no research investigates whether this extra funding and the subsequent resources improvement really brings out enhancement in students' labor market outcomes.

4 Data and Samples

This paper compiles data on HEIs funding and expenditure and links these data to individual income records. Funding data comes from the MOE of Taiwan. Expenditure data comes from annual financial reports acquired from each HEI, where the teaching expenditure recorded includes faculty salary and welfare, constructing and maintaining expenditure of instructional building, books, software, equipment, and other instructional materials. This paper combines funding and expenditure data to form panel data on per-student funding and expenditure for Taiwan HEIs annually from 2005 to 2014.

The individual-level data comes from taxation administrative record acquired from the Fiscal Information Agency (FIA), Ministry of Finance (MOF) of Taiwan. The dataset contains income data, wealth data, and tax-deductions data (includes the National Health Insurance (NHI) premiums and the educational tuition), tracking individuals from 2004 to 2015. The tuition data helps to match graduates with the HEIs they graduated from. The key outcome variables are annual earnings and average monthly earnings. This paper constructs annual earnings by summing each individual's income from profit, income from professional practice, and income from salaries and wages. Average monthly earnings equal to the total amount of annual earnings divided by the number of employment months for each individual.

The taxation dataset does not contain information on the number of months of employment, so this paper uses the data on the NHI premium to estimate individuals' number of months of employment. Taiwan has a universal and compulsory National Health Insurance system, and any Taiwanese national is required to participate in the NHI system. According to the regulation, all employed people should enroll in the NHI through the agencies, schools, enterprises, institutions, or employers, which they work for, or the unions or association where they hold membership. Each individual's duration of employment in months is estimated by calculating the durations of different insurance groups that he/she participate in.

The institution level samples for this paper are the HEIs, which are qualified to apply for funding from the PETEU. In order to construct a balanced panel dataset, this paper excludes HEIs which were newly founded, closed or merged with another HEI in the observation period (from year 2005 to 2014). The total number of institutions included in the sample is 122. The treatment group contains HEIs which had received funding from the PETEU at least once while the control group includes

HEIs, which never received funding in the observation period (from year 2005 to 2014).

The individual-level samples are undergraduate students who graduated from the spring semester of 2010 to the spring semester of 2014 (thus, they enrolled in HEIs from the fall semester of 2006 to the fall semester of 2010). This paper aims to identify expenditure effects on students who are going to participate in the labor market, so students who attended graduate school are excluded from the samples. The final dataset includes 5 generations of graduates that enrolled in and graduated from the HEIs in different years. This design creates variations in the amount of instructional expenditure within the same institutions between different years as well as within the same year between different institutions.

5 Empirical Design

The aim of this study is to identify the causal effect of instructional expenditure on graduates' earnings. The main concern of such estimation is the endogenous problem that some unobservable factors which affect students' achievement are correlated with educational spending. The basic method of dealing with endogeneity is to find an exogenous variation from controlled or natural experiments (Webbink, 2005). This paper employs instrumental variables (IV) estimation methods and uses the PETEU as a natural experiment to create an exogenous variation in teaching expenditure. The underlying assumption is that the timing of receiving funding is not correlated with student outcomes. This paper estimates the following equations using the method of two-stage least squares (2SLS):

$$Y_{ijk} = \alpha_0 + \alpha_1 \widehat{Expenditure}_{jk} + \Pi X_i + \delta_j + \delta_k + Type_j \cdot \delta_k + \varepsilon_{ijk} \tag{1}$$

$$Expenditure_{jk} = \beta_0 + \beta_1 Funding_{jk} + \Phi X_i + \zeta_j + \zeta_k + Type_j \cdot \zeta_k + \nu_{ijk} \tag{2}$$

Where Y_{ijk} is the interested outcomes of individual i graduating from HEI j in school year k. The outcome variables are annual and monthly earnings of the graduates at one and a half years after their graduation. These variables include continuous variables of annual earnings and average monthly earnings, as well as dummy variables which indicate whether an individual earns more than the median. $Expenditure_{jk}$ is the cumulatively per-student instructional expenditure from enrollment to graduation for individuals graduating from HEI j in school year k. In the second stage, Eq. 1 uses the predicted per-student expenditure acquired from Eq. 2 instead of the actual value to estimate the

equation. $Funding_{jk}$, is the cumulative amount of per-student funding received from the PETEU for HEI j from school year $k-3$ to k. δ_j and ζ_j are institution fixed effects, a set of dummy variables that indicates which institution the individual graduating from. These variables absorb the factors correlated with time-invariant institutions' characteristics (such as the reputation and ranking of the universities). δ_k and ζ_k are year fixed effects, a set of dummy variables that indicates which year the individual graduated in. These variables absorb the factors related with graduation year (such as the economic environment and nationally wide policy). $Type_j \cdot \delta_k$ and $Type_j \cdot \zeta_k$ are the interaction terms between types of institutions (i.e., public/private and general/vocational) and the year fixed effects. These variables absorb the factors which are related to graduation year and have heterogeneous effects on graduates from different types of institutions. X_i is a vector of control variables including personal, family, and peer characteristics. ε and ν are error terms.

This study combines a difference-in-differences (DID) design in the first stage with the 2SLS estimation method. Since different institutions change their treatment status at disparate years, this study follows Jackson et al. (2015), directly using the variable $Funding$ to define treatment status as well as to include fixed year and fixed institution effects. Students who graduated from institutions that never received funding from the PETEU are the control group while students who graduated from institutions that were ever affected by the project are the treatment group. In the treatment group, students who enrolled in the institution in different years have different treatment status because not all the institutions received funding every year. For those students in the treatment group, the ones who enrolled in and graduated from their HEIs before the institutions received any funding were unaffected by the project. In contrast, graduates who graduated from their HEIs after the institution had received the funding would benefit from the project. The number of years for which each graduate was affected by the project depends on the exact school year, in which he/she enrolled in and graduated from their HEIs.

This paper then compares the difference in teaching expenditure per-student between students who benefited from the funding and those who did not benefit from the funding. To account for any underlying differences that may arise as a result of the year of graduation, this paper compares the differences in expenditure within the same graduation year between the institutions which received funding and those that never received funding in that year. The difference in expenditure between the affected and unaffected graduates in the treatment group minus the difference in expenditure in

the same graduation year in the control group yields a DID estimate of the effect of the PETEU on instructional expenditure.

6 Results

6.1 Descriptive Statistics

Table 1 presents basic descriptive statistics for the graduates' sample. The full sample includes 46% male and 54% female participants. Regarding the treatment and instrumental variables, the mean per-student instructional expenditure (the cumulative amount for 4 years) is NTD 465,607 (around USD 15,196). This amount is considerable because the average tuition expenditure for a 4-years undergraduate program is around NTD 200 thousand for public HEIs and NTD 400 thousand for private HEIS in Taiwan. In other words, students get much more than the amount they have paid. The average per-student for students who ever received funding from the PETEU was NTD 17,578 (around USD 574). This amount only accounts for a trivial 3.8% of total instructional expenditure.

Table 1: Descriptive Statistics of Graduates Sample (N = 518,281)

	Male (N=238,703)		Female (N=279,578)		All (N=518,281)	
	Mean	SD	Mean	SD	Mean	SD
Treatment Variables						
Per-Student Instructional Expenditure	473,419	107,744	458,936	112,283	465,607	110,452
Per-Student Funding	12,593	11,903	12,149	11,717	12,353	11,805
Per-Student Funding (Exclude 0)	18,137	10,174	17,111	10,415	17,578	10,318
Outcome Variables						
Annual Earnings	250,244	211,212	265,660	204,729	258,560	207,882
Average Monthly Earnings	31,828	27,051	30,242	24,592	30,955	25,739
Number of Months Employed	7.9468	4.739	8.8342	4.5035	8.4255	4.6346
% of Employed	0.8165	-	0.8532	-	0.8363	-
Control Variables						
Parental Income (NTD)	822,421	1,440,632	813,065	1,692,734	817,374	1,581,629
Parental Wealth (NTD thousands)	18,851	73,576	17,330	58,179	18,030	65,724
Peers' Average Parental Income	811,024	286,962	838,910	293,142	826,067	290,644
Mother is Married	0.8386	-	0.831	-	0.8345	-
Number of Sibling	2.4986	0.7976	2.6846	0.8797	2.5989	0.848

Note: Dollars are converted into 2016 real NT dollars using CPI.

Regarding the outcome variables, the mean of annual earnings at the observation year (one and a half years after graduation) of the samples is NTD 250,244 (around USD 8,167) for males and NTD 265,660 (around USD 8,670) for females. The mean of average monthly earnings is NTD 31,828 (around USD 1,039) for male and NTD 30,242 (around USD 987) for Female. Females on average earn lower monthly earnings but higher annual earnings than males because Taiwanese males are required to serve in the military for one year after graduating from universities.

6.2 The Effect of Government Funding on Instructional Expenditure

Figure 1 presents the average amount of per-student expenditure by different groups of HEIs from school year 2004 to 2013. In order to compare the previous amount of expenditure with the expenditure after the policy intervention, the treatment group in Figure 1 only includes HEIs which received funding from 2009 to 2013. The control group includes the HEIs which never benefited from the PETEU from 2004 to 2013.

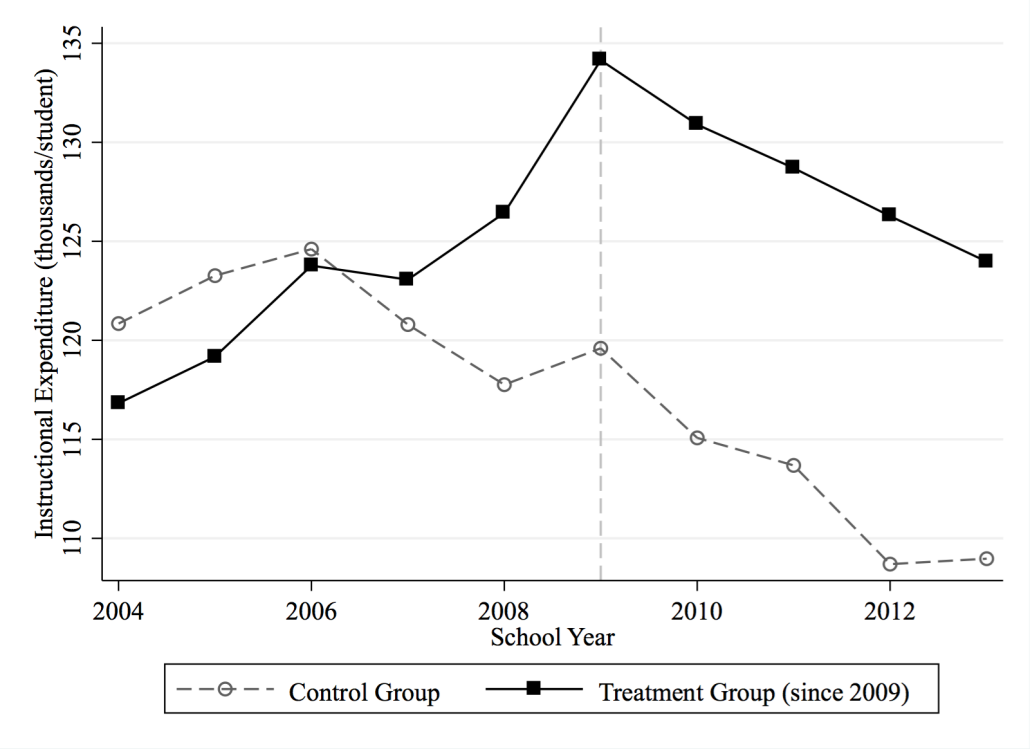

Figure 1: The amount of per-student instructional expenditure by two groups, school year 2004–2013.
Note: Expenditures are converted into 2016 real NT dollars using CPI.

Prior to 2009, the average amount of per-student instructional expenditure for the treatment group is almost the same as that for the control group (NTD 121 thousand for the control group and NTD 117 thousand for the treatment group). However, the amount of per-student instructional expenditures for

the treatment group experienced an obvious jump in 2009 (NTD 120 thousand for the control group and NTD 134 thousand for the treatment group), and the gap between these two groups also increased after the PETEU intervention. In other words, the evidence supports the hypothesis that increase in government funding leads to an increase in instructional expenditure of HEIs.

Table 2 examines the relationship between government funding and instructional expenditure more formally by regressing instructional expenditure on government funding. Panel A shows the result based on the institution level sample, and Panel B displays the result based on the individual samples. Though the effect of government spending on educational resources allocation happens at institutions level, the effects of instructional spending on students' future earnings happen at the individual-level. Therefore, Table 2 presents both institution- and individual-level results, and the estimations of the effects on earnings in the next section would be based on the results acquired from individual samples.

Table 2: First Stage: The Effect of PETEU Funding on Instructional Expenditure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	OLS	DID	Public	Private	General	Vocational
Panel A: Institution Level								
Funding (NTD)	4.0346***	3.3872***	1.5662***	1.8568***	1.2837***	2.3364***	1.0437	3.2025***
	(0.3179)	(0.2667)	(0.3941)	(0.3859)	(0.2964)	(0.5819)	(0.6418)	(0.4095)
Observations	122	122	122	122	32	90	53	69
Panel B: Individual-Level								
Funding (NTD)	3.8050***	3.6162***	1.6277 ***	2.2423***	1.3335	2.5764***	1.3207**	3.1597***
	(0.7258)	(0.6775)	(0.7765)	(0.6563)	(0.8682)	(0.8276)	(0.5845)	(1.0892)
Observations	518,281	518,281	518,281	518,281	87,191	431,090	245,705	272,576
Institution Control		V	V	V	V	V	V	V
Institution Fixed Effect			V	V	V	V	V	V
Year Fixed Effect				V	V	V	V	V
Institution Type # Year				V	V	V	V	V

Note: The samples are the undergraduate students graduating from Taiwan HEIs from 2008 to 2013. The key treatment variable, *Funding*, is the cumulative (from enrollment to graduation) per-student funding received from the PETEU. Institution control variables are: type of institutions (public/private and general/vocational) and location of institutions. Robust standard errors are in parentheses (cluster at institution level).
$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

Panel A presents the intuition-based estimations. Without including any covariate, the simple regression shows that a dollar increase in per-graduate funding from the PETEU leads to a 4.0346 dollars' increase in per-graduate instructional expenditure (column 1). Adding institutional control

variables, the point estimate decreases slightly to 3.3872 (column 2). After including institution fixed effects, the point estimate reduces to 1.5662 (column 3). The DID estimation (further include year fixed effects as well as the interaction term between the types of institutions and the year) is 1.8568 (column 4), indicating that the effect of a dollar finding on increase in spending is greater than a dollar.

Panel B presents the results of individual samples. Similar to the estimations acquired from institution level samples (Panel A), the coefficients reduce when more covariates are included. The DID estimation indicates that a dollar increase in government funding results in a 2.2423 dollars' increase in instructional expenditure (column 4). Once again, the evidence supports a strong stimulation effect of government funding on institutions' spending.

Next, column 4 to 7 split the samples according to the types of institutions (public or private institution) and the tracks of the programs (general/academic or vocational track). The point estimates vary across different categories of institutions, with private institutions having stronger responses than public ones, and vocational institutions responding more strongly than the general ones. However, the comparatively small sample size leads to an increase in standard errors, leading to insignificance of some estimates. The number of institutions is 122 for the full sample, but only 32 to 90 for each subgroup.

6.3 The Effect of Instructional Expenditure on Earnings

Table 3 presents the estimated results of the instructional expenditure effect on graduates' earnings. The treatment variable is the cumulative per-student instructional expenditure from enrollment to graduation (i.e., the total amount of instructional expenditure spent on a student for his/her 4-year study). The outcome variables are the earnings of each individual at one and a half years after his/her graduation. Panel A displays the results of annual earnings; Panel B displays the results of monthly earnings; Panel C displays the results of individual earnings reaching the median of annual earnings (i.e., NTD 253,063/year or about USD 8,435/year); Panel D displays the result of individual earnings reaching the median of monthly earnings (i.e., NTD 28,097/month or about USD 937/month).

Table 3: The Effects of Instructional Expenditure on Graduates' Earnings

	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	OLS	2SLS
Panel A: Annual Earnings					
Expenditure (NTD)	0.1496***	0.0894***	-0.0144	-0.0306	0.0305
	(0.0561)	(0.0268)	(0.0300)	(0.0341)	(0.0657)
Observations			518,281		
Control Group Mean			244,271		
First Stage F					11.8943
Panel B: Monthly Earnings					
Expenditure (NTD)	0.0157***	0.0107***	0.0011	-0.0026	0.0032
	(0.0055)	(0.0018)	(0.0025)	(0.0025)	(0.0063)
Observations			433,431		
Control Group Mean			29,592		
First Stage F					12.0603
Panel C: Reaching the Median of Annual Earnings					
Expenditure	0.0133**	0.0128**	0.0007	-0.0017	0.0226
(NTD 100 thousand)	(0.0065)	(0.0053)	(0.0054)	(0.0058)	(0.0150)
Observations			518,281		
Control Group Mean			0.4673		
First Stage F					11.8943
Panel D: Reaching the Median of Monthly Earnings					
Expenditure	0.0258***	0.0265***	0.0147**	-0.0014	0.0283**
(NTD 100 thousand)	(0.0097)	(0.0053)	(0.0060)	(0.0051)	(0.0143)
Observations			433,431		
Control Group Mean			0.4539		
First Stage F					12.0603
Individual Control		V	V	V	V
Institution Fixed Effect			V	V	V
Year Fixed Effect				V	V
Institution Type # Year				V	V

Note: The key treatment variable, *Expenditure*, is the cumulative (from enrollment to graduation) per-student instructional expenditure. The instrumental variable (in column 5) is per-graduate funding (the cumulative per-student funding received from the PETEU). The outcome variable is the earnings status one and a half years after graduation. Individual control variables are: gender, field of study, mother's marital status, parental income, parental wealth, number of siblings, birth place, and average parental income of peer. Robust standard errors are in parentheses (cluster at institution level).
$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

Among all outcome variables, the OLS estimated results without including fixed institution effects (column 1 and 2) are all positive and significantly different from zero. However, once the fixed

institution effects are added, the point estimates reduce, indicating upward biased OLS estimations. According to the preferred results acquired from 2SLS (column 5): instructional expenditure has no significant effect on annual earnings or monthly earnings, and on the likelihood of earnings reaching the median of annual earnings. The effect only exists in the likelihood of earnings reaching the median of monthly earnings. As presented in Panel D column 5, on average, increasing per-graduate instructional expenditure by NTD 100 thousand enhances the likelihood of reaching the median of monthly earnings by 2.83 percentage points (equivalently to 6.23% of the control group mean).

The effect on annual earnings could be decomposed into the effect on monthly earnings and the effect on employment intensity. The above estimated results provide no evidence of spending effect on annual earnings but support the effect on monthly earnings, implying that instructional expenditure probably has no effect on employment intensity, so the effect on monthly earnings does not reflect on the annual earnings.

6.4 Heterogeneous Effects

The main result suggests that enhancing instructional expenditure only leads to increased likelihood of reaching the median of monthly earnings, but has no effect on other earnings outcomes. However, the effect of expenditure on labor market outcomes is likely to be quite heterogeneous. This section explores the heterogeneous effects of instructional expenditure by investigating whether students who have different family backgrounds and have been enrolled in different fields/institutions experience the same magnitudes of instructional expenditure effects. Table 4 reports the results of the subgroup analysis. Column 1 and 2 separate graduates according to their family income (below or above the median, i.e., NTD 521,109); Column 3 and 4 separate graduates according to their birth location (rural or city); Column 5 and 6 separate graduates according to their major fields, denoting whether they received Bachelor of Arts (B.A.) or Bachelor of Science/Engineer (B.S./B.E.); Column 7 and 8 separate graduates according to their institution type (general track or vocational track).

Panel A and B examine the instructional expenditure effects on annual and monthly earnings. Though all coefficients are not significantly different from zero, the point estimates are all positive and higher for graduates from disadvantaged families (i.e., low-income families and born in rural areas) and vocational institutions while almost all are negative and lower for graduates from advantaged families (i.e., high-income families and those born in cities) and general institutions.

Table 4: Subgroup Analysis by Family Income, Birth Location, Major Fields and Institution Types

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Family Income		Birth Location		Degree		Institutions Type	
	Poor	Rich	Rural	City	B.A.	B.S. / B.E.	General	Vocational
Panel A: Annual Earnings								
Expenditure (NTD)	0.0923	-0.0445	0.0642	0.0005	0.0098	0.0235	-0.0946	0.0693
	(0.0646)	(0.1043)	(0.0744)	(0.0781)	(0.1115)	(0.0574)	(0.1981)	(0.0560)
Observations	259,140	259,141	220,028	298,253	241,759	192,747	245,705	272,576
Control Group Mean	234,956	254,514	242,099	246,117	235,950	255,701	258,161	234,186
First Stage F	11.5072	11.8338	10.5899	9.4457	6.2689	13.2124	5.0278	8.5218
Panel B: Monthly Earnings								
Expenditure (NTD)	0.0068	-0.0019	0.0113	-0.0038	0.0078	0.0009	-0.0075	0.0065
	(0.0088)	(0.0098)	(0.0087)	(0.0080)	(0.0124)	(0.0060)	(0.0173)	(0.0062)
Observations	219,429	214,002	185,328	248,103	201,592	162,232	200,002	233,429
Control Group Mean	28,489	30,810	28,925	30,163	28,816	30,363	31,373	28,330
First Stage F	11.7354	11.9797	10.7316	9.5903	6.5081	13.2443	5.2465	8.6223
Panel C: Reaching the Median of Annual Earnings								
Expenditure	0.0361**	0.0070	0.0295*	0.0172	0.0138	0.0216	0.0307	0.0175
(NTD 100 thousand)	(0.0172)	(0.0189)	(0.0165)	(0.0188)	(0.0261)	(0.0178)	(0.0339)	(0.0157)
Observations	259,140	259,141	220,028	298,253	241,759	192,747	245,705	272,576
Control Group Mean	0.4534	0.4826	0.4602	0.4734	0.4620	0.4920	0.4846	0.4548
First Stage F	11.5072	11.8338	10.5899	9.4457	6.2689	13.2124	5.0278	8.5218
Panel D: Reaching the Median of Monthly Earnings								
Expenditure	0.0287*	0.0266	0.0190	0.0362**	0.0268	0.0272	0.0340	0.0226
(NTD 100 thousand)	(0.0160)	(0.0188)	(0.0165)	(0.0170)	(0.0220)	(0.0171)	(0.0308)	(0.0148)
Observations	219,429	214,002	185,328	248,103	201,592	162,232	200,002	233,429
Control Group Mean	0.4352	0.4725	0.4452	0.4596	0.4358	0.4862	0.4016	0.4224
First Stage F	11.7354	11.9797	10.7316	9.5903	6.5081	13.2443	5.2465	8.6223

Note: The key treatment variable, *Expenditure*, is the cumulative (from enrollment to graduation) per-student instructional expenditure. The instrumental variable is per-graduate funding (the cumulative per-student funding received from the PETEU). The outcome variable is the earnings status at one and a half years after graduation. All columns include the same covariates as in Table 3 column 5. Robust standard errors are in parentheses (cluster at institution level).
$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

Panel C reports the effects on reaching the median of annual earnings, indicating that instructional expenditure presents heterogeneous effects between different groups of graduates. The point estimate of the instructional effect on the likelihood of reaching the median of annual earnings is 0.0361 (Panel C, column 1) for graduates from poor families, which is positive and significantly different from zero. That is, on average, an increase of NTD 100 thousand in instructional expenditure results in a 3.61 percentage points increase in the likelihood of reaching the median of annual earnings, equating to 7.96% of the control group mean. In contrast, for graduates from rich families, the coefficient is 0.007 (Panel C, column 1), which is not significantly different from zero. In other words, the effect size for

graduates from poor families is 5.16 times the one for graduates from rich families. Similarly, the estimated instructional effect on the likelihood of reaching the median of annual earnings is positive and significant for graduates from rural regions while not significant for graduates born in cities. The effect size for rural students is 1.72 times that for city students.

Panel D displays the results of reaching the median of monthly earnings. Though the coefficient is significant for poor students but insignificant for rich students, the difference between the two estimates is trivial. The point estimate is 0.0287 for poor students (column 1) and 0.0266 for rich students (column 2), both nearing the main result of 0.0283, supporting no heterogeneous effects. Regarding the birth location, converse to the result in the case of monthly earnings, the instructional effect on gaining high monthly earnings is insignificant for rural students but significant for city students. All estimated results for degree and institution type subgroups are insignificant.

6.5 Robustness Check

The timing of receiving funding varies across institutions; some institutions even received the funding occasionally and discontinuously. This pattern results in no clear policy intervention boundary in the DID estimation, and may cause some inaccuracy in the estimation. To deal with this concern, this paper conducts a robustness check by only including HEIs, which receive funding continuously (i.e., receive funding at a certain time and is never interrupted before the end of the observation period) in the treatment group. Table 5 presents the results.

Similar to the main result, the OLS estimation without fixed institution effects were positive and significant while the point estimates reduced after applying the DID covariates. Column 5 reports the 2SLS estimation results with all insignificantly different from zero. The main results showed a significantly positive effect of expenditure on higher monthly earnings, at a point estimate of 0.0283 (Table 3, Panel D, column 5). Though the counterpart coefficient here becomes insignificant, the point estimate, which is 0.0271 (Table 5, Panel D, column 5), is close to the main result. Since the number of institutions decreases when only the HEIs that receive funding continuously are included, the standard error increases, leading to an insignificant result. However, given the similar point estimate, the finding is still robust.

Table 5: Robustness Check: Samples Receiving Funding Continuously

	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	OLS	2SLS
Panel A: Annual Earnings					
Expenditure (NTD)	0.1967**	0.1149***	-0.0252	-0.0570	-0.0110
	(0.0800)	(0.0258)	(0.0410)	(0.0457)	0.1017
Observations			383,294		
Control Group Mean			244,271		
First Stage F					7.6843
Panel B: Monthly Earnings					
Expenditure (NTD)	0.0181**	0.0113***	0.0002	-0.0037	0.0039
	(0.0082)	(0.0021)	(0.0037)	(0.0036)	(0.0096)
Observations			321,103		
Control Group Mean			29,592		
First Stage F					7.7941
Panel C: Reaching the Median of Annual Earnings					
Expenditure	0.018**	0.0183***	0.0008	-0.0049	0.0132
(NTD 100 thousand)	(0.0086)	(0.0058)	(0.0067)	(0.0067)	(0.0194)
Observations			383,294		
Control Group Mean			0.4673		
First Stage F					7.6843
Panel D: Reaching the Median of Monthly Earnings					
Expenditure	0.0261*	0.029***	0.0123	-0.0062	0.0271
(NTD 100 thousand)	(0.0137)	(0.0064)	(0.0077)	(0.0058)	(0.0209)
Observations			321,103		
Control Group Mean			0.4539		
First Stage F					7.7941
Individual Control		V	V	V	V
Institution Fixed Effect			V	V	V
Year Fixed Effect				V	V
Institution Type # Year				V	V

Note: The key treatment variable, *Expenditure*, is the cumulative (from enrollment to graduation) per-student instructional expenditure. The instrumental variable (in column 5) is per-graduate funding (the cumulatively per-student funding received from the PETEU). The outcome variable is the earnings status at one and a half years after graduation. Individual control variables are: gender, field of study, mother's marital status, parental income, parental wealth, number of siblings, birth place, and the average parental income of peer. Robust standard errors are in parentheses (cluster at institution level).

$^{*}p < 0.1$ $^{**}p < 0.05$ $^{***}p < 0.01$

7 Discussion and Conclusion

This paper uses the PETEU as a natural experiment that generates an exogenous variation in spending to estimate the effect of instructional expenditure on graduates' earnings. To link educational resources and individual labor market outcomes, this study combines HEIs' financial reports and the taxation administrative data. The DID estimation suggests that government funding significantly increases instructional expenditure, and the magnitude of the effect is considerable. On average, a dollar extra funding leads to 1.86 dollars increase in instructional expenditure. This result implies that the effect of government funding on stimulating expenditure is not crowded out by reductions in other sources of revenue, in consistence with previous studies (Card & Payne, 2002; Goodspeed, 1998; Hyman, 2017; Lafortune, Rothstein, & Schanzenbach, 2018).

Regarding the effect of instructional expenditure on earnings, this paper finds: First, the increase in instructional expenditure does not lead to an improvement in students' annual and monthly earnings. The estimated results do not change even when only the institutions that receive funding continuously (therefore, are supposed to experience a stronger effect), are included. The result is consistent among different subgroups of family backgrounds, fields of study, and institution types.

Second, the results support the effects of instructional expenditure on enhancing the likelihood of reaching the median of monthly earnings. Specifically, increasing per-graduate instructional expenditure by NTD 100 thousand (accounts for around 20% of instructional expenditure) leads to 2.83 percentage points increases in the likelihood of reaching the median of the monthly earnings. However, no evidence supports the effect of expenditure on enhancing the likelihood of reaching the median of annual earnings, leaving inconsistencies between the estimations between annual and monthly earnings. To get high annual earnings, the individual should get both a fair level of salary and stable employment status. Nevertheless, half of the graduates did not work for more than 10 months over the observed period. The effect on salary, therefore, does not reflect on annual income. Considering the inconsistent results between treating earnings as a continuous variable and as a dummy variable (indicating whether an individual reached the median), the explanation could be that the relationship between teaching resources and earnings is not linear. Overall, this paper supports no evidence on the stably linear effect of educational resources in higher education on students' future earnings. The effect of instructional expenditure only exists in a particular case that helps students get higher income than the median.

Third, the effects of the expenditures on higher annual earnings are more obvious and greater for students from disadvantaged families and rural regions, than students from non- poor families and city regions. For students from families where the parents' income is lower than the median, increasing per-graduate instructional expenditure by 100 thousand leads to a 3.61 percentage points increase in the likelihood of getting annual earnings greater than the median. The magnitude of effect size for disadvantaged students is 5.16 times greater than non-poor students. Similarly, the magnitude of effect size for rural students is 1.72 times greater than city students. Educational investment benefits disadvantaged students more than it benefits advantaged students, as reported by Jackson et al. (2015). Brand and Xie (2010) suggest that the individuals from disadvantaged backgrounds, or those with the lowest probability of enrolling in universities, benefit the most from higher education. The reason is that these students cannot get enough resources and cultural capital from their families so they consider education to be important for them. On the other hand, the estimation of expenditure effect on monthly earnings does not show the same pattern of favoring disadvantaged students. One possible explanation is that students from disadvantaged families have high pressure to immediately find a job after graduation while students from advantaged families do not encounter similar pressure. Hence, the effect on monthly earnings for advantaged students does not reflect on annual income.

Overall, this paper finds only limited evidence for instructional expenditure effect on graduates' future earnings, which is not aligned with Grogger (1996) and Jackson et al. (2015), who found significantly positive effects of spending in primary and secondary education. The explanation of this inconsistency could be the underlying differences between primary and higher education. Psacharopoulos (1985) indicates that primary education is the most profitable educational investment opportunity, followed by secondary education, while higher education has the smallest rate of return. Bennell (1998) investigates the rates of return on education in Asia, and he also found that the rate of return on primary education is significantly higher than the one for higher education. The reason is that primary education benefits the majority of the bottom in the society, and the difference in productivity between the illiterate and the educated people is substantial (Psacharopoulos, 1985). However, universities are attended by people who have comparably high socio-economic backgrounds. Even under the background of higher education expansion in Taiwan, students from advantaged families still have a higher probability of attending universities, particularly the selective public universities with abundant educational resources (Chang & Lin, 2015). For these people, the added-value of higher education is

probably not as considerable as primary education (Psacharopoulos, 1985; Tilak, 1989). Therefore, students may not experience great effect from the investment in universities.

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